

SATELLITE AND SPACE COMMUNICATIONS

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SSC Newsletter

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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.

Location: ICEC (Istanbul Congress & Exhibition Center), Room Sultan I

Date: Tuesday, June 13th

**Time: Start time: 12.00 p.m.
End time: 02.00 p.m.**

Future SSC Meetings

Nov. 2006 San Francisco, CA, USA
June 2007 Glasgow, Scotland, UK
Nov. 2007 Washington, D.C., USA

ICC 2006 SSC Committee Activities

TUTORIALS & WORKSHOP (June 11th and June 15th)

W01 NEWCOM Workshop on Wireless Communications

Date and Time: Sunday, 11 June, Full-Day, 8:30am-05:00pm
Chairmen: A. Polydoros, S. Palazzo, P. Duhamel

T06 Wireless Network Standards and Their Convergence

Date and Time: Sunday, 11 June, 8:30am-12:00pm
Instructor: Prof. H Anthony Chan, University of Cape Town, South Africa

T16 Traffic Engineering and Quality of Service Management for IP-based Next Generation Networks

Date and Time: Thursday, 15 June, 8:30am-12:00pm
Instructor: Prof. George Pavlou, University of Surrey, UK

W04 Workshop on IP over Broadcasting Networks

Date and Time: Thursday, 15 June, Full-Day, 8:30am-5:00pm
Chairman: Charalabos Skianis

TECHNICAL SYMPOSIA (June 12th – June 14th)

CQ-17 Performance of Wireless Networks, Wednesday 14 June, 16:00-17:30

NG-02 Transmission Techniques in NGN, Monday 12 June, 14:00-15:30

NG-03 Advanced Technologies and Applications, Monday 12 June, 16:00-17:30

NG-05 Satellites in NGN, Tuesday 13 June, 10:30-12:00

NG-11 Voice over IP in NGN, Wednesday 14 June, 16:00-17:30

NG-12(P) Topics in Next Generation Mobile Networks, Wednesday 14 June, 14:00-17:30

SP-11 Wireless Communications, Wednesday 14 June, 10:30-12:00

WC-49 Wireless Networks, Wednesday 14 June, 16:00-17:30



HOW TO JOIN SSC COMMITTEE AND MAILING LIST

If you like to join SSC Technical Committee: Please send your name and e-mail address to the SSC Secretary, optionally include your mail address, telephone and fax numbers.

If you like to join SSC Mailing List: Instructions on how to subscribe/unsubscribe are available at <http://cassius.ee.usyd.edu.au/mailman/listinfo/ssc>.

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MESSAGE FROM THE CHAIR

Abbas Jamalipour

The Satellite and Space Communications (SSC) Technical Committee (TC) members will meet again on Tuesday 13 June, at 12:00 pm in Istanbul during IEEE ICC2006. SSC TC is an international volunteer organization governed by the IEEE Communications Society. SSC has been providing a forum for technical advancement of space communications since its founding in 1962. The SSC TC meets two times a year during ICC and GLOBECOM conferences, and the meeting is a very good opportunity for all people from industry and academia with any interest in research and development in satellite and space communications. All conference attendees are welcome to attend and those who are attending the SSC TC meeting for the first time will automatically become a member of TC. Please join us to discuss mutual topics of interest in this important field in communications technology. The meeting agenda and other information about SSC TC activities and operation can be found at the TC web page:

<http://www.comsoc.org/socstr/org/operation/techcom/satellite.html>.

This will be my last message as the TC Chair. The TC officially has three officers, including Chair, Vice Chair, and Secretary. The normal term for each office is two years, and new officers are elected by the TC members. When I took the office, my goal was to continue activities in reestablishing the satellite research position among telecommunications engineers. With the help of TC members, we could achieve many goals during the past two years. We could organize and publish several special issues in prestigious journals including two in IEEE Journal on Selected Areas in Communications on the topic of broadband satellite IP. We could organize, sponsor, and co-sponsor many other symposiums, conferences, and workshops. In ICC2005 and ICC2006, the TC has co-chaired symposiums on next generation mobile networks, which ratified the importance of the satellite communication as part of next generation mobile networks. In Globecom2005, the TC has been actively involved in the largest

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symposium of the conference, the Wireless Communications Symposium, where I was the Symposium Chair. For Globecom2006, the TC could guarantee its individual symposium, and in ICC2007, we have proposed a joint symposium with two other TCs from the Communications Society. The TC members including its officers were heavily involved in other major IEEE Communications Society conferences, including WCNC and PIMRC in the past two years.

All these activities have illustrated that the satellite communications still has its irreplaceable position among other communications technologies. With several new technologies emerging to the limited mobile communications market, satellite has shown its unique capability in providing many services including broadcasting, core network interconnectivity, remote area coverage, global positioning and so on. The number and quality of technical papers submitted to these and many other venues, along with the research funds devoted to the satellite R&D around the world shows that the satellite is here to stay and it would be hard to be replaced with any other communications medium. We believe that we could achieve our goals as one of the technical forums in this field.

We will hold our TC election during the meeting on 13 June 2006 and I have already sent out a call for

candidates. Besides normal duties of the officers stated on the TC guidelines (available at SSC TC web page), the new officers will need to work hard to continue the effort in strengthening the satellite research and promoting the TC goals. The TC officers have been always relied and will rely on voluntarily helps from members.

The nomination for our next award for Distinguished Contribution to Satellite Communications is due shortly (July 15). All members are encouraged to consider this important event to nominate anyone who they know with a good contribution to the satellite research. Nomination should be forwarded to the new officers of the TC.

Finally, I would like to thank all members for their support during our term in the past two years. Without your help, we could not organize any conference or review any paper. I look forward to work with you in other occasions toward enhancing the knowledge in the field of mobile communications in general and of satellite communications in particular.

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

SCANNING THE WORLD

Mario Marchese

This is my last "Scanning the World". In conformance with my previous ones, I would like to summarize satellite research activity throughout the world in these last few months and, in particular, the activity of our committee. A good track is represented by papers submitted to Globecom'06 – SatComm, the IEEE Globecom 2006 Satellite and Space Communications Symposium, our first dedicated symposium after ICC'02. First of all, I think it is useful to have a general look about Globecom'06, including all symposia: 2538 submitted papers. Fig. 1 contains the percentage of submitted papers for each country. More specifically about our symposium: we received 75 papers. Fig. 2 reports the percentage of submitted papers for each country. While, on one hand, 75 submissions (2.95 % of the papers) are not a great result and confirm the trend of the satellite community to send scientific papers to smaller and dedicated conferences, on the other hand, the results obtained after reviewing are really excellent and can give hopes to confirm our Symposium also for next Globecom and ICC. We could accept 30 papers so getting a 40% acceptance rate, which is a little bit higher than Globecom'06 average (39%). In more detail, all the papers have

received at least 3 reviews with an average of 3.77 reviews for papers, so assuring a fair evaluation and a proper selection of the best papers. The metric to evaluate the papers is the weighted average of review scores, computed as: $0.2 \cdot \text{Relevance/Timeliness} + 0.4 \cdot \text{Technical Contributions} + 0.2 \cdot \text{Quality of Presentation} + 0.2 \cdot \text{Your Overall Recommendation}$.

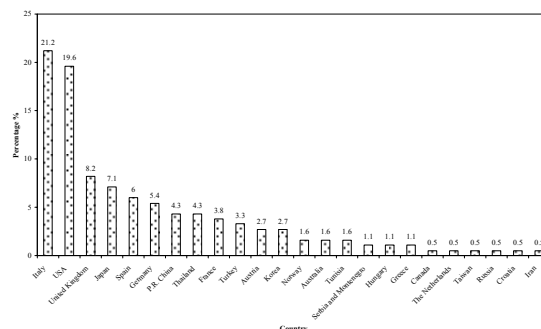


Fig. 1. Percentage of submitted papers for each country, Globecom'06.

The average score of the submitted papers is 3.14, which, actually, is very high and certifies the quality of the papers released by our community. On

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the other hand, due to the strict Globecom requirements and acceptance rate, we could accept only the papers with a minimum 3.5 average score. Moreover, the average score of the accepted papers is close to 4 (3.84, in detail). It means real high quality! Another interesting data may be the measure of the score spam (max-min): it is about 1, both for submitted and accepted papers. It certifies the uniform evaluation by the reviewers.

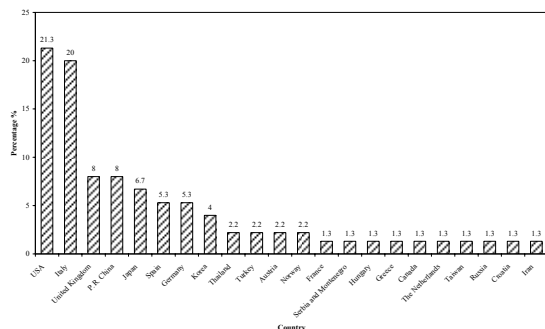


Fig. 2. Percentage of submitted papers for each country, Satellite Symposium.

These data should encourage satellite community to provide an additional effort and to submit their scientific works at Globecom and ICC, where most relevant scientists about communications join together. We are an important and scientifically solid community and we need to let others know.

Last lines of "Scanning the world" are dedicated to introduce the "Perspective paper", which recently has assumed the three columns, three pages form of the IEEE Communications Letter. This time, we have selected the paper "Data Transport Protocols for Space Internet" by Ruhai Wang. Ruhai summarizes a number of data transport protocols with main focus on the developments of this last few years. I am sure that reading it attentively, we could find not only solid know-how for our activity but also innovative ideas for our future research.

*Prof. Mario Marchese, Vice-Chair
Satellite and Space Communications
Technical Committee*

FORTHCOMING GLOBECOM AND ICC CONFERENCES

Globecom 2006

November 27 – December 1, 2006, San Francisco, CA, USA

The theme of IEEE GLOBECOM 2006 "Communications: The Global Bridge" characterizes the continuing pervasiveness of telecommunications in all aspects of global society, industry, and government.

ICC 2007

June 24 – 28, 2007, Glasgow, Scotland, UK

The Conference is aimed at addressing key themes on "Smart Communications Technologies for Tomorrow". The program will feature a General Conference, ten Specific Symposia, Applications Sessions and Tutorials. Prospective authors are invited to submit original technical papers for oral or poster presentations at ICC 2007 and publication in the Conference Proceedings.

MILCOM 2006

October 23-25, 2006, Washington DC, USA

MILCOM 2006 is soliciting both unclassified and classified papers relevant to communication and information system capabilities that address the 21st century and beyond challenges of National Defense.

COSPONSORING / RELATED CONFERENCES AND WORKSHOPS

Industry, academic and government organizations from the U.S. and other DoD-approved countries are encouraged to participate.

2006 Tyrrhenian International Workshop on Digital Communications (TIWDC'06), Satellite Navigation and Communications Systems

September 6 – 8, 2006 Island of Ponza, Italy

TIWDC'06 is an opportunity of exchanging results and perspectives for the satellite navigation and communications community.

The Workshop envisages technical sessions organized by leading researchers and accommodates both invited and regular papers selected on an open-call basis.

IWSSC 2006 - 2nd Int. Workshop on Satellite and Space Communications

September 14 – 15, 2006, Leganes-Madrid, Spain

IWSSC'06 seeks to address and capture highly innovative research from the satellite community. The scope of the workshop includes a wide range of technical challenges: multi-media and broadband access to satellite communication systems, evolution of access across hybrid platforms, and definition of cross-layer design.

CONFERENCES CALENDAR

CONFERENCE	LOCATION	INFORMATION
ISCN 2006 7 th International Symposium on Computer Networks	June 15 – 16, 2006 Istanbul, Turkey	http://www.cmpe.boun.edu.tr/iscn
SPECTS 2006 Int. Symp. on Perf. Ev. of Computer & Tlc Systems	July 30 – Aug. 3, 2006 Calgary, Canada	http://www.scs.org
TIWDC'06 Tyrrhenian Int. Workshop on Digital Comms, Sat. Navigation and Comms Sys	Sept. 6 – 8, 2006 Island of Ponza, Italy	http://www.cnit.it/workshops/2006/index.html
PIRMC 2006 16 th IEEE Int. Symp. on Personal, Indoor & Mobile Radio Communications	Sept. 11 – 14, 2006 Helsinki, Finland	http://www.pimrc2006.org
IWSSC 2006 2 nd Int. Workshop on Satellite and Space Communications	Sept. 14 – 15, 2006 Leganes-Madrid, Spain	http://iwssc2006.tsc.uc3m.es
VTC 2006 Fall 64 th IEEE Vehicular Technology Conf.	Sept. 25 – 28, 2006 Montreal, Canada	http://www.vtc2006fall.org
12th Ka and Broadband Communications Conference	Sept. 27 – 29, 2006 Naples, Italy	http://www.kaconf.org
MILCOM 2006 IEEE/AFCEA Military Communications Conf.	October 23-25, 2006, Washington DC, USA	http://www.milcom.org/2006
GLOBECOM 2006	Nov. 27 – Dec. 1, 2006 San Francisco, CA, USA	http://www.ieee-globecom.org/2006
WCNC 2007 IEEE Wireless Comms and Networking Conference	March 11-15, 2007 Hong Kong, China	http://www.ieee-wcnc.org
ICC 2007	24-28 June 2007, Glasgow, Scotland, UK	http://www.ieee-icc.org/2007

To all SSC members: If your postal address, telephone or fax numbers have changed, please update them with the committee secretary. You can review our current records on our web page at <http://www.comsoc.org/~ssc/>.

Data Transport Protocols for Space Internet

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Introduction

It is well known that high bit-error-rates (BERs), long link delays, channel bandwidth asymmetry, and other challenges over space channels limit the performance of TCP in the space Internet. A variety of data transport protocols including congestion control mechanisms have been proposed for the realization of the Internet in the space environments. Surveys on these protocols are seen in the literature [1-3]. These surveys discussed only a very limited number of transport protocols or proposals. This article summarizes a variety of development of data transport protocols for the space Internet, and survey these protocols and mechanisms with focus on the advanced development in recent years. The aim of this article is to keep the community updated the research progress on data transport technologies of the space Internet in an integrated form.

Overview of Data Transport Protocols

The protocol solutions proposed to address the problems of TCP can be roughly classified as two approaches:

Approach one—The solutions involve modifications to the TCP protocol only, generally on the congestions-control and error-control algorithms. Typical solutions belonging to this approach include satellite transport protocol (STP) [4], extended STP (XSTP) [5], TCP Peach [6], explicit congestion control (XCP) [7], proportional XCP (P-XCP) [8], TP-Planet [9], explicit and fair window adjustment (XFWA) [10], and TCP Westwood (TCPW) [11]. These solutions only involve change to TCP at the end terminals, and they keep the end-to-end semantic of TCP remain unchanged.

Approach two—The solutions involve modifications to both the protocol and network operation infrastructure. The modification to operation architecture is to isolate the space link(s) by dividing the TCP connection into multiple segments with the space link running a space-optimized protocol. The examples of transport protocols belonging to this approach are the Space Communication Protocol Standard (SCPS)-Transport Protocol (SCPS-TP) [12], performance enhancing transport architecture (PETRA) [13], and on-board satellite “split-TCP” proxy [14].

Protocols Involving Only Changes to TCP

STP [4] is developed as a satellite-specific transport layer protocol by modifying an existing ATM-based, reliable link layer protocol. STP incorporates many of the features that have been proposed for TCP to improve its performance but it has no mechanism to differentiate packet losses caused by link congestion and bit-error corruption. XSTP [5] solves the problem of STP using an end-to-end probing mechanism similar to TCP-probing. TCP Peach [6] addresses the challenges of a large bandwidth-delay product (BDP) and high BER over space channels. It replaces slow start and fast recovery with new sudden start and rapid recovery, in addition to direct adaptation of classical congestion avoidance and fast recovery of TCP. The new mechanisms use low priority “dummy” packets to probe the availability of network resources. XCP [7] is originally developed to handle the congestion in a communication environment with a large BDP similar to the space, but not necessarily for satellite networks. Its main contribution is to use explicit congestion control feedback instead of the sender probing for availability of network bandwidth resource. XCP addresses the large BDP problem on space channel but a high BER and channel asymmetry still deteriorate the performance of XCP. P-XCP [8] is proposed to overcome the problems left by XCP. TP-Planet [9] is designed to achieve high throughput performance on deep-space backbone links of the interplanetary network. Main contributions of TP-Planet are two novel algorithms, i.e., initial state and steady state. It also deploys a modified rate-based additive-increase multiplicative decrease (AIMD) congestion control to avoid throughput degradation. XFWA [10] is proposed to improve the TCP efficiency and fairness over multihops space networks. It is designed by taking advantage of multihops satellite constellations to make an approximate estimate of flows RTT and BDP of the link. TCPW [11] modifies the TCP congestion control algorithms to improve its performance, especially over lossy wireless links such as space links. The key idea of TCPW is to continuously measure the bandwidth used by the connection at the sender via monitoring the arrival rate of acknowledgements.

Protocols Involving Changes to Both TCP and Operation Infrastructure

SCPS-TP [12] is a standardized protocol to provide reliable data transfer in space environments. Its performance over stressed space links is improved by breaking the end-to-end TCP connection into multiple transport layer connection using gateways. As a TCP extension in space, SCPS-TP addresses the problems of high BER, long RTT, and space channel asymmetry. It also solves the problem of erroneous congestion decision by implementing both the TCP-Vegas congestion control mechanisms. The objective of PETRA [13] is to optimize both the throughput performance and the efficient utilization of network resources in space. PETRA preserves the end-to-end connection reliability and semantics by dividing the transport layer into two sublayers: lower transport layer (LTL) responsible for data transport and error recovery with each of communication segment, and upper transport layer (UTL) responsible for maintaining the end-to-end reliability and semantics. The solution of on-board satellite "split-TCP" proxy [14] is based on the classical split-TCP concept but the splitting occurs on board of satellite. A proxy agent on the satellite maintains two separate connections for each endpoint of the TCP sessions. The DTN [15] is proposed to handle data transmission over networks with long-delayed and lossy links, especially over the interplanetary links. The central idea of DTN is to use a bundling protocol which operates in a stored-and-forward approach to address the challenges over deep-space links.

Following the above discussions, Table I provides a comparative summary of the main features for each protocol. Please note that the performance results are adopted from the protocol's developers. The discussed protocols are proposed for different application environments, and therefore their focuses are different. While most of them [4-8, 10-11, 13-14] are designed for the Earth-orbit satellite networks, some of them [9, 12, 15] focus on the deep-space interplanetary links. Almost all the protocols solve the problems of high BER and/or long link delay that are the primary challenges in space communications. Some of them also solve other problems such as bandwidth asymmetry, channel efficiency and fairness. All protocols employ the window-based congestion control mechanisms while some of them employ both window-based and rate-based congestion control mechanisms.

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Table I. Comparison of Data Transport Protocols for Space Internet.

Protocols		Application Environments	Problems Solved				Congestion Control Mechanisms		Performance Advantages
			High BER	Long Delay	Channel Asymmetry	Other Problems	Window-based	Rate-based	
STP	Original STP	LEO/GEO	Yes	Yes	Yes	No	Yes	Yes	Achieves up to an order of magnitude reduction in the reverse bandwidth used for large file transfer
	XSTP	LEO	Same as STP	Same as STP	Same as STP	Erroneous congestion decision	Yes	Yes	Improves the effective throughput and increases the energy efficiency of the protocol under various network error conditions
TCP Peach		Satellite (IP) Networks	Yes	Yes	No	No	Yes	No	Outperforms other TCP schemes for satellite networks in terms of goodput, and provides a fair share of network resources
XCP	Original XCP	High BDP Networks	No	Yes	No	High BDP	Yes	No	Outperforms TCP in both conventional and high bandwidth-delay environment, and achieves fair bandwidth allocation, high utilization, small standing queue size, and near-zero packet drops, with both steady and highly varying traffic
	P-XCP	Same as XCP	Yes	No	No	Link under-utilization	Yes	No	Overcomes the problems of XCP with high BER and link underutilization; Shows a throughput almost double that of XCP when PER is over 0.1; Retains the excellent queue length stability and low congestion dropping of the original XCP
TP-Planet		IPN Internet deep space links	Yes	Yes	Yes	Black out condition	Yes	Yes	Significantly improves the throughput performance and addresses the challenges posed by the IPN backbone networks
XFWA		Multihops satellite environment	No	No	No	Efficiency and fairness	Yes	No	Substantially improves the system fairness, reduces the number of packet drops, and makes better utilization of the bottleneck link
TCPW		Wired/wireless networks, especially lossy wireless networks	Yes	No	No	No	Yes	No	Improves throughput performance and fairness; Friendly with TCP Reno; Extremely effective in mixed wired and wireless networks where throughput improvement of up to 550% is obtained; Performs as well as localized link layer protocol
SCPS-TP		All space environments	Yes	Yes	Yes	Erroneous congestion decision	Yes	Yes	Solves almost all space-channel problems and supports current and future space communication configurations ranging from LEO to IPN environments; Implementation available; Well evaluated over emulation testbed and real satellites; Performs significantly better than TCP at the BERs of 10^{-7} or greater
"Split-TCP" Proxy		Satellite networks	Yes	Yes	Yes	No	Yes	No	Enhances throughput up to threshold for both TCP New Reno and TCPW, in some scenarios, with relatively modest on-board buffering requirement
PETRA		Targeted GEO environment but not excluded LEO	Yes	Yes	Yes	No	Yes	No	Significantly enhances throughput performance
DTN		IPN Internet deep space links	Yes	Yes	Yes	Intermittent connectivity	Yes	Yes	Under evaluation