

- [Magazine Main Page](#)
- [Society News](#)
- [Conference News](#)
- [Publication News](#)
- [TC News](#)
- [Chapter and DL News](#)
- [Initiatives & Trends](#)
- [New Theses](#)
- [New Books](#)
- [Research Opportunities](#)
- [In-Depth Reports](#)
- [About the E-Newsletter](#)
- [Submission Instruction](#)
- [E-Newsletter Team](#)



# IEEE Signal Processing Magazine

[November'07](#) [October'07](#) [August-September'07](#)  
[July'07](#) [June'07](#) [May'07](#) [April'07](#)

## Inside Signal Processing E-Newsletter

December 2007

[Society News](#)      [Conference News](#)      [Publication News](#)      [TC News](#)      [Chapter/DL News](#)  
[Initiatives & Trends](#)      [PhD Theses](#)      [New Books](#)      [Research Opportunities](#)

### Highlights of This Issue

- [Society News](#): 2008 IEEE Fellows announced; Open-Access Educational Repository Effort with Connexions
- [Call for Nominations](#) of Editor-In-Chief for five SPS Journals and Magazine
- [Conference News](#): Check out deadlines of upcoming SPS conferences and workshops
- [Journal News](#): Call for papers of new special issues from SPS journals
- [TC News](#): Exclusive report from the Bio Imaging and Signal Processing (BISP) TC
- [New Trends](#): Relaying and cooperative communications; Extensible 3D Graphics Standard
- [Research Funding Opportunities](#) in EU - ERC Advanced Grant
- [New PhD Theses](#), [New Books](#), and [Scholarship/Post-doc Opportunities](#)

Please bookmark <<http://enews.ieee-spm.org>> for current and archived issues of the Inside Signal Processing E-Newsletter. IEEE members may manage their subscription of the email notification of the E-Newsletter at this URL <<http://ewh.ieee.org/enotice/options.php?LN=SP001>>.

---

## 1. Society News

### 32 SPS Members Elevated to IEEE Fellow

The Signal Processing Society congratulates the following 32 SPS members who were recognized with the grade of Fellow as of 1 January 2008:

Ali Akansu, Naofal Al Dhahir, John Apostolopoulos, Mourad Barkat, Pau-Choo Chung, Pamela Cosman, Paul Ebert, Ling Guan, Christian Jutten, Walter Kellermann, Janusz Konrad, Hamid Krim, Pai-Chi Li, Nam Ling, Philippe Loubaton, Benoit Macq, Vijay Madisetti, William Melvin, Peter Mikhalevsky, Karen Panetta, Fernando Pereira, Athina Petropulu, Markku Renfors, Massimo Rudan, Ananthram Swami, Sergios Theodoridis, Charles Therrien, Paul Van Den Hof, Xiaodong Wang, En-Hui Yang, Jinyun Zhang, and Abdelhak Zoubir.

Two individuals were evaluated by the IEEE Signal Processing Society, but are not Society members. They are: Abeer Alwan and Guanghan Xu.

Each year, the IEEE Board of Directors confers the grade of Fellow on up to one-tenth percent of the members. To qualify for consideration, an individual must have been a Member, normally for five years or more, and a Senior Member at the time for nomination to Fellow. The grade of Fellow recognizes unusual distinction in IEEE's designated fields. Visit [this link](#) for full citations of these new fellows and more information about the Fellow program. Nominations are now being accepted till March 1, 2008, for the [IEEE Fellow class of 2009](#).

### SPS Partnering with Connexions for Open-Access Educational Repository

IEEE is partnering with open-access educational repository [Connexions](#) on a major initiative to develop a critical mass of signal processing educational modules and courses that will be available for free access by anyone, anywhere, at any time. This is one of the latest education and outreach effort by the IEEE Signal Processing Society (SPS), as announced by the SPS President Alfred O. Hero in the November 2007 issue of IEEE Signal Processing Magazine [[PDF of article](#)].

The materials will pass through a careful IEEE-SPS peer review that will earn them the imprimatur of the IEEE brand for quality and eventually will be available not just in English but also in a number of languages, including Spanish and Chinese.

The project will begin accepting submissions of content for conversion and reviewing in January 2008. If you would like to get started early contributing your own content, please visit the Connexions [Author's Guide](#). For more information, read more from [this SPM article](#) and visit the project website at <http://www.ieeeecnx.org>.

### Call for Nominations of Editor-In-Chief for SPS Publications: Nomination Due January 31, 2008

The IEEE Signal Processing Society invites nominations for the positions of Editor-in-Chief for the following publications:

- IEEE Transactions on Signal Processing
- IEEE Signal Processing Magazine
- IEEE Transactions on Audio and Speech Processing
- IEEE Signal Processing Letters
- IEEE Transactions on Information Forensics and Security

The nominee must be a member in good standing of IEEE and of the IEEE Signal Processing Society. He/she must have served as an associate editor or in a management capacity for an archival journal. The duties include the identification of associate editors to serve across the topical scope of the transactions, management of the day-to-day operations in Manuscript Central with the assistance of the Signal Processing Society's publications staff; identifying areas that require strengthening and working with the Society and its technical committees to achieve that goal.

The Editor-in-Chiefs will report to the Society's Vice President - Publications. He/she chairs the Editorial Board for the publication and serves on and is a voting member of the Society's Publications Board. The terms of service will be from January 1, 2009 to December 31, 2011.

Please submit nominations to K. J. Ray Liu, Vice President - Publications, IEEE Signal Processing Society, via <kjrliu AT umd.edu>. Your nomination must include a brief biography (no more than one page). The biography should include the web address that contains the CV (Do not send complete curricula vitae with the nomination). Also include a statement of the candidate's experience as an associate editor or other publications management position. Should the nominee so wish, a statement of interest of up to 500 words may be submitted stating the nominee's interest and special qualifications for the positions.

Nomination form - Please submit by January 31, 2008

EDITOR-IN-CHIEF for [Name of the journal]

1. Names of candidate and nominator
2. A short IEEE-style biography
3. A narrative supporting statement from the nominator
4. A personal statement of the candidate (optional, limited to 500 words)

[Back to Top](#)

## 2. Conference News

SPS Conference Call-for-Paper & Deadlines	Location	Date	Tutorial/Special Session	Submission Deadline
<a href="#">1st IEEE International Workshop on Genomic Signal Processing and Statistics (GENSIPS'08)</a>	Phoenix, Arizona	June 8-10, 2008		<b>Dec. 22, 2007</b>
<a href="#">IEEE International Conference on Multimedia &amp; Expo (ICME'08)</a>	Hanover, Germany	June 23-26, 2008		<b>Dec. 24, 2007</b>
<a href="#">1st International Workshop on Cognitive Information Processing</a>	Santorini, Greece	June 9-10, 2008		<b>Jan. 5, 2008</b>
<a href="#">IEEE International Conference on Image Processing (ICIP'08)</a>	San Diego, CA	Oct. 12-15, 2008		<b>Jan. 18, 2008</b>
<a href="#">IEEE Workshop on Signal Processing Advances in Wireless Communications (SPAWC'08)</a>	Receife, Brazil	July 6-9, 2008		Jan. 28, 2008
<a href="#">International Conference on Audio, Language and Image Processing (ICALIP'08)</a>	Shanghai, China	July 7-9, 2008		Jan. 31, 2008

IEEE Workshop on Multimedia Signal Processing (MMSP'08)	Cairns, Queensland, Australia	Oct. 8-10, 2008	March 8, 2008	April 18, 2008
---	-------------------------------	-----------------	---------------	----------------

Upcoming Signal Processing Conferences	Location	Advanced Registration	Conference Dates
IEEE Automatic Speech Recognition and Understanding Workshop (ASRU'07)	Kyoto, Japan		Dec. 9-13, 2007
IEEE International Workshop on Computational Advances in Multi-channel Sensor Array Processing (CAMSAP'07)	U.S. Virgin Islands		Dec. 12-14, 2007
IEEE International Symposium on Signal Processing & Information Technology (ISSPIT'07)	Cairo, Egypt		Dec. 15-18, 2007
IEEE Speaker and Language Recognition Workshop (Odyssey'08)	Stellenbosch, South Africa		Jan. 21-25, 2008
International Symposium on Communications, Control and Signal Processing (ISCCSP'08)	St. Julians, Malta	<b>Jan. 12, 2008</b>	March 12-14, 2008
IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP'08)	Las Vegas, NV	<b>Jan. 18, 2008</b> (authors)	Mar. 31-April 4, 2008
IEEE/ACM Information Processing in Sensor Networks (IPSN'08)	St. Louis, MO	TBA	April 22-24, 2008
Symposium in Signal and Multimedia Processing (SMP) at 21st IEEE Canadian Conference on Electrical and Computer Engineering (CCECE)	Niagara Falls, Canada	March 7, 2008	May 4-7, 2008
IEEE International Symposium on Biomedical Imaging (ISBI'08)	Paris, France	March 14, 2008	May 14-17, 2008

[Back to Top](#)

### 3. Publication News

Upcoming Deadlines for **Signal Processing Magazine**: <http://www.ieee-spm.org/?i=cfp>

- [Columns/Forums](#) rolling submission deadlines

**Special Issue Deadlines** of SPS Publications - Journal of Selected Topics in Signal Processing

- [Signal Processing for Astronomical and Space Research Applications](#) - Deadline: **1 February 2008**
- [fMRI Analysis for Human Brain Mapping](#) - Deadline: 15 March 2008
- [Digital Image Processing Techniques for Oncology](#) - Deadline: 15 April 2008
- [Visual Media Quality Assessment](#) - Deadline: 30 April 2008
- [DSP Techniques for RF/Analog Circuit Impairments](#) - Deadline: 1 June 2008

**Recent Issues** of SPS Sponsored and Co-sponsored Publications

Journal Title	Latest Issue	Contents (in PDF)	Xplore Link
IEEE Signal Processing Magazine <ul style="list-style-type: none"> <li>• Special Section on Multi-view Imaging and 3D TV</li> <li>• DSP Forum on Signal Processing for Biometric Systems</li> </ul>	vol. 24, no. 6	<a href="#">PDF</a>	<a href="#">Html</a>
IEEE Transactions on Audio, Speech, and Language Processing	vol. 15, no. 8	<a href="#">PDF</a>	<a href="#">Html</a>
IEEE Transactions on Image Processing	vol. 16, no. 12	<a href="#">PDF</a>	<a href="#">Html</a>
IEEE Transactions on Information Forensics and Security	vol. 2, no. 4	<a href="#">PDF</a>	<a href="#">Html</a>
IEEE Transactions on Signal Processing	vol. 55, no. 12	<a href="#">PDF</a>	<a href="#">Html</a>
IEEE Signal Processing Letters	vol. 14, no. 12	<a href="#">PDF</a>	<a href="#">Html</a>
IEEE Journal of Selected Topics in Signal Processing <ul style="list-style-type: none"> <li>• Adaptive Waveform Design for Agile Sensing and Communication</li> <li>• Network-Aware Multimedia Processing and Communications</li> <li>• Performance Limits of Ultra-Wideband Systems</li> </ul>	vol. 1, no. 1 vol. 1, no. 2 vol. 1, no. 3	<a href="#">PDF</a> <a href="#">PDF</a> <a href="#">PDF</a>	<a href="#">Html</a>
Journal Title	Latest Issue	Contents (in PDF)	Xplore Link
IEEE Transactions on Medical Imaging	vol. 26, no. 12	<a href="#">PDF</a>	<a href="#">Html</a>
IEEE Transactions on Mobile Computing	vol. 7, no. 1	<a href="#">PDF</a>	<a href="#">Html</a>
IEEE Transactions on Multimedia	vol. 9, no. 8	<a href="#">PDF</a>	<a href="#">Html</a>
IEEE Sensors Journal	vol. 7, no. 12		<a href="#">Html</a>
IEEE Transactions on Wireless Communications	vol. 6, no. 11	<a href="#">PDF</a>	<a href="#">Html</a>
Computing in Science & Engineering Magazine	vol. 9, no. 6	<a href="#">PDF</a>	<a href="#">Html</a>
IEEE MultiMedia	vol. 14, no. 4	<a href="#">PDF</a>	<a href="#">Html</a>

[Back to Top](#)

## 4. TC News

### Bio Imaging and Signal Processing (BISP) Technical Committee

The Bio Imaging and Signal Processing (BISP) Technical Committee is one of the youngest in the SP Society. It was approved and formed in late 2004, in response to the growing need within our society to have a forum and umbrella for activities related to processing of signals in biology and medicine. Specific fields of interest include (but are not limited to): molecular and medical imaging, microscopy, SP in computational biology and biological networks, signal processing of physiological signals, and bioinformatics. Learn more about the organization and activities of the BISP TC through this [exclusive in-depth report](#).

[Back to Top](#)

## 5. Chapter News and Distinguished Lectures

**Do you know?** IEEE SPS provides travel support for local chapters to invite **SPS Distinguished Lecturers**. See a list of SPS [2007 DLs](#) and [2008 DLs](#), and check each issue of the E-News for upcoming SPS Distinguished Lectures near you.

If you are interested in organizing a new SPS chapter, or participating in activities in a SPS local chapter near you, please check out [Local Chapter Resources](#). Additional questions and comments can be addressed to the [SPS Chapters Committee](#).

[Back to Top](#)

---

## 6. New Initiatives and Trends

### Research Trends in Relaying and Cooperative Communications

A relay channel consists of a source, a destination, and a relay that does not have a message of its own, but assists in the communication of the two other nodes. This channel was introduced by van der Muelen in 1971, and its capacity was investigated by Cover and El Gamal in 1979. Then the topic laid dormant for many years, until the appearance in 1998 of the work of Sendonaris, et al. Since then, the relay channel has been the focus of much attention and at the present, many conferences in signal processing and communications dedicate multiple sessions to this topic. Learn more about this active research area from [this in-depth report](#).

Learn [Standards in a Nutshell](#) from the latest issue of SPM on "**X3D: Extensible 3D Graphics Standard**" by L. Daly and D. Brutzman (November 2007).

Explore the [In-the-Spotlight](#) topic on "**Motion Capture Technology for Entertainment**" by C. Bregler (November 2007).

[Back to Top](#)

---

## 7. New PhD Theses

**Shan He** (University of Maryland, College Park, USA):  
"**A Joint Coding and Embedding Framework for Multimedia Fingerprinting**", July 2007.  
Advised by: Prof. Min Wu

This dissertation addresses the problem of protecting multimedia content from illicit redistribution through anti-collusion digital fingerprinting technology. We present a joint coding and embedding framework for multimedia fingerprinting by employing a code layer for efficient fingerprint construction and leveraging the embedding layer to achieve high collusion resistance. Two new joint-coding-embedding techniques are proposed, which show an excellent balance between collusion resistance, efficient construction, and efficient detection. Based on the proposed joint coding and embedding framework, we then develop practical algorithms to fingerprint video in such challenging practical settings as to accommodate more than ten million users and resist hundreds of users' collusion. We further study dynamic fingerprinting for subscription based content services, such as cable TV, to dynamically adjust the fingerprint design based on the

detection results of previously pirated signals. Other issues related to multimedia fingerprinting, such as fingerprinting via QIM embedding, are also discussed in this dissertation.

Click [here](#) to download the dissertation, or contact the [author](#) for more information.

### Interested in submitting or recommending a recent Ph.D. thesis?

Please prepare the following material and visit the [web submission site](#) to provide your input. Contact Associate Editor Prof. Alessandro Piva at <piva AT lci.det.unifi.it> if you have any question.

- (1) thesis author's information (full name, contact, current affiliation, URL if available), Ph.D granting institution, thesis advisor's name and contact information;
- (2) title, URL, and a short summary of the thesis (100-150 words); and
- (3) an email from the thesis advisor to Associate Editor at <piva AT lci.det.unifi.it>, confirming that the author has already successfully defended the Ph.D. thesis and that a final version of the thesis has officially been submitted according to the Ph.D. degree requirements of the author's institution.

[Back to Top](#)

## 8. New Books

### ***Computer Graphics Using OpenGL,***

by Francis S. Hill, Jr. and Stephen M. Kelley, 3rd Edition, Prentice Hall, 2006.

[Book description from the Publisher:](#) Updated throughout for the latest developments and technologies, this text combines the principles and major techniques in computer graphics with state-of-the-art examples that relate to things students see everyday on the Internet and in computer-generated movies. Practical, accessible, and integrated in approach, it carefully presents each concept, explains the underlying mathematics, shows how to translate the math into program code, and displays the result.

An in-depth review is available in [SPM November 2007](#). Visit the [book's website](#) for detailed Table of Contents and ordering information.

### ***Principles of Embedded Networked Systems Design,***

by Gregory Pottie and William Kaiser, Cambridge University Press, 2005.

[Book description from the publisher:](#) Embedded network systems (ENS) provide a set of technologies that can link the physical world to large scale networks in applications such as monitoring of borders, infrastructure, health, the environment, automated production, supply chains, homes, and places of business. This book details the fundamentals for this interdisciplinary and fast-moving field. The book begins with mathematical foundations and the relevant background topics in signal propagation, sensors, detection and estimation theory, and communications. Key component technologies in ENS are discussed: synchronization and position localization, energy and data management, actuation, and node architecture. Ethical, legal, and social implications are addressed. The final chapter summarizes some of the lessons learned in producing multiple ENS generations. A focus on fundamental principles together with extensive examples and problem sets make this text ideal for use in senior design and graduate courses in electrical engineering and computer science. It will also appeal to engineers involved in the design of ENS.

Visit the [book's website](#) for detailed Table of Contents and ordering information.

### Books Featured in Previous Issues [[details](#)]

*Model-Based Signal Processing*, by James V. Candy, John Wiley/IEEE Press, 2006.

*Streamlining Digital Signal Processing: A Tricks of the Trade Guidebook*, edited by Richard Lyons, John Wiley/IEEE Press, 2007.

*Algorithmic Information Theory: Mathematics of Digital Information Processing*, by Peter Seibt, Springer Press, 2006.

*Wavelets and Subband Coding*, by M. Vetterli and J. Kovačević. Open Access Edition.

*Speech Enhancement: Theory and Practice*, by P. Loizou, CRC Press, 2007.

[Back to Top](#)

---

## 9. Research Opportunities

### Research Funding Opportunities - European Research Council (ERC) Advanced Grant

The Scientific Council of the European Research Council (ERC) announced the publication of the Call for ERC Advanced Grant, that will channel around 4 billion Euros over the next six years to the very best research projects and the most talented researchers across Europe.

Depending on the nature of the research, ERC Advanced Grants may be up to €3,500,000 for a period of five years and will target researchers who already have established themselves as exceptional leaders in their field. ERC grants are open to researchers of any nationality, working or planning to work in Europe, and working in any field of science, scholarship or engineering. The selection process for these prestigious grants is based on an open competition with scientific excellence as the sole award criterion. Grants are awarded and managed according to simple procedures that maintain the focus on scientific excellence, encourage creativity and interdisciplinary activities, and combine flexibility with accountability.

Interested scientists will need to take into account that applications will only have a chance of succeeding if the project is outstanding and the Principal Investigator can demonstrate an outstanding track record and leadership profile in terms of originality and impact of research achievements. More info about this news can be found at <http://erc.europa.eu/>.

### Research Opportunities Featured in Previous Issues [\[details\]](#)

- Post-doc position at the Multimedia Information Analysis (MIA) Laboratory of University of Kentucky, USA.
- Post-doc position at the Signal Processing Laboratory of Washington University in St. Louis, USA.
- R&D positions in Navigation and Wireless Terrestrial Communications at Universitat Autònoma de Barcelona (UAB) Spain.

### Job Posting Portals

<http://careers.ieee.org/>

<http://jobs.phds.org/jobs/engineering/>

[http://engineering.academickeys.com/seeker\\_job.php](http://engineering.academickeys.com/seeker_job.php)

[Back to Top](#)

## Contributors of articles in this issue:

Jelena Kovačević and Aria Nosratinia.

---

## About the Inside Signal Processing E-Newsletter

Since April 2007, the IEEE Signal Processing Magazine has introduced a new form of publication - the Inside Signal Processing E-Newsletter. This monthly electronic newsletter will complement the bi-monthly Magazine to serve the members in the IEEE Signal Processing Society (SPS). Through email notification and expanded coverage on its website, the E-Newsletter will provide members with timely updates on:

- society and technical committee news,
- conference and publication opportunities, new books, and Ph.D. theses,
- signal processing related research opportunities, and
- activities in industry consortiums, local chapters, and government programs.

The Inside Signal Processing E-Newsletter is a gateway to reach out to signal processing professionals around the world. We invite you to contribute and share your news with tens of thousands of SPS members through this monthly electronic publication with fast turn-around cycle. IEEE members may manage their subscription of the email notification of the E-Newsletter and related SPS announcements at [this page](#). Please bookmark <<http://enews.ieee-spm.org>> for current and archived issues of the Inside Signal Processing E-Newsletter.

---

## Submission Instructions - Contribution for the January-February '08 Issue Due January 10, 2007

Visit the [web submission site](#) to provide your input. Make sure that you include your name, affiliation, and email and phone contact information. Contributions submitted by **January 10, 2007** will be considered for inclusion in the **next issue** of the Inside Signal Processing E-Newsletter. Please contact the Associate Editors of the corresponding sections as listed below if you have questions. Your comments and suggestions on the new submission system are welcome.

---

## Contact Information of the E-Newsletter Team

Min Wu, *SPM Area Editor for E-Newsletter*, University of Maryland, College Park, USA (minwu AT umd.edu)

Huaiyu Dai, *Associate Editor*, North Carolina State University, Raleigh, USA (huaiyu\_dai AT ncsu.edu)  
*Conference and publication news (including new books)*

Alessandro Piva, *Associate Editor*, University of Florence, Italy (piva AT lci.det.unifi.it)  
*News and activities in local chapters and research groups (including new Ph.D. theses)*

Mihaela van der Schaar, *Associate Editor*, University of California, Los Angeles, USA (mihaela AT ee.ucla.edu)  
*News and activities of SPS Technical Committees, industry consortiums and international standards*

Nitin Chandrachoodan, *Digital Production Editor*, Indian Institute of Technology – Madras (nitin AT ee.iitm.ac.in)  
*Online submission and production system*

Shih-Fu Chang, *SPM Editor-in-Chief*, Columbia University, New York, USA (sfchang AT ee.columbia.edu)

\* Please replace "AT" in the email addresses with @.

[Back to Top](#)

---

## In-Depth Articles of E-News - December 2007

### Exclusive Report from

### Bio Imaging and Signal Processing (BISP) Technical Committee

Contributor: Jelena Kovačević (TC Chair)



The Bio Imaging and Signal Processing (BISP) Technical Committee is one of the youngest in the Signal Processing Society; it is currently in its third year of existence. It was approved and formed in late 2004, in response to the growing need within our society to have a forum and umbrella for activities related to processing of signals in biology and medicine. Specific fields of interest include (but are not limited to): molecular and medical imaging, microscopy, SP in computational biology and biological networks, signal processing of physiological signals, and bioinformatics.

The BISP TC is organized similarly to the other TCs: Chair with a two-year term (Michael Unser was the inaugural chair), Vice Chair with a two-year term (currently Erik Meijering), and a membership of 32 members with three-year terms, including the current Editor-in-Chief of the IEEE Transactions on Image Processing. Each year, a third of the membership is renewed. Member responsibilities include reviewing for conferences (including ICASSP, ISBI, and GENSIPS), promoting activities in the Signal Processing Society related to the areas of biology and medicine, promoting papers in those areas and nominating them for paper awards, making connections to the funding agencies dealing with the BISP areas, etc. Unlike some of the other TCs, the BISP TC instituted a category of Associate Members (currently six members). These members are typically our younger colleagues for whom this is an opportunity to learn about the growing area and who provide us with additional resources to conduct the activities above.

Our members are diverse in many ways and we would like to continue promoting that: 21 of our members are in the general area of Bioimaging, six are in Bioinformatics and seven in Biomedical Signal Processing; 14 members are from North America, 19 from Europe and one from Asia; six members are female.

The BISP TC is intimately involved in planning and organizing International Symposium on Biomedical Imaging ([ISBI](#)). All of its past and present chairs have been members of the BISP TC. Similarly, the leadership of International Workshop on Genomic Signal Processing and Statistics ([GENSIPS](#)) is from the BISP TC. These are examples of active involvement of the TC in promoting activities within our charter.

If you would like to get involved in the work of this new and exciting TC, want to contribute ideas, suggestions, or would simply like to learn more about it, please contact Jelena Kovačević <jelenak AT cmu.edu> or visit the [TC website](#).

[Return to TC News](#)

## Research Trend in Relaying and Cooperative Communications



Contributor: Aria Nosratinia

A relay channel consists of a source, a destination, and a relay that does not have a message of its own, but assists in the communication of the two other nodes. This channel was introduced by van der Muelen in 1971, and its capacity investigated by Cover and El Gamal in 1979. Then the topic laid dormant for many years, until the appearance in 1998 of the work of Sendonaris, et al. Since then, the relay channel has been the focus of much attention.

A key difference between the relay channel and the conventional packet forwarding in the network layer (e. g. TCP/IP) is that in TCP/IP, the packets go through one node at a time. The network layer has traditionally decoupled the operations of nodes, for robustness purposes. The relay channel, on the other hand, operates in the physical layer where the source and the relay's transmissions are coordinated. Relaying has tangible benefits, especially under fading conditions in wireless links, but it also needs more complex signal processing.

Relaying has been introduced in the 802.16j (WiMax) standard. The present provisions for relaying in 802.16j are basic ones, and are mostly for coverage extension. The most sophisticated aspects of relayed cooperation are, at the moment, absent from the standards.

There has been some debate regarding the computational power needed for relaying, and if it is worth the savings in transmit power. In the past few decades, semiconductor and circuit technologies have reduced the cost of computation. Despite ominous clouds on the horizon, the trend has not abated to the present. While the computational power per flop has continued to shrink, the laws of propagation are immutable, so it seems that the future is with methods that reduce transmit power at the cost of additional computation. In the end, however, we must acknowledge that the validity of this argument (as well as the continued growth of the communications industry as a whole) is largely dependent on innovations in semiconductors and circuits.

Many open questions remain in both the theory as well as the practical aspects of the relay channel. It is too early to make specific predictions about the adoption of cooperative methods in commercial products. Nevertheless, the ideas and algorithms that are developed in cooperative communication seem too promising to lay fallow forever. It is not a stretch to predict that these ideas will be introduced into communication systems in the future, although possibly in ways that we do not foresee today.

Interested readers may read more from this [tutorial article](#) and recent special issues on cooperative communications in IEEE Journal on Selected Areas in Communications ([Feb. 2007](#)) and IEEE Trans. Information Theory ([Oct. 2007](#)).

[Return to Initiatives and Trends](#)