SATELLITE AND SPACE COMMUNICATIONS **SSC**
http://www.comsoc.org/socstr/org/operation/techcom/satellite.html

IEEE COMMUNICATIONS SOCIETY

SSC Newsletter **Vol. 15, No. 1, May 2005**

CONTENTS

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: **Room Venus**

Date: **Wednesday, May. 18th**

Time: **Start time: 12.30 p.m.**
End time: 02.00 p.m.

Future SSC Meetings

Nov/Dec 2005 St. Louis, MO, USA
June 2006 Istanbul, Turkey

ICC 2005 SSC Committee Activities

TUTORIALS (May 16th and May 20th, 2005)

Tu01: Wireless Broadband Communications
Duration: Full Day (Monday, May 16) 9:00 am - 5:00 pm
Instructor: Prof. K. C. Chen, Taiwan University
Tu11: Next Generation Networks and Internet
Duration: Full Day (Friday, May 20) 9:00 am - 5:00 pm
Instructor: Abbas Jamalipour, University of Sydney, Australia

TECHNICAL SYMPOSIA (May 17th - May 19th, 2005)

NG01 - Mobile Network Architectures and Services - Tuesday, 17 May, 10:50 am - 12:20 pm
NG05 - TCP - Wednesday, 18 May, 10:50 am - 12:20 pm
NG06: Satellite Services - Wednesday, 18 May, 02:00 pm - 03:30 pm
NG10: Novel Schemes for Service Provisioning - Thursday, 19 May, 02:00 pm - 03:30 pm
GC02: Resource Allocation - Tuesday, 17 May, 10:50 am - 12:20 pm
MC02: Multimedia Coding and Transport over Wireless Networks I - Tuesday, 17 May, 02:00 pm - 03:30 pm

BUSINESS APPLICATION SESSIONS

Broadband Wireless Services & Applications
Wednesday 18 May 2005, 09:00 am -10:30 am
Organizer & chairs: Iltaek Lim, Nextreaming, Ming-Yee Lai, Telcordia
Internet Technologies for Communication
Thursday 19 May 2005, 09:00 am -10:30 am
Organizer & Chairs: James P.G. Sterbenz, Lancaster Univ. UK, and Univ. of Massachusetts - Amherst, Dawei Huang, Bell Labs Research

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: the indications how to subscribe/unsubscribe are reported at http://cassius.ee.usyd.edu.au/mailman/listinfo/ssc.

SSC COMMITTEE OFFICERS

MESSAGE FROM THE CHAIR

Abbas Jamalipour

The Satellite and Space Communications (SSC) Technical Committee (TC) members will meet again on Wednesday 18 May 2005, at 12:20 pm in Seoul during IEEE International Conference on Communications (ICC2005). 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.

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 our founding in 1962. Please help us to continue our contributions to this exciting field by active participation in our committee. There are numerous ways to be active as can been seen from our web site. Organizing special issues in journals and magazines, conferences, symposiums and technical sessions, and also reviewing papers related to satellite communications are among those activities.

In continuation of our success in organizing two special issues in IEEE Journal on Selected Areas in Communications (J-SAC) in February and April 2004 on the topic of "Broadband IP Networks via Satellites," this year our members have organized two special issues in the IEEE Wireless Communications Magazine. These special issues are on the topics of "Key Technologies and Applications of Present and Future Satellite Communications" and "The Synergy of Space and Terrestrial Communications in Next-generation Hybrid Wireless Systems" and they are scheduled for October 2005 publication. There was an overwhelming response to

the open call for papers for these two special issues which shows the great research activities in the field. Other than IEEE publications, SSC TC members have been also active in organizing special issues in other professional journals.

SSC is actively involved in organizing sessions and workshops for major IEEE ComSoc conferences such as ICC, Globecom, and WCNC, as well as sponsoring important workshops in the field of satellite communications. For the ICC2005, SSC TC has sponsored Symposium on Next Generation Networks for Universal Services, and papers related to satellite communications have been organized into two technical sessions. Several other papers have been also included in other symposiums, including the Wireless Communications and Wireless Networks Symposiums. The SSC TC members have been actively involved in the review process for the submitted paper to ICC2005. We will have strong participation in organizing symposiums in upcoming conferences including GLOBECOM2005 (Wireless Communications), ICC2006 (Next Generation Mobile Networks), GLOBECOM2006, and ICC2007. We will need support and help of TC members.

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.

SSC TC has endorsed several international conferences such as the 23rd AIAA International Communications Satellite Systems Conference (ICSSC-2005), IWSC 2005 to be held in Siena, Italy, from 8 - 9 September 2005, which is also endorsed by the EU's 6th IST framework program SatNEx, the Satellite Communications Network of Excellence, and the IEEE 2005 International Symposium on Microwave, Antenna, Propagation and EMC Technologies For Wireless Communications (MAPE 2005) to be held August 8-12, 2005 in Beijing, China.

As part of TC's commitment to promote research and development activities in the area of satellite communications within the industry and academia research community, we have established the "Distinguished Contributions to Satellite Communications Award" in 2001. This annual award is usually presented during Globecom conference. The last award was presented in GLOBECOM2004, Dallas, Texas, to Dr. Satchandi Verma for his long period of contribution to the satellite communications technology. For more information about eligibility criteria and how to apply for this award, please visit the SSC TC web. This award is funded from the annual budget of TC provided by the IEEE Communications Society through the Technical Activities Council.

This year, I am the Chair of IEEE Globecom2005, Wireless Communications Symposium. We have received around 670 papers and they are now under review. Many of submitted papers are related to the satellite communications and I am delighted that many of our TC members are among the Technical Program Committee of the symposium.

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. As stated before, by attending one of SSC TC meetings, you will automatically become a member and can participate in a warm research community toward future of satellite communications.

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

SCANNING THE WORLD

Mario Marchese

In my previous "Scanning the World", I focused on the importance of the satellites in future technology and applications for broadband communication. I wrote that the success of satellites is strictly linked to new technological solutions.

As written by our Chair in his Message, two joint special issues of the IEEE Wireless Communications Magazine were launched in 2004 with the aim of covering most satellite communication aspects and to check the answer of the satellite community. "Key Technologies and Applications of Present and Future Satellite Communications": aimed at individuating key space and ground technologies, technical challenges that can make feasible the exploitation of satellite networks. "The Synergy of Space and Terrestrial Communications in Next-generation Hybrid Wireless Systems": aimed at highlighting the intrinsic points of strength and limitations when satellites are integrated with terrestrial segments.

It is now interesting to check the response of the satellite community to the calls for papers. Both issues received, globally, almost 70 papers, which is a huge number of submissions compared with similar call for papers in other research fields. It implies, on

one hand, the great activity of the satellite research but, on the other hand, the limited possibilities that this community has to propose its ideas and solutions. It should suggest to SSC scientists and designers to increase their participation in international conferences and to personally propose special issues of journals and magazines dedicated to general and particular aspects of satellite communications.

In more detail, it interesting to report a classification for topics of the papers submitted. Concerning "Key Technology": 16% of the papers focused on the "Evolution of satellite communication and the Description of Projects"; 8% were dedicated to "Transport Layer and Reliable Transport Architectures"; 18% to "DVB-RCS/S" technology including switching on board (11% of the "DVB" papers); 30% focused on "Quality of Service", and 40% of them were related to "Bandwidth Management"; 4% investigated "Security"; 8% "CDMA" technology; and 6% "ARQ" techniques. The rest of the submissions treated alternative topics. "Synergy", more concentrated on integration, received, approximately: 30% of the papers about "Technology integration"; 25% about "HAPs" and 25% related to "Hybrid architectures". The other papers concerned "QoS integration and services".

Three percentages deserve special attention: 18% for DVB-RCS/S, which shows to be a really challenging technology of the future; 30% for QoS and Bandwidth Management, a research topic always of main interest; and 25% for HAPs, which are increasing their importance more and more, especially for integration. Other topics, as security, considered of topical importance for the industry, would deserve more attention, as well as satellite networking in challenging environments.

I would like to conclude this "Scanning the world" by attracting the attention of the readers on two future special issues: *International Journal on Wireless Information Networks* on "Communications via High Altitude Platforms: Technologies and Trials", scheduled for 4th quarter, 2005; *Computers and Electrical Engineering Journal* on "Recent Advances in Wireless Networks and Systems", where satellites, as clear from the call for papers, will receive a great attention, tentatively scheduled for February, 2006, and still open for submissions (deadline June 30th, 2005).

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

FORTHCOMING GLOBECOM AND ICC CONFERENCES

MILCOM 2005
October 17-21, 2005,
Atlantic City, NJ, USA
The theme for MILCOM 2005 is "Innovation...Fueling the Transformation". The technical sessions and exhibits will focus on information relevant to communication and information systems capabilities that address the 21st century challenges of National Defense and Homeland Security.

Globecom 2005
November 28 – December 2, 2005, St. Louis, Missouri, USA.
It is held in St. Louis to celebrate discoveries in communications: past, present, and future. It will feature keynote presentations, technical symposia, tutorials, developers forum, and application sessions.

ICSSC 2005
September 26 - 30, 2005, Rome, Italy.
It is a premier technical conference covering all aspects of satellite communication. It is a forum for satellite systems developers, component and equipment designers, satellite operators and service providers. Presentations and papers cover advances in communications techniques, technologies and systems architectures, as well as their impacts on applications and services (including fixed, broadcast, mobile and personal communications).

ICC 2006
June 11 – 15, 2006, Istanbul, Turkey
The technical program will feature 9 technical symposia disseminating the latest research in communications and networking, and 12 executive panels and applications sessions, where industry leaders will address the hottest challenges for the future. ICC 2006 will thus feature a very rich technical program equally attracting academics and engineers from industry, network operators, and service providers.

COSPONSORING / RELATED CONFERENCES AND WORKSHOPS

CONFERENCE CALENDAR

CONFERENCE	LOCATION	INFORMATION
VTC 2005 Spring IEEE Vehicular Technology Conference Spring 2005	May 29 – June 1 2005 Stockholm, Sweden	http://vtc2005spring.org/
SPECTS 2005 Int. Symp. on Performance Evaluation of Computer & Telecommunication Systems	July 23-28, 2005 Philadelphia, PA, USA	http://www.scs.org/
PIRMC 2005 16th IEEE Int. Symp. on Personal, Indoor & Mobile Radio Communications	September 11-14, 2005 Berlin, Germany	http://www.vde.com/Conferences_en/Pimrc2005/
VTC Fall 2005 IEEE Vehicular Technology Conference Fall 2005	September 26-29, 2005 Dallas, TX, USA	http://ewh.ieee.org/soc/vts/conf/temp/Dallas_VTC.pdf
ICSSC 2005 23nd AIAA International Communications Satellite Systems Conference	September 26 - 30, 2005, Rome, Italy	www.aiaa-icssc.org
MILCOM 2005 IEEE/AFCEA Military Communications Conference	October 17-21, 2005, Atlantic City, NJ, USA	http://www.milcom.org/2005/
GLOBECOM 2005 IEEE Global Communications Conference	November 28 – December 2, 2005, St. Louis, MO, USA	http://www.ieee-globecom.org/2005/
ICC 2006 Int. Conf. on Communications	June 11 - 15, 2006, Istanbul, Turkey	http://www.icc06.org/

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/.

PERSPECTIVE ARTICLE May 2005

Polarization-Time Coding in Satellite Links

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Introduction

It is more-or-less a commonplace statement that in the wireless technology of recent years systems applying multiple transmit and multiple receive antennas (MIMO, Multiple Input Multiple Output) have become one of the few methods of really innovating character. Space-time processing (STC) techniques as applied to MIMO systems in multipath environment result in improvement both in transmission capacity and in performance and reliability of really surprising proportions. An excellent tutorial paper [1] summarizes results of virtually all aspects of the topic.

Roughly speaking MIMO/STC can have two results in multipath environment: i. the number of routes between transmitter and receiver is increased to $m \times n$ and ii. coding gain can be achieved. Various advantages can result from i: capacity of the system is proportional to min. (m, n); there can be a large number of diversity routes – at a first glance up to $m \times n$; a number of independent signals can be transmitted via this system; and others. Advantage of ii is self-evident: the total gain of this system is higher than what is yielded by diversity operation. For an extremely simple space-time block coding method yielding maximal diversity gain – but no coding gain – (to be applied here) see [2].

Studies on the application of the MIMO concept for satellite communications are rather rare. Even discussion about applications in general, about the special application conditions and about the advantages is missing. Ref. [3], however, deals with multi-satellite UMTS to mention one example. About *operating* MIMO satellite systems the authors have no knowledge.

In this paper we are briefly dealing with application of and some problems in satellite MIMO. One particular MIMO system, applicable in satellite links in a relatively simple way is discussed to some detail. In this a 2×2 MIMO system is realized via dual polarized antennas both on the satellite and in the ground terminal. The system can be called Polarization Time Coding (PTC). (Note that [1] mentions terrestrial application of this system.)

MIMO in satellite links

In terrestrial application of STC multipath channels and relevant fading characteristics – Rayleigh, Rice, Suzuki, etc – are assumed. A similar situation is present in satellite to mobile/indoor links. Among others in [4] it is experimentally proved that the LEO satellite to indoor channel has nearly exactly Rayleigh character at any fixed indoor spot. More precise models are available, (Loo, Corrazza, etc.) well describing the multipath behavior and not differing too much from terrestrial. Consequently similar-to-terrestrial results can be foreseen in satellite links.

In principle generalized satellite diversity and generalized site diversity would be the main candidates in forming MIMO channels but site diversity can be excluded in the present – mobile/indoor – situations. In *satellite* diversity at least one problem arises not present in terrestrial systems, i.e. that of synchronization. In terrestrial MIMO systems both n transmit and m receive antennae are at distances from each other in the order of the wavelength. Consequently the path length of the n×m routes is very closely identical and thus signals arriving from the transmit to receive antennas are *synchronous*. This makes identification and decoding of the received signals rather easy. In the case of satellite diversity, the satellites serving as diversity terminals are at significant distance from each other. Consequently the arrival time of signals from two satellites can be shifted by several symbol times relative to each other. Signal processing in such cases is significantly more complicated (see e.g. [5]).

PTC, to be dealt with in the sequel is free from this problem.

In conventional polarization diversity there is one transmit antenna and two receive antennae, these latter polarized orthogonally. To apply PTC, *transmit* antenna must be dual-polarized; in this way a 2×1 or (with still dual polarized receive antenna) a 2×2 MIMO channel is formed. In dual polarized antennae the output/input ports of the of the transmission system – being a 3-port or a 4-port network – are essentially co-located. Thus the above path-length

difference and the resulting synchronization problem are non-existing, this being the main advantage in satellite applications. Further, like polarization diversity is much simpler than other forms of diversity PTC requires also simpler hardware and/or less frequency band than STC or its modified versions. All these make PTC a desirable candidate for the application of MIMO-based techniques in satellite systems.

Polarization-Time Coding

The functioning of polarization *diversity* is described in detail in [6]. The concepts of Stokes-space seemed to be the most appropriate to describe polarization states, random polarization and polarization filtering.

The operation of a PTC system is similar to polarization diversity, and Stokes-space is also appropriate to describe its functioning. Results of [6] to be applied in the present discussion are:

i. in diffuse fields polarization can be regarded as completely random which statement is experimentally verified in [6] and in several other investigations;

ii. this means that received field vectors in the Stokes space are uniformly distributed on the surface of a sphere;

iii. in this case received field statistical behavior is the same, whatever the polarization state of the transmitted field is; in the following discussion the two orthogonally polarized antennas will be taken as right- and left-hand circular;

iv. in the case of right-hand circularly polarized antenna power loss due to polarization mismatch between the received field and the receive antenna can be given as

$$1/L_P = \frac{1+\sin\gamma}{2};\ |\gamma| \le \pi/2,\ \text{distributed uniformly} \quad (1)$$

Note that in the Stokes space antipodal points correspond to orthogonal polarization states. Thus for left-hand circular polarization γ has to be replaced by $-\gamma$ in (1).

The system to be investigated is shown in Fig. 1. Encoder applies Alamouti-s block coding scheme. As seen, 2×2 system is assumed and relevant inverse operations are done in the receiver. At the two receive antennae both fields are of random polarization.

Performance of this system will be investigated in the simplest, time and frequency nonselective fading. However, purpose of the present investigation is not so much to give a detailed theory of the problem – this requires further studies – but rather to get an insight into this technique. Therefore simulation results will only be shown. Further, unclear points will be studied by bounding techniques rather than clarifying these points at the present stage.

In the discussion of conventional polarization *diversity* (i.e. having one transmitter only) there is no particular need on the discussion of the correlation properties of fields of different polarization (see [6]).

In the present case i.e. when there are *two* fields of different polarization, field correlation is of essential importance. Rather than assuming certain (or no) correlation, upper and lower bounds are determined. In the best case the two signals are uncorrelated. In the worst case signals of the same polarization at the receiver are corrupted by the *same* fading.

Effect of the random polarization is given in Eq. (1). One point, however, is unclear: whether orthogonality of the two fields is maintained while both are becoming random. As far as known by the authors neither theoretical nor ray-tracing nor experimental results are on this available. Therefore in the simulations two cases are taken into account. In the first a γ is taken from a set of uniformly distributed numbers and applied in (1) for one of the polarizations and $-\gamma$ is taken for the other polarization. (This means: the two polarizations while becoming random maintain their orthogonality.) In the second independent γ-s are chosen for the two polarizations – meaning that random variation of the two polarizations is independent from each other. Ideal knowledge of the channel is throughout assumed. Simulation results are shown in Fig. 2.

Upper and lower curves are given as reference: they are BER vs. E/N_0 in 2×1 and 2×2 STC systems respectively. Upper and lower bounds of the investigated PTC systems are shown in the rest.

Nearly coinciding curves “uncorr orth” and “uncorr random” are for fully uncorrelated multiplicative noise in each of the four channels of Fig. 1. “Orth” and “random” mean maintained orthogonality and random relative polarization, respectively.

Curves with “corr” are for identical multiplicative noises in the two received channels of the same polarization. These two curves are also nearly coincident.

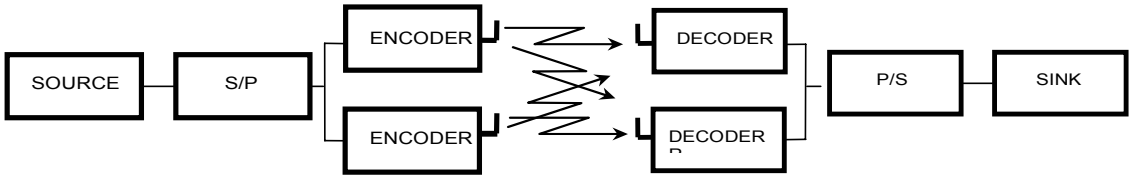

Fig. 1 Basic schematic of the investigated PTC transmitter

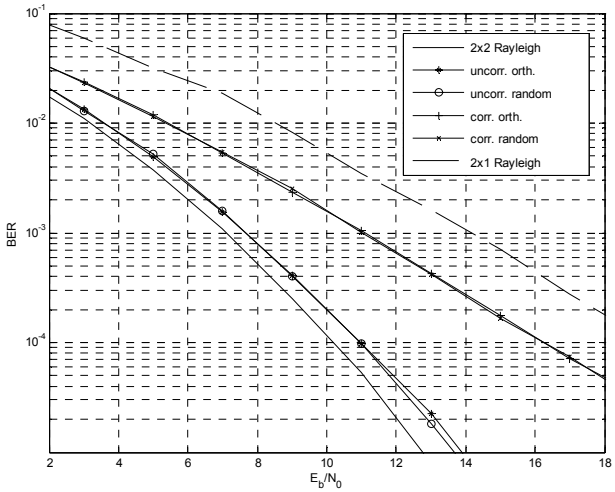

Fig. 2 Simulation results: BER vs. E/N_0 in binary PSK; ideal knowledge of the channel is assumed

Conclusions

PTC systems are investigated transmitting BPSK signals with 2×2 Alamouti-type coding. The following conclusions can be drawn:

i. If all four channels are fully uncorrelated performance is nearly the same as that of an Alamouti 2×2 STC system, although marginally worse. This is due to some polarization mismatch loss.

ii. If channels of the same polarization are identically fading, slope of the BER curve is the same as that of a 2×1 STC system; diversity in polarization has, however the effect of an improvement of about 3 dB.

iii. Maintained or lost orthogonality of the channels transmitted in orthogonal polarization has no effect on systems performance.

References

[1] D. Gesbert & al, From Theory to Practice: An Overview of MIMO Space- Time Coded Wireless Systems, IEEE J. Select. Areas Commun., Vol. 21, pp. 281-302, April 2003

[2] S. M. Alamouti, A simple transmit diversity technique for wireless communications, IEEE J. Select. Areas Commun., Vol. 16, pp. 1451-1458, Oct. 1998.

[3] L. Muchi & al.: Space-time MMSE detectors…, esa Int. Workshop of COST 272 and 280, pp. 311-319, Nordwijk, The Nethetlands, 26-28 May, 2003

[4] Z. Bodnár, & al.: A detailed experimental study of the LEO satellite to indoor channel characteristics, Int. J. of Wireless Information Networks Vol. 6, No. 2, pp.79-91, Sept-Oct 1999

[5] J. Mietzner and P. A. Hoeher: Distributed space-time codes for cooperative wireless networks in the presence of different propagation delays and path losses, IEEE SAM 2004, Sitges, Barcelona, Spain, paper no. S5_5, July 2004.

[6]. I. Frigyes, B. Molnár, Z. Herczku, Z. Bodnár: Antenna gain and polarization effects in LEO satellite links, IEEE ICC 99, Vol. 2, pp. 1051-1057, Vancouver, Canada, 6-12 June, 1999.