IEEE Information Theory Society Newsletter

Vol. 55, No. 1, March 2005 | Editor: Lance C. Pérez | ISSN 1059-2362

President's Column

Steven W. McLaughlin

2005 IT Society President, Steven W. McLaughlin

In my first column as IT Society President I first want to say that I am honored to serve as President for 2005 and to thank my predecessor Hideki Imai for his leadership that has left our Society in excellent shape. We have an exciting year ahead and I would like to highlight some of the activities and initiatives that are already underway.

First some background, over the past three years the membership of the IT Society has decreased considerably, from 5100 members in 2002 to about 3900 today. Many IEEE Societies have seen significant decreases in membership, although our decrease is more than most. This has been coupled with a financial crisis at IEEE that has seen the IT Society reserves depleted from about $1.2 million in 2001 to about $350,000 today; the loss resulting almost completely from so-called infrastructure charges levied on our Society by the IEEE. At this point it appears that our decreases in membership and reserves have stabilized, and we appear to be on a slow increase in both areas. The IEEE has conducted a society-by-society survey to look for any specific reasons for the membership decreases, and most of the conclusions are as expected – a downturn in the economy in the last few years seems to dominate, plus many members no longer have need of their own paper copies of the Transactions. For the IT Society, we need to undertake measures to attract new and maintain existing members. A high priority for me is to reach out to younger members of the Society.

Despite that somewhat pessimistic outlook, it is clear that as a discipline information theory is at its strongest in the last 30 years. Our transactions is very healthy – paper submissions have been up more than 25% in the last two years, and page counts are following suit. In the Information Theory course I teach at Georgia Tech, I have had more than 85 students per class the last two years, and a growing fraction (about 33%) of those students come from physics and the biological sciences. A recent article in Scientific American highlighted the advancements in understanding the information-theoretic nature of black holes that are being made by our colleagues in physics. Our Society needs to do a better job of reaching out to broader communities, and I hope to do more of this in the coming year.

For the rest of this column, I want to address what I think is one of the most important issues facing our Society in the next few years – the so-called 'open access' topic. Last year's Society President Hideki Imai first addressed this topic in his June 2004 column – I want to expand on it here.

Open Access

The IEEE has made significant progress in the general area of electronic publication, chiefly with IEEE Xplore®, and the IT Society has played a pioneering role in this transition. We were the first IEEE Society to create a digital library, and the current form of Xplore® uses many of the innovations that we jointly developed with their vendor, Parity Computing.

There are many evolving 'open access' models for wide, and often free, dissemination of research papers via the Internet. Hideki mentioned the Sabo bill in the U.S. Congress (HRR2613), which sought to "exclude from copyright protection works resulting from scientific research substantially funded by the Federal government." Although the Sabo bill currently seems unlikely to pass, it represents a strong feeling of many academics, politicians and citizens that research (particularly biomedical research) needs to be more widely available, and less subject to the huge subscription fees assessed by many of the current publishers of this research.

More recently, the U.S. National Institutes of Health has proposed a public access policy that requires NIH-funded researchers to post published papers on a free public server within six months of their publication in a peer-reviewed journal (see http://www.nih.gov/about/publicaccess/index.htm).

Our first 'open access' initiative involves ArXiv, a public preprint server that has now established an "information

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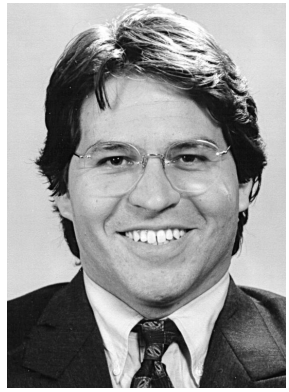
From the Editor



Lance C. Pérez

Welcome to the first issue of the IEEE Information Theory Society Newsletter} for 2005. In this issue we welcome the new IT Society President Steve McLaughlin. His first President's column continues the theme of open access publications started by last year's President, Hideki Imai. Steve's column and the accompanying article by Dave Forney discuss the Society's decision to participate in the ArXiv public preprint server. This is an important initiative and I encourage everyone to read both pieces.

Please help make the Newsletter as interesting and informative as possible by offering suggestions and contributing news. The deadlines for the 2005 issues of the Newsletter are as follows:

Issue	**Deadline**
June 2005	April 15, 2005
September 2005	July 15, 2005
December 2005	October 15, 2005

Electronic submission, especially in LaTeX and Word formats, is encouraged. Please keep in mind that any electronic photographs should be high resolution.

I may be reached at the following address:

Lance C. Pérez
Department of Electrical Engineering
209N Walter Scott Engineering Center
University of Nebraska, Lincoln
Lincoln, NE 68588-0511
Phone: (402)472-6258
Fax: (402)472-4732
Email: lperez@unl.edu

IEEE Information Theory Society Newsletter

IEEE Information Theory Society Newsletter (USPS 360-350) is published quarterly by the Information Theory Society of the Institute of Electrical and Electronics Engineers, Inc.

Headquarters: 3 Park Avenue, 17th Floor, New York, NY 10016-5997.

Cost is $1.00 per member per year (included in Society fee) for each member of the Information Theory Society. Printed in the U.S.A. Periodicals postage paid at New York, NY and at additional mailing offices.

Postmaster: Send address changes to IEEE Information Theory Society Newsletter, IEEE, 445 Hoes Lane, Piscataway, NJ 08854.

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The Historian's Column

A. Ephremides

Occasionally a historian pauses and makes a bold attempt to interpret current events from a historical perspective. Such an endeavor is fraught with risk and should not be undertaken lightly. I have indulged in it infrequently and having suffered no serious consequences so far, I am about to do an "encore".

What stimulated my thoughts is the fascinating notion of the "software-defined radio". For the uninitiated, this is a concept for a transceiver that is carefully crafted to anticipate complete operational instructions that the licensed authorities will download to it. It can then mimic the desired profile and operate as, say, a GSM cell-phone, or CDMA terminal, or a military radio with full encryption, as the case may be. It can be instructed to operate at 750 MHz or at 2.7 GHz and use modulation and coding schemes from a vast repertoire of options. What a miraculous device, and how à propos with the intelligent, digital revolution!

Which prompts some deeper thinking. As Nobert Wiener foresaw in his little-known monograph *God and Golem, Inc.*, man has created machines in his own image (as God may have created man in his own image according to some major religious faiths). So, the concept of a software-defined radio is an incarnation of artificially intelligent devices that are designed to learn, or accept, dictated behavior. Which is not unlike what humans do to their – young! Think about the parallels – they are stunning! We are born pre-wired with memory space and an ability to learn. But all is blank. The first downloads start at home and continue throughout our education. In fact, they continue all through our lives. We can receive "code" from enlightened teachers who will instruct us how to think or we can receive "code" from fanatics who will teach us how to hate. And, there will be the occasional malfunction, where the most benevolent "code" will "morph" into destructive maliciousness. Whether we will become CDMA terminals or analog transceivers, whether we will use space-time codes or Morse codes, whether we will be productive citizens or anti-social elements, whether we will be distinguished innovators or mere "earth-weights", may be the result of the code that was downloaded to us in our formative years. In other words, we may be no more than software-defined people.

Now, I am aware that you can carry analogies only so far. So, the statements above must be tempered somewhat by the realization that human greatness has manifested itself whenever the downloaded code was either rejected or reinterpreted to create unplanned behavior (of course, human depravity has also been the result of the same process). But then try to download code to a software-defined radio that has not been designed to accept it and obey it. All hell may break loose or the device can bloom into unexpected heights (the latter, rather unlikely). So, in the end, just as in an Orwellian script, humans still have an edge over the machines they design. Just as our creator (whoever it may be) is likely to have an edge over us. Just as in the data processing theorem, information is lost as we go down the serial chain of creation.

Lest these thoughts are taken more seriously than they are intended to be let me dispel the beliefs of the faithful by pointing out that education is the highest form of "software"; it can train our "hardware" to critically assess all future downloads. This ability, I think, is still eluding the design of software defined radios. In fact, education can even make our hardware create their own software. How is that for a challenge to the AI industry? Can it refine the SDR to develop its own free will? Can it design a radio that not only says "no" to a preposterous download request, but also "upload" a revolutionary response? I suspect we are close to achieving such an ultimate design. But then, we will also need a non-software-defined historian to properly record and interpret what transpires.

A concluding thought: the best defense against a hierarchy of downloaded behavioral patterns is the ability to counter every download with an upload. But this is exactly what is happening at scientific conferences, as opposed to the traditional classroom. The motto is "exchange" code! Our only hope against the threat of becoming software-defined. Use our pre-wired ability to create code beyond the confines of the downloads we receive. Escape the bonds of the data processing theorem. Create true multi-user Information Theory where everyone is both a transmitter and a receiver. Keep loading, up or down or sideways! Set our minds free (but keep the radios under control).

Nomination Subcommittee Solicits Candidates for the Board of Governors

by Han Vinck

According to our bylaws, no later than two weeks prior to the Annual Meeting of the Board, the Nominations Subcommittee shall forward to the Board the biographies of at least 12 Society members for election by mail ballot by all of the members of the Society. This year's Annual Meeting of the Board occurs in September 2005 in Adelaide, Australia, during ISIT 2005.

This list must also include any Society members endorsed by twenty or more members of the Society in response to a Newsletter solicitation published in the first issue of the current year. This list must also include any Society member endorsed by five or more members of the Board.

In order to ensure adequate international representation from regions which have been historically under-represented in the Board of Governors, in addition to the six nominees receiving the largest number of votes, the top nominee (not among those six) from every under-represented region shall be elected to the Board.

Please send your response to:
Han Vinck
chairman 2005 nomination committee
vinck@exp-math.uni-essen.de

Call for Nominations: 2005 Information Theory Society Aaron D. Wyner Award

The IT Society Aaron D. Wyner Award honors individuals who have shown outstanding leadership in, and provided long standing exceptional service to, the Information Theory community. This award was formerly known as the IT Society Distinguished Service Award.

Nominations for the Aaron D. Wyner Award can be submitted by anyone and are made by sending a letter of nomination to the President of the IT Society by April 15, 2005. The individual or individuals making the nomination have the primary responsibility for justifying why the nominee should receive this award.

How to nominate: Letters of nomination should

- Identify the nominee's areas of leadership and exceptional service, detailing the activities for which the nominee is believed to deserve this award;
- Include the nominee's current vita;
- Include two letters of endorsement.

Current officers and members of the IT Society Board of Governors are ineligible.

Please send all nominations by April 15, 2005 to
Steven W. McLaughlin
IEEE IT Society President
Georgia Tech Lorraine
2-3, rue Marconi
Metz Technopole
57070 Metz FRANCE
email: swm@ece.gatech.edu

Call for Nominations: 2005 IEEE Information Theory Society Paper Award

Nominations are invited for the 2005 IEEE Information Theory Society Paper Award.

Outstanding publications in the field of interest to the IT Society appearing anywhere during 2003 and 2004 are eligible. The purpose of this award is to recognize exceptional publications in the field and to stimulate interest in and encourage contributions to the fields of interest of the IT Society.

The Award consists of an appropriately worded certificate and an honorarium of US$1000 for a single author, or US$2000 equally split among multiple authors.

NOMINATION PROCEDURE: Please email a brief rationale (limited to 300 words) for each nominated paper explaining its contributions to the field by March 1, 2005 to the Transactions Editor-in-Chief at poor@princeton.edu, with a cc to Lynn Stetson at lstetson@princeton.edu.

Call for Nominations: 2005 Joint Information Theory/Communications Society Paper Award

The Joint Information Theory/Communications Society Paper Award recognizes one or two outstanding papers that address both communications and information theory. Any paper appearing in a ComSoc or IT Society publication during the year 2004 is eligible for the 2005 award.

Please send nominations to David Neuhoff (neuhoff@eecs.umich.edu) by February 1, 2005.

A Joint Award committee will make the selection by April 10, 2005.

President's Column

theory" category. ArXiv has played a substantial role in evolving the research culture in physics, math and computer science in a positive and open way. Last year our society established an ArXiv Ad Hoc Committee consisting of Dave Forney, Ralf Koetter, Alex Vardy, Vince Poor, and Han Vinck. At the recommendation of this committee, the IT Society BoG voted in October to promote posting of IT preprints on ArXiv, in the hope of fostering the kind of rapid research dissemination culture that exists in physics and parts of math and computer science. We are the first society to try this within the IEEE, and they will be watching our experiment closely.

A hallmark of our Society is, first and foremost, a genuine love of information theory and a strong desire for its dissemination and promotion throughout the world. This distinguishes us from any other Society with which I interact, and we should be proud of our culture. We do not really know what the financial impact of this initiative will be, but initially we expect it to be minimal, especially with our "preprints only" policy. The Society plans to monitor results closely and to make midcourse corrections as necessary, but for now, we consider the potential benefit to members and the world at large to be much more important than any possible financial impact.

I encourage everyone to participate in ArXiv, and I hope that everyone will automatically post papers and conference submissions to ArXiv in the future. In this edition of the Newsletter (see the article below) Dave Forney gives all the necessary information for posting on ArXiv. The same information appears on the IT Society Web site. We will pursue this initiative aggressively in the coming year, and I would be happy to hear your input (swm@ece.gatech.edu).

Finally, I would like to wish everyone a prosperous 2005!

IT Society Endorses Posting Paper Preprints on ArXiv

by G. David Forney

ArXiv is a public preprint server (partly funded by the NSF) which in the past decade has become the dominant method for distributing new papers in the physics community, and more recently in substantial parts of math and computer science. It has been called the "physics model" for "open access" publication. Recently ArXiv has established an information theory category. In October 2004, the IT Board of Governors unanimously voted to encourage IT authors to post all of their preprints (both journal and conference) on ArXiv, to encourage rapid dissemination of new research. IEEE-published articles should however continue to be accessed through IEEE Xplore®. Several questions about ArXiv are answered in the following FAQ.

ArXiv: Questions and Answers

Q: What is ArXiv?

A: ArXiv is a public preprint server (at arXiv.org) which was set up more than 10 years ago at Los Alamos to serve the physics community. It has since moved to Cornell, and has expanded to cover large parts of mathematics and computer science. ArXiv is partially funded by the National Science Foundation (NSF). The computer science part is also known as the Computing Research Repository (CoRR), and is sponsored in part by the Association for Computing Machinery (ACM). Recently a subcategory (cs.IT) has been set up to cover information theory, and a synonymous math subcategory (math.IT) is planned. (There are no engineering categories currently on ArXiv.)

Q: What is the IT Society policy toward ArXiv?

A: At its October 2004 meeting, the Information Theory Society Board of Governors unanimously adopted a policy encouraging IT authors to post preprints only on ArXiv. The report upon which this vote was based may be found at the end of this FAQ.

Q: Why should I post my preprints on ArXiv?

A: In the communities in which it has been widely adopted, ArXiv serves as the primary mechanism for rapid and broad communication of new research results. All anecdotal evidence indicates that it has been a tremendous stimulus to research and collaboration.

Q: When should I post my preprints on ArXiv?

A: Posting is entirely at the option of the author. However, authors often post preprints when they make a submission to a journal or to a conference, or when they would normally post them on their own Web page.

Q: How do I post my preprints on ArXiv?

A: There are clear instructions at arXiv.org/help or arXiv.org/corr. The preferred format is LATEX. All material in the article, including figures and bibliography, must be included. If the article has been submitted to a journal or to a conference, then you should so indicate.

Q: Why can't I submit a .pdf file? I don't want people looking at my LATEX source.

A: ArXiv has adopted this policy so that they will be able to distribute material in all common present and future formats. You'll have to clean up your LATEX source files.

Q: Can I update a posting?

A: Yes. However, the original posting remains, with a time stamp.

Q: What do I do when my article is published?

A: You should update your posting by adding the bibliographic reference to the published journal or conference paper and the Digital Object Identifier (DOI) number. Clicking on the DOI number takes readers directly to the appropriate page on IEEE Xplore® (or other publisher's Web site), from which they can download the published article.

Q: Why not just update my posting with the published article?

A: The income of the IT Society is based in part on the number of downloads of IT Transactions articles from IEEE Xplore®. The Society therefore wants members who have access to IEEE Xplore® to download IT Transactions articles from that source. This policy attempts to balance the interests of members in rapid and broad dissemination of research results with the financial health of the IT Society.

Q: Is this policy OK with the IEEE?

A: For some time the IEEE has explicitly permitted authors to post preprints and IEEE published articles on their own Web pages, or on institutional servers. However, the IEEE has not yet formulated a policy toward public preprint servers such as ArXiv. It appears that the IT Society is the first IEEE society to address this issue. The IT Society has been in informal contact with the IEEE Publications Board, who are agreeable to seeing this policy go forward as an experiment. The IEEE may take the results of this experiment into account in formulating a future IEEE-wide policy.

Q: How about copyright?

A: The author retains copyright to preprints posted on ArXiv. The IEEE retains copyright to IEEE-published articles.

Q: Is there any quality control on ArXiv?

A: It has not proved necessary so far to restrict access to ArXiv. Each subcategory has a moderator (Madhu Sudan for cs.IT, Joachim Rosenthal for math.IT), who has the power to delete unsuitable postings. There is also a mechanism to register authors, which has not been implemented yet for the IT subcategories.

Q: How do I subscribe to ArXiv?

A: You may subscribe by sending an e-mail message to cs@arXiv.org with "subscribe [your name]" as the subject line and "add IT" as the text. You will then receive daily messages with all postings to the IT subcategory. If the volume of IT articles becomes as substantial as we hope, then the moderators may create mailing lists for sub-subcategories.

Report of the Ad Hoc ArXiv Study Committee to the Board of Governors of the IEEE Information Theory Society

Dave Forney (Chair), Ralf Koetter, Vince Poor, Alex Vardy, Han Vinck

Summary

As reported at the June Board of Governors meeting, an information theory (IT) category has recently been set up on the public preprint server ArXiv (arXiv.org). This committee was created to recommend whether the IT Society should take any steps to endorse and actively promote the posting of IT papers on ArXiv.

We recommend unanimously that the IT Society should endorse and actively promote the posting of preprints only on ArXiv. IT Society policy should be that when the IEEE-published paper becomes available, authors should update their ArXiv posting with its bibliographic reference and Digital Object Identifier (DOI) number, which will provide an immediate link to the IEEE published paper on IEEE Xplore®.

We further recommend steps to encourage wide adoption of ArXiv in the IT community.

Background

ArXiv is a public preprint server which was set up more than 10 years ago at Los Alamos to serve the physics community. Subsequently it has become an NSF-funded facility at Cornell, and has expanded to cover wide areas of mathematics and computer science. All anecdotal reports indicate that it has become a valued service to research wherever it has been widely adopted.

Posting of preprints on ArXiv is completely at the option of the author. The preferred format is LATEX. Most commonly, preprints are posted when they are submitted for publication. Once posted, preprints are time-stamped and archived in perpetuity, although updates and revisions may be appended subsequently. Daily announcements are made of new postings. Papers may be freely downloaded from ArXiv in various formats, and various bibliographic tools are available.

Many IT authors have already posted papers on ArXiv in various existing categories in math, computer science, and physics. Recently an IT category (cs.it and math.it; they are synonymous) has been established, whose scope is basically the same as that of the IEEE Transactions on Information Theory. The moderators are Joachim Rosenthal and Madhu Sudan. An announcement of this new category has been made in the IT Society Newsletter. Authors are currently free to post papers in this category as they like.

The charge to our committee has been to address the question of whether the IT Society should endorse and actively promote the use of the IT category on ArXiv. The primary reason to do so is that the benefits of ArXiv are much greater when the routine posting of new papers becomes part of the culture of a research community. The primary concerns have been the possible risks to our publication income, and/or possible conflict with IEEE policies.

IEEE Policy and Financial Considerations

The IEEE, like every other professional society and publisher, is concerned about the impact of electronic publication. It has to balance member benefits against possible financial impact.

Preprint posting is just one aspect of the electronic publishing revolution. The IEEE has for many years explicitly permitted posting of both preprints and IEEE-published articles on personal and institutional servers. However, it appears that the IEEE has not yet really grappled with a policy for public preprint servers such as ArXiv. (For the current version of the IEEE policy on electronic information dissemination, see the IEEE web site.)

Other societies have adopted various policies toward electronic preprint servers such as ArXiv. The professional societies in physics and math generally support ArXiv, and seem to be successfully coexisting with it. Some journals, such as the Annals of the Institute for Mathematical Statistics, have even decided to post all of their published articles on ArXiv. On the other hand, some societies are vigorously opposed, and some journals, such as Science, will not accept papers that have previously been posted anywhere.

When a paper is finally accepted and published, IEEE policy asks authors to replace a posted preprint with either a link to the IEEE-published paper or with the IEEE-published paper itself. However, on ArXiv it is not possible to remove a posted preprint (although it can be updated), and we do not believe that it is in the IEEE's (or the IT Society's) best financial interest to have the IEEE-published paper freely available via ArXiv.

Neither we nor the IEEE has any way of estimating the financial impact of routine use of public preprint servers such as ArXiv. One might expect that in the future the primary value offered by the IEEE and other publishers will be easy access to an orderly, peer-reviewed, and quality-controlled literature. Academic and corporate libraries cannot rely on authors for this, and therefore may be expected to continue to subscribe to publishers' services such as IEEE Xplore.

Recommendation

We recommend that the IT Society endorse and actively promote the use of ArXiv as a potentially important service to the IT community. However, we recommend that the IT Society should promulgate a preprints only policy for the use of ArXiv. Authors should preferably post preprints at the time of submission to the IT Transactions or to a conference. Authors should maintain a clear distinction between preprints and IEEE-published papers; e.g., a single-column format is recommended for preprints. When a paper is published, the author should add the bibliographic reference and a link to IEEE Xplore via the DOI number; this may actually stimulate downloading from IEEE Xplore. We believe that this policy will maximize the benefits of early dissemination of new research results, while minimizing the risk of reduced society income due to fewer downloads of IEEE-published papers.

We are communicating this proposal to the IEEE staff and Publications Board, but believe that it will be some time before they can definitively address policy toward public preprint servers such as ArXiv. Meanwhile, we believe that the IT Society's adoption of this policy may serve as a useful "trial balloon" for the IEEE as a whole.

Active promotion

We further recommend the following steps to generate a critical mass of use of ArXiv:

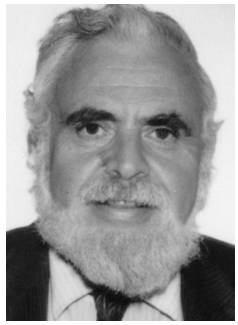
1. A series of promotional articles in the IT Newsletter.
2. Demonstrations, literature and advocacy at IT workshops and symposia.
3. Work with ArXiv moderators to create interest groups and mailing lists.
4. Ask key IT members, such as BoG members and Associate Editors, to post all of their personal current preprints on ArXiv.
5. Ask IT authors who have posted papers in other categories to cross-list them on cs.it/math.it.
6. Suggest (but not require) that authors post preprints on ArXiv when they submit papers to the IT Transactions or to IT conferences.

Respectfully submitted,
Ad Hoc ArXiv Study Committee

GOLOMB'S PUZZLE COLUMN™

Perfect Powers and Powerful Numbers

Solomon W. Golomb



The *perfect powers* are the squares, cubes, and higher powers of the positive integers. They form the set $P = \{1, 4, 8, 9, 16, 25, 27, 32, 36, 49, 64, 81, 100, 121, 125, 128, 144, 169, 196, 216, 225, 243, 256, 289,...\}$.

The *powerful numbers* are those positive integers n such that, if the prime p divides n, then p^2 divides n. The set Q of powerful numbers contains all members of P, but also such numbers as 72, 108, 200, 288, 392, 500, 675, etc.

For some of these problems, you will need to be familiar with the Riemann Zeta Function, $\zeta(s)$, which for real values of $s > 1$, satisfies

$$\zeta(s) = \sum_{n=1}^{\infty} \frac{1}{n^s} = \prod_{\text{all } p} \left(1 - \frac{1}{p^s}\right)^{-1},$$

where the product is taken over all prime numbers p.

Here are the problems.

1. The relation between the sets P and Q is given by:

   (a) $Q = P \times P$, the direct product of P with itself

   (b) $Q = P + P$, the direct sum of P with itself

   (c) $Q = \{$set of all finite products of elements of $P\}$

   (d) None of the foregoing.

2. Which of the following is equal to $\sum_{n \in Q} \frac{1}{n}$, the sum of the reciprocals of the powerful numbers?

   (a) $\zeta(2) + \zeta(3) - \zeta(6)$

   (b) $\zeta(2)\zeta(3) - \zeta(6) + 1$

   (c) $\zeta(2)\zeta(3)/\zeta(6)$

   (d) None of the foregoing.

3. Which of the following is equal to $\sum_{n \in P} \frac{1}{n}$, the sum of the reciprocals of the perfect powers?

   (a) $\sum_{k=2}^{\infty} (-1)^k \zeta(k)$

   (b) $-\sum_{k=2}^{\infty} \mu(k)\zeta(k)$

   (c) $\sum_{k=1}^{\infty} \mu(k)\zeta(2k)$

   (d) None of the foregoing.

   (Here $\mu(k)$ is the Möbius mu-function.)

4. Which of the following is equal to $\sum_{\substack{n \in P \\ n>1}} \frac{1}{n-1}$, where the sum is taken over all perfect powers greater than 1?

   (a) 1

   (b) $\log_e 2$

   (c) $\frac{\pi}{4}$

   (d) None of the foregoing.

5. Prove that there are infinitely many pairs of consecutive powerful numbers, such as (8, 9). (*Note.*} Unless you include (0, 1), the pair (8, 9) is the only example of consecutive perfect powers.)

GOLOMB'S PUZZLE COLUMN™

A Quadratic Sequence Solutions

Solomon W. Golomb

The problems concern the sequence $S = \{s_n\} = \{2n^2 + 2n + 1\}$. Note that $s_n = 2n^2 + 2n + 1 = n^2 + (n+1)^2 = ((2n+1)^2 + 1)/2$. In particular, each s_n is a sum of two consecutive squares. The following facts are well-known from elementary number theory:

a. The primes which are sums of two squares are those of the form $4m + 1$, and 2.

b. If u and v are relatively prime, all prime factors of $u^2 + v^2$ are primes which are sums of two squares. If further $u^2 + v^2$ is odd, its prime factors must all be of the form $4m + 1$.

c. For primes p of the form $4m + 1$, the number -1 is a *quadratic residue* modulo p. That is, there is a number a such that $a^2 \equiv -1 (\text{mod } p)$; and then also $b = p - a$ satisfies $b^2 \equiv -1 (\text{mod } p)$.

Now for the solutions.

1. Since n and $n+1$ are relatively prime, and $s_n = n^2 + (n+1)^2$ is odd, all prime factors of s_n are primes of the form $4m + 1$, for every s_n.

2. and 3. Given any $p = 4m + 1$, a prime, we will find values of n such that p divides $s_n = ((2n+1)^2 + 1)/2$, i.e., such that $((2n+1)^2 + 1)/2 \equiv 0 (\text{mod } p)$. Multiplying both sides by 2, this says $(2n+1)^2 \equiv -1 (\text{mod } p)$, and by fact c., there are numbers a_0 and $d_0 = p - a_0$ with $a_0^2 \equiv d_0^2 \equiv -1 (\text{mod } p)$. Since $a_0 + d_0 = p$, which is odd, one of a_0 and d_0 must be odd, say a_0. Then take $a_0 = 2n + 1$, so that $n = (a_0 - 1)/2$. For this value of n, and all other n congruent to it modulo p, s_n is a multiple of p, i.e., $2a^2 + 2a + 1$ is a multiple of p for all $a \equiv a_0 (\text{mod } p)$; i.e., all $a = a_0 + kp$ for all integers k. Now take $b_0 = p - a_0 - 1$. For $n = b_0$, $s_n = 2b_0^2 + 2b_0 + 1 = 2(p - a_0 - 1)^2 + 2(p - a_0 - 1) + 1 \equiv 2a_0^2 + 4a_0 + 2 - 2a_0 - 2 + 1 \equiv 2a_0^2 + 2a_0 + 1 \equiv 0 (\text{mod } p)$. Thus p divides s_n for $n = b_0$ and for all $n \equiv b_0 (\text{mod } p)$. Note also that $a_0 \neq b_0$, for otherwise $a_0 = b_0 = \frac{p-1}{2}$, leading to $a_0^2 \equiv b_0^2 \equiv (\frac{p-1}{2})^2 \equiv -1 (\text{mod } p)$, from which $(p-1)^2 \equiv -4 (\text{mod } p)$; but $(p-1)^2 \equiv (-1)^2 \equiv 1 \equiv -4 (\text{mod } p)$, and $5 \equiv 0 (\text{mod } p)$, which happens only for $p = 5$. However, looking at the actual sequence S, s_n is not divisible by 5 when $n = 2 = \frac{5-1}{2}$, but when $n = a = 1$, and when $n = b = 5 - 1 - 1 = 3$.

4. For $s_n = n^2 + (n+1)^2 = c^2$, we have a "Pythagorean triple" of the special form $(n, n+1, c)$, such as (3, 4, 5) and (20, 21, 29). We find the general solution as follows: Suppose $s_n = ((2n+1)^2 + 1)/2 = y^2$ for some y. Set $x = 2n + 1$, so that $x^2 + 1 = 2y^2$, $x^2 - 2y^2 = -1$. This is a case of "Pell's equation", which we now solve. The *smallest* solution has $x_0 = y_0 = 1$, so that $1^2 - 2 \cdot 1^2 = -1$. We factor the Pell equation to get $(x + \sqrt{2}y)(x - \sqrt{2}y) = -1$, and then $(x + \sqrt{2}y)^n (x - \sqrt{2}y)^n = (-1)^n$. At $n = 2$, we have $(x_1 + \sqrt{2}y_1)^2 = (1 + \sqrt{2})^2 = 3 + 2\sqrt{2}$, for $x_2 = 3$, $y_2 = 2$, as in $3^2 - 2 \cdot 2^2 = (-1)^2 = +1$. At $n = 3$, $(1 + \sqrt{2})^3 = 7 + 5\sqrt{2}$, corresponding to $7^2 - 2 \cdot 5^2 = (-1)^3 = -1$. It is only for *odd* values of n that we get $x_n^2 - 2y_n^2 = -1$. Remember that $x = 2n + 1$, so that $n = (x-1)/2$. From $x_1 = 1, n_1 = 0$, and $s_0 = 0^2 + 1^2 = 1^2$. From $x_3 = 7, n_3 = 3$, and $s_3 = 3^2 + 4^2 = 5^2$. At $n = 4$, we have $(1 + \sqrt{2})^4 = 17 + 12\sqrt{2}$, as in $17^2 - 2 \cdot 12^2 = (-1)^4 = +1$. At $n = 5$, we have $(1 + \sqrt{2})^5 = 41 + 29\sqrt{2}$. From $x = 41, n = 20$, and $s_{20} = 20^2 + 21^2 = 841 = 29^2$. Next, $(1 + \sqrt{2})^6 = 99 + 7\sqrt{2}$, where $99^2 - 2 \cdot 70^2 = +1$; but $(1 + \sqrt{2})^7 = 239 + 169\sqrt{2}$, where $239^2 - 2 \cdot 169^2 = -1$. With $x = 239$, $n_5 = 119$, and $s_{119} = 119^2 + 120^2 = 28,561 = 169^2$.

5. Thus, the sub-sequence $C = \{c_1, c_2, c_3, c_4, ...\}$ of *square roots* of the squares in sequence S begins $C = \{1, 5, 29, 169, ...\}$, and can easily be generated recursively by: $c_0 = 1, c_{n+1} = 6c_n - c_{n-1}$ for $n \geq 1$. (This can be proved inductively from the Pell equation approach. It yields a much simpler way of obtaining the values of the c_n's.) Thus $c = \{1, 5, 29, 169, 985, 5741, 33461, 195025, 1136689, 6625109, 38613965, 225058681, 1311738121, 7645370045, 44560482149, 259717522849, \dots\}$. The recursion $c_{n+1} = 6c_n - c_{n-1}$ corresponds to the polynomial equation $x^2 - 6x + 1 = 0$, with roots $3 \pm 2\sqrt{2}$. Let $\rho = 3 + 2\sqrt{2} = 5.8284271247\dots$. Then $c_{n+1} = \lfloor \rho c_n \rfloor$ for all $n \geq 0$, and $\lim_{n \to \infty} (c_{n+1}/c_n) = \rho$. To get the s_n corresponding to c_n (*not* the same values of n) we have $\left(\left\lfloor \frac{c_n}{\sqrt{2}} \right\rfloor\right)^2 + \left(\left\lceil \frac{c_n}{\sqrt{2}} \right\rceil\right)^2 = c_n^2$, where $\left\lfloor \frac{c_n}{\sqrt{2}} \right\rfloor + 1 = \left\lceil \frac{c_n}{\sqrt{2}} \right\rceil$. It is remarkable how close the (irrational!) values of ρ^n are to integers. (Actually, $\rho^n + \rho^{-n}$ *is* an integer for every $n \geq 1$, and the powers of $\rho^{-1} = 3 - 2\sqrt{2}$ go to 0 very rapidly with n.)

6. If any s_n is a perfect *even* power it must be in the sequence C. Among the first 250 terms of $\{s_n\}$, the only power higher than the second power is $s_{119} = 28,561 = 13^4$. I don't know of any *odd* (perfect) powers in S, or other perfect even powers, but they may well exist.

7. It is "very likely" that the sequence $S = \{s_n\}$ contains infinitely many primes. However, this has not yet been proved for *any* quadratic expression in n. The "twin primes" result from removing, from the set of *all* odd integers > 0, two residue classes modulo every prime $p > 2$, and no one has yet been able to prove that there are infinitely many twin primes. In the quadratic sequence S, of a sparse subset of the odd integers > 0, we remove two residue classes modulo those primes of the form $4m + 1$ to see what (prime) values remain; so proving that S contains infinitely many prime values seems at least as hard as (or harder than) the "twin prime" problem.

Vince Poor Wins IEEE Education Medal

H. Vincent Poor has been named recipient of the 1995 IEEE James H. Mulligan Education Medal with the citation:

> "For leadership in electrical engineering education through inspired teaching, a classic textbook, innovative curricular development, research, and mentoring."

The IEEE James H. Mulligan Education Medal (formerly IEEE Education Medal) was established in 1956 by the American Institute of Electrical Engineers, and continued by the Board of Directors of the IEEE.

It is through this Medal that the Institute recognizes the importance of the educator's contributions to the vitality, imagination, and leadership of the members of the engineering profession.

H. Vincent Poor

The Medal is presented annually for a career of outstanding contributions to education in the fields of interest of IEEE. It is presented only to an individual.

In the evaluation process, the following criteria are considered: Excellence in teaching and ability to inspire students, Leadership in electrical engineering education through publication of course materials and writings on engineering education, Leadership in the development of programs in curricula or teaching methodology, Contributions to the engineering profession through research, engineering achievements, and technical papers, and Participating in the education activities of professional societies.

IT Members Win Several IEEE Awards

Several IT Society Members have been awarded 2005 IEEE Medals.

Eugene Wong won the 2005 IEEE Founders Medal with the citation:

"For leadership in national and international engineering research and technology policy, for pioneering contributions in relational databases."

Jim K. Omura won the 2005 IEEE Alexander Graham Bell Medal with the citation:

"For contributions to the theory of communication systems and the commercial applications of spread spectrum radios and public key cryptography."

Neil Sloane's won the 2005 Hamming Medal with the citation:

"For contributions to coding theory and its applications to communications, computer science, mathematics and statistics."

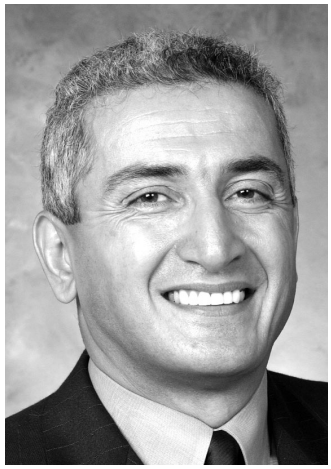
H. Vincent Poor has been named recipient of the 2005 IEEE James H. Mulligan Education Medal with the citation:

For leadership in electrical engineering education through inspired teaching, a classic textbook, innovative curricular development, research, and mentoring.

IT Members Receive Stephen O. Rice Award

Andrew Sendonaris

Eliza Erkip



Behnaam Aazhang

Andrew Sendonaris, Elza Erkip and Behnaam Aazhang received the IEEE Communications Society 2004 Stephen O. Rie Prize in the Field of Communications Theory, for the best original paper published in the IEEE Transactions on Communications in 2003. The award was received for the papers User Cooperation Diversity-Part I: System Description and User Cooperation Diersity-Part II: Implementation Aspects and Performance Analysis, which appeared in IEEE Transactions on Communications, Volume 51, No. 11, pp. 1927-1948, November 2003.

The papers propose a new form of spatial diversity for wireless communications, i which the diversity gains are obtained via the cooperation of mobile users. In a cooperative system two or more active users in the network share information by overhearing each other's transmissions and then jointly re-transmit, either at different ties or simultaneously, to obtain higher reliability and efficiency than they could have individually. Through a capacity and outage analysis, the papers illustrate that user-cooperation improves achievable rates, system throughput and cell coverage, while roviding robustness against channel variations. Cooperation strategies for CDMA systems and practical implementation issues are also discussed.

Andrew Sendonaris (S'93-M'99) received the B.S. (summa cum laude), M.S. and Ph.D. degrees in electrical engineering from Rice University, Houston, TX, in 1993, 1995, and 1999, respectively.

He is currently with Qualcomm Inc., where he led the System Design effort on one of Qualcomm's latest chips implementing WCDMA, a global third-generation Code Division Multipe Access (CDMA) wireless telephony standard. He is the holder of seven U.S. patents in the area of wireless communications system design and has several additional patents pending. His research interests include multiple access communications over fading ultipath channels, CDMA systems, the capacity of, and resource allocation for, cellular mobile radio networks, and digital transmission over twisted pair copper loops.

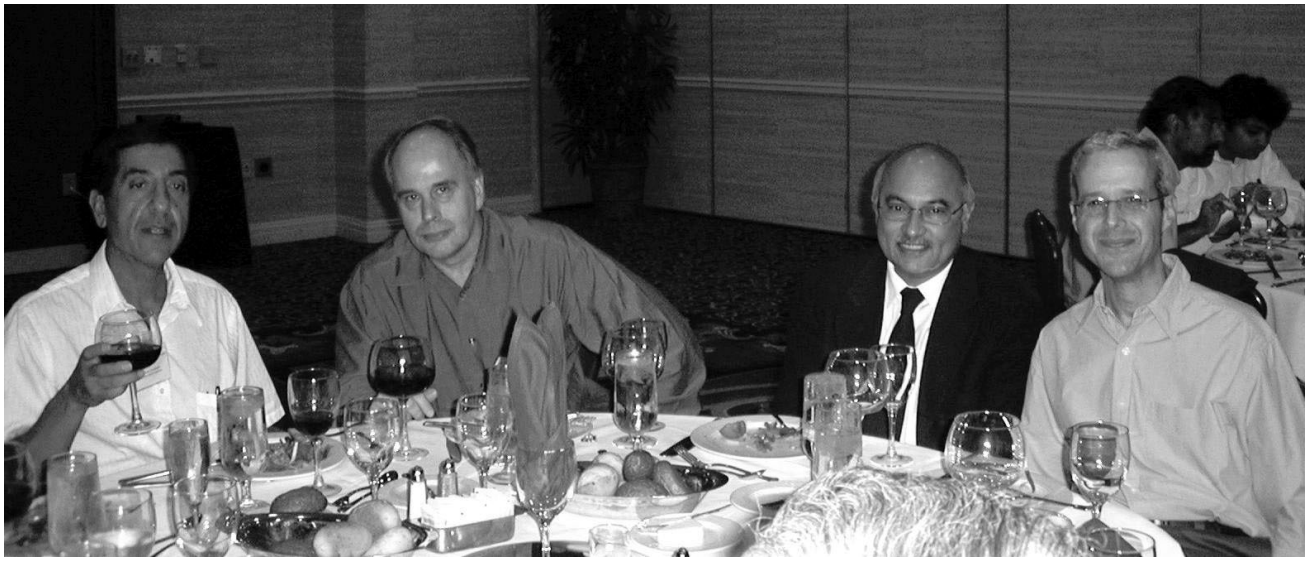
Elza Erkip received the Ph.D. and M.S. degrees in Electrical Engineering from Stanfor University in 1996 and 1993 respectively, and the B.S. degree in Electrical and Electronic Engineering from Middle East Technical University, Turkey in 1990. Dr. Erkip joined Polytechnic University, Brooklyn in Spring 2000, where she is currently an Assistant Professor of Electrical and Computer Engineering. During 1996-1999 she was with the Department of Electrical and Computer Engineering of Rice University. Dr. Erkip received an NSF CAREER award in 2001 and IBM Faculty Partnership Award in 2000. Her research interests include wireless communications, information theory and communication theory.

Behnaam Aazhang received his B.S. (with highest honors), M.S., and Ph.D. degrees in Electrical and Computer Engineering from University of Illinois at Urbana-Campaign in 1981, 1983, and 1986, respectively. In August 1985, he joined the faculty of Rice University, Houston, Texas, where he is now the J.S. Abercrombie Professor and Chair of the Department of Electrical and Computer Engineering and also the Director of Center for Multimedia Communications. Dr. Aazhang is a Fellow of IEEE, a recipient of the Alcoa Foundation Award 1993, the NSF Engineering Initiation Award 1987-1989, and the IBM Graduate Fellowship 1984-1985, and is a member of Tau Beta Pi and Eta Kapa Nu. His research interests are in the areas of communication theory, information theory, and their applications with emphasis on multiple access communications, cellular mobile radio communications, and wireless communication networks.

Workshop Report: The 2004 IEEE Information Theory Workshop

October 24-29, 2004
San Antonio, Texas, USA

by Costas Georghiades



Costas Georghiades, Robert Calderbank, P. Kumar and Alon Orlitsky at the 2004 ITW banquet.

Organized under the auspices of the IEEE Information Theory Society, the 2004 IEEE Information Theory Workshop took place in San Antonio, Texas on October 24-29, 2004. The beautiful San Antonio Riverwalk provided a nice backdrop for the more than 125 workshop attendees who had their hands (and ears) full from the five day long technical program. The technical program committee, co-chaired by Robert Calderbank and Alon Orlitsky, did an outstanding job in putting together the technical program, which consisted of 32 invited talks and approximately 50 from the open call. The workshop included a number of firsts: a) it had five plenary speakers, one for each day of the workshop; b) two of the plenary talks and some of the invited talks were from presenters with expertise outside the typical information theorist's; c) six-page papers were published in the Proceedings.

The lineup of plenary talks was:

- David Haussler, "What We Might Learn from Reconstructing the Evolutionary History of the DNA in the Human Genome"
- Marc Mezard, "Message Passing Methods in Statistical Physics, Optimization, and Coding Theory"
- Madhu Sudan, "Codes and Complexity"
- P.R. Kumar, "Capacity, Architecture, Protocols and Sensing in Wireless Networks"
- A. Paulraj, "Time Reversal in Wireless Communication".

The Workshop Proceedings were published on a CDROM, as well as on the workshop web page at: http://ee-wcl.tamu.edu/itw2004/program.html. They are also available through IEEE Xplore®.

On the administrative side, thanks to the diligence of committee members and volunteers before and during the workshop, things moved along smoothly. The fine choices of wines by general co-chair Sergio Verdú, for example, went a long way in making the reception and banquet a success. Many thanks go to all committee members. Special thanks to Ms. Sonny Matous, whose attention to detail made sure all administrative aspects went smoothly, and to Professor Deepa Kundur who oversaw the web page. Finally, we gratefully acknowledge NOKIA for their financial support as a general sponsor of the workshop.

Eighth International Symposium on Communication Theory and Applications (ISCTA '05)

17th – 22nd July, 2005, Ambleside, Lake District, UK

FINAL CALL FOR PAPERS

A major objective of the Symposium will be to pursue the progression from communication and information theory through to the implementation, evaluation and performance of practical communication systems of various types. You are invited to submit original papers in the following and related areas:

Digital Transmission and Recording
Source and Channel Coding
Modulation, Detection, Channel Estimation
Channel Modelling, Synchronisation
Optical and Magnetic Recording

Special Topics in Channel Coding, Source Coding, Information Theory
Turbo Codes, Low Density Parity Check Codes
Source Coding and Data Compression
Privacy, Secrecy and Security
Multi-Functional Coding
Sequences and Arrays

Detection Techniques
Vector Detection, Multiuser Detection
Combined Equalisation, Decoding and Channel Estimation
Iterative (Turbo) Schemes

Ultra Wideband Techniques

Space-Time Techniques
Information-Theoretic Aspects, Channel Capacities
Space-Time-Coding, Signal Constallations
Spatial Spreading, Linear Dispersion Codes
MIMO Detection and Channel Estimation
MIMO Precoding, Writing on Dirty Paper
Time Reversal

Realisation
DSP for Communication Systems
MIMO Demonstrators
Complexity Considerations

Systems, Multiple Access, Protocols
Communication System Architectures
3G and Beyond-3G Wireless Communication Systems
Sensor Networks
Ad Hoc Networks
Multiple Access Techniques, Protocols
Multimedia Networking

The deadline for the submission of papers for consideration is **Friday 4th March, 2005.** Papers should not exceed 6 pages in length, including figures. Please submit your paper to:

Professor Bahram Honary
Department of Communication Systems
Lancaster University
Lancaster LA1 4YR UK
Tel: +44 1524 592121
Fax: +44 1524 592713
E-mail: b.honary@lancaster.ac.uk

or

Professor Juergen Lindner
Department of Information Technology
University of Ulm, Albert-Einstein-Allee 43
D-89081 Ulm, Germany
Tel: + 49 73150 26250
Fax: +49 73150 26259
E-mail: juergen.lindner@e-technik.uni-ulm.de

You will be notified of acceptance by **22nd April, 2005**. There will then be an opportunity to revise your paper, taking into account any comments by the referees, and to put it into the required format for the Symposium Proceedings. The deadline for receipt of your revised paper is **20th May, 2005**, so that the Proceedings can be published in time to be made available to all participants at the Symposium.

Organising & Program Committee

The Symposium **Venue** is St. Martin's College, Ambleside, Cumbria, UK, where all the presentations, most meals, and social events, will take place. Ambleside is in the famous and very beautiful English Lake District, and there will be opportunities for walks and excursions during the Symposium.

For information on registration fees and accommodation, please consult our website: http://www.hwcomms.com/iscta05.htm or http://www.dcs.lancs.ac.uk

Rinicom Ltd

Call for Papers

Joint special issue of the IEEE Transactions on Information Theory and the IEEE/ACM Transactions on Networking

Networking and Information Theory

A joint issue of the IEEE Transactions on Information Theory and the IEEE/ACM Transactions on Networking will be devoted to the connections between networking and information theory. Original research papers that make major contributions to research on information theoretic aspects of networking, operations of networks and other related problems with an information theoretic components are sought.

While connections between networking and information theory have always been promising, recent developments point to especially fruitful common ground between these two areas. On the networking side, the complexity of physical layer issues, particularly in wireless networks, has prompted an inter-layer approach that fits well in the context of information theory. On the information-theoretic side, classical approaches to multiuser information theory have been enhanced by an active interest in casting practical networking problems in an information-theoretic setting. In particular, theoretical developments in information theory have drastically changed the angle of attack on information theoretic problems of networking.

Examples of such intersection areas are scaling laws in networks, network coding, implementation and theory of multiuser systems, wireless network design involving multi-input multi-output channels, and queueing and delay issues in information-theoretic capacity settings. A special issue that focuses on these activities and gives an overview of related efforts would serve both the networking and information theory communities and, we hope, deepen interest in interdisciplinary work.

Papers for this special issue should relate to the developments described above. Expository papers, survey papers, research papers and correspondence items are welcome. Topics include, but are not limited to, the following:

- Network coding
- Limit behavior of large networks
- Multi-terminal information theory for networks
- Information theory for queueing and network delay
- Coding for network robustness and reliability

Prospective authors should follow the regular guidelines of the IEEE Transactions on Information Theory. Further information and submission details can be found at:

`http:www.special-issue-it-ton.info`

Guest Editors

N. Cai, University of Bielefeld
M. Chiang, Princeton University
M. Effros, Caltech
R. Koetter, University of Illinois Urbana-Champaign
M. Medard, Massachusetts Institute of Technology
B. Prabakhar, Stanford University
R. Srikant, University of Illinois Urbana-Champaign
D. Towsley, University of Massachusetts
R. W. Yeung, The Chinese University of Hong Kong

Schedule

Submission deadline: Feb. 15, 2005
Selection of papers: Dec. 15, 2005
Publication: June, 2006

Call for Papers

10th International OFDM-Workshop 2005 (InOWo'05)

31. August - 1. September 2005
Hotel Atlantic, Hamburg, Germany

TUHH Technische Universität Hamburg-Harburg

The 10th International OFDM-Workshop (InOWo'05) is comming back to the beautifull city of Hamburg, Germany, and is held from Wednesday, 31. August through Thursday, 31. September 2005. The Workshop provides an opportunity for international researchers interested in all aspects of the OFDM transmission technique to meet and discuss current results of their research work. In addition to the two day conference a half-day tutorial on various aspects of the OFDM transmission technique is planned for the 30. August 2005.

Paper submissions for technical sessions may cover all aspects of multi-carrier transmission including any of the following areas (but not limited to):

Signal Processing in OFDM Systems:
- Modulation Techniques
- Equalisation and Synchronisation
- Channel Coding
- Non-Linearities
- Multiple Access Techniques

OFDM System Concepts:
- Crosslayer Optimisation
- 4th Generation Networks
- Hiperlan/2 and IEEE 802.11a
- DLC-Protocol Issues
- Ad-Hoc Networking
- XDSL

MIMO with OFDM:
- Antenna Techniques
- MIMO Coding
- Multi User Systems and MIMO

Experimental Systems and Field Trials:
- Implementation Issues
- VLSI Architectures
- Software Defined Radio for OFDM

Authors are invited to submit a one-page extended abstract, including the authors' full contact information, to the Workshop e-mail address ofdm@tu-harburg.de.

Important Dates

Deadline for Extended Abstracts:	April 17, 2005
Notification of Acceptance:	May 29, 2005
Early Registration:	July 17, 2005
Final Papers Due:	July 17, 2005

For further information about this Workshop, as well as detailed instruction for submitting the final paper, please visit our web page at:

http://ofdm.tu-harburg.de/

Conference Chair

Prof. Hermann Rohling
Department of Telecommunications
Technical University Hamburg-Harburg
Eissendorfer Strasse 40
21073 Hamburg, Germany
Phone: +49 (0)40 – 42878 – 3028
E-Mail: rohling@tu-harburg.de

OFDM-Workshop Organizers

Christian Stimming, Nico Tönder
Department of Telecommunications
Technical University Hamburg-Harburg
Phone: +49 (0)40 – 42878 – 2164/2168
Fax: +49 (0)40 – 42878 – 2281
E-Mail: ofdm@tu-harburg.de
http://ofdm.tu-harburg.de

Conference Calendar

DATE	CONFERENCE	LOCATION	CONTACT/INFORMATION	DUE DATE
April 3-7, 2005	**WiOpt 2005**	Trento, Italy	http://www.wiopt.org/	October 5, 2004
May 19-20, 2005	**26th Symposium on Information Theory in the Benelux**	Université Libre de Bruxelles, Brussels, Belgium	http://www.ulb.ac.be/di/benelux05	June 12-15, 2005
June 5-8, 2005	**Canadian Workshop on Information Theory (CWIT) 2005**	Monteal, Quebec	http://www.ece.mcgill.ca/~cwit2005	February 14, 2005
June 12-15, 2005	**2005 IEEE Communication Theory Workshop**	Park City, Utah	http://www.ece.ualberta.ca/~ctw05/index.html	February 1, 2005
June 17-23, 2005	**Four International Workshop on Optimal Codes and Related Topics 2005**	Pamporovo, Bulgaria	http://www.moi.math.bas.bg/oc2005/oc2005.html	March 31, 2005
August 29 - September 1, 2005	**2005 Information Theory Workshop (ITW)**	The Royal Lakeside Novotel Rotorua, New Zealand	http://www.cs.auckland.ac.nz/itw2005	January 31, 2005
Aug. 31 - Sept. 1	**InOWo'05 - 10th International OFDM Workshop 2005**	Hamburg, Germany	http://ofdm.tu-harburg.de See CFP in this issue	April 17, 2005
September 4-9, 2005	**2005 IEEE International Symposium on Information Theory (ISIT)**	Adelaide Convention Center Adelaide, AUSTRALIA	http://www.isit2005.org Dr. Alex Grant Institute for Telecommunications Research University of South Australia SA 5095 Australia Prof. Rodney A. Kennedy Research School of Information Sciences and Engineering Australian National University ACT 0200 Australia rodney.kennedy@anu.edu.au	January 30, 2005
April 3-7, 2006	**4th International Symposium on Turbo Codes and Related Topics**	Munich, Germany	http://www-turbo.enst-bretagne,fr/	Oct. 15, 2005
TBA	**2006 IEEE International Symposium on Information Theory (ISIT)**	Seattle, Washington, USA	TBA	TBA