Signal and Information Processing Laboratory

Prof. Dr. A. Lapidoth, Prof. Dr. H.-A. Loeliger, Dr. K. Heutschi

ANNUAL REPORT

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Address:	Signal and Information Processing Laboratory ETH Zurich, Sternwartstr. 7, CH-8092 Zürich
Phone:	+41- 44 - 632 2764
Fax:	+41- 44 - 632 1208
Electronic mail:	sekr@isi.ee.ethz.ch
World Wide Web:	http://www.isi.ee.ethz.ch
Editor:	B. Röösli

Foreword

Writing the forward to the Jahresbericht could be a chore, but if I think of it as an opportunity to look back on the many things we have accomplished in the previous year, it becomes a pleasure. What a treat it is to watch our students' transformation: once curious but inexperienced beginners, they develop into seasoned researchers whose beautiful results are published in the most prestigious journals in our field. If the purpose of Graduate Studies is to bring out the best in everyone and to allow the students to fulfill their enormous potential, we have succeeded admirably.

But, alas, once they achieve their potential, we must allow them to leave the nest. This year we bid farewell to Junli Hu, or, should I say, *Dr.* Junli Hu. Fortunately, we have also welcomed new people to our Institute: Mehdi Molkaraie (as a post-doc) and Jiun-Hung Yu, who is here to study for a Ph.D.

We also achieved things outside the academic sphere. This year, for example, we applaud our visitor, Prof. Willi-Hans Steeb, for completing the Alpine Marathon of Davos.

In 2008 our Institute also organized the International Zurich Seminar. I would like to take this opportunity to thank all of you who helped organize and run this very successful event.

Finally, I would like to thank Andi for heading the Institute with true dedication. It is now my turn, and I shall try my best to follow the path he has forged.

Mai 2009 Amos Lapidoth

Contents

1. Personnel

Professor for Information Theory:

Prof. Dr. Amos Lapidoth

Professor for Signal Processing:

Prof. Dr. Hans-Andrea Loeliger

Adjunct Lecturer:	**Dr. Kurt Heutschi**		
Secretaries:	**Bernadette Röösli**		
	Marion Brändle	left on 31.10.2008	
Senior Researcher:	**Dr. Nikolai Nefedov**		
Research Assistants:	**Jonas Biveroni**	Dipl.El.Eng.	
	Lukas Bolliger	MSc ETH	
	Murti Devarakonda	Dipl.El.Eng	
	Junli Hu	Dipl.El.Eng.	left on 31.7.08
	Tobias Koch	Dipl.El.Eng.	
	Mehdi Molkaraie	Postdoc	since 24.11.08
	Maja Ostojic	Dipl.El.Eng.	
	Christoph Reller	MSc ETH	
	Stephan Tinguely	Dipl.El.Eng.	
	Ligong Wang	MSc ETH	
	Michèle Wigger	Dipl.El.Eng.	
	Georg Wilckens	MSc ETH	
	Jiun-Hung Yu	MSc.NCTU Taiwan since 16.10.08	
Technical Staff:	**Francesco Amatore**		
	Thomas Schärer		
	Patrik Strebel	El.Eng.HTL	

Academic Guests: (see 6.1 for report of activities)

Dr. Christian Vogel	Technical University Graz, Austria	01.01.-31.12.08
Prof. Andrew Eckford	York University, Toronto, Ontario, Canada	11.05.-16.05.08
Prof. Ciamac Moallemi	Columbia University, New York USA	19.05.-23.05.08
Prof. Chandra Nair	Chinese University of Hong Kong, Hong Kong	19.05.-23.05.08
Prof. V. Anantharam	UC Berkeley, CA., USA	19.05.-23.05.08
Prof. Willi-Hans Steeb	University of Johannesburg, Auckland Park, South Africa	15.05.-15.08.08
Prof. Ram Zamir	Tel Aviv University, Tel Aviv, Israel	01.08.-30.09.08
Dr. Shraga Bross	Bar-Ilan University, Ramat Gan, Israel	13.08.-13.09.08
Prof. Yossef Steinberg	Technion – Israel Institut of Technology, Technion City, Haifa, Israel	20.08.-10.09.08

2. Teaching

2.1 Lectures

Sem.	Instructors	Title	ETH-No.
5th	Prof. H.-A. Loeliger	Discrete-Time and Statistical Signal Processing	227-0101
7th	Prof. H.-A. Loeliger	Signal and Information Processing	227-0427
8th	Prof. H.-A. Loeliger	Algebra and Error Correcting Codes	227-0418
5/7th	Prof. A. Lapidoth	Applied Digital Information Theory I	227-0417
6th	Prof. A. Lapidoth	Information Transfer	227-0104
8th	Dr. H.P. Schmid	Analog Signal Processing and Filtering	227-0468
7th	Dr. K. Heutschi	Acoustics I	227-0477
8th	Dr. K. Heutschi	Acoustics II	227-0478

2.2 Practica

5/6th	Practica	Laboratory for "Fundamentals in Electrical Engineering"	227-0095
1st/2nd	T. Koch,	Coding and Cellular Automata in Matlab	PPS
3rd/4th	L. Bolliger, G. Wilckens	Practical Signal Processing using a DSP	PPS
2nd/3rd	Th. Schaerer	EMG Biofeedback Device	PPS

2.2 Semester Projects and Diploma Theses

During the spring semester 2008 and fall semester 2008, 7 Semester Projects (7 candidates) and 6 Diploma Theses (6 candidates) were carried out.

Candidates	Title	Supervisor
Semester Projects FS 2008		
Adrian Bärlocher	Autoregressive Filter Identification	Ch. Reller
Aldo Bazzi	Message Passing Through a Multiplier Node	L. Bolliger Ch. Reller
Efe Aksüyek	Information Theory and Portfolio Management	M. Feiler L. Wang
Raphael Rolny	On the Capacity of Interference Networks at High SNR	M. Wigger
Semester Projects HS 2008		
Ken Christen	Signal Class Filter with 2nd-Order Elements	Ch. Reller
Efe Aksüyek	Redundtant Matrices	M. Ostojic
Philippe Loeliger	Distributed Estimation in Wireless Networks (coupled oscillators approach)	N. Nefedov J. Biveroni
Diploma Theses FS 2008		
Samuel Braendle	A Watershed Algorithm with Shape Constraints	J. Crespo H.-A. Loeliger
Reza Moosavi	Blind Separation of Filtred Spike Signals	Ch. Reller
Vinodh Venkatesan	On Low Power Capacity of the Poisson Channel	L. Wang
Thomas Loser	Equalization for WCDMA/HSDPA Receiver (2)	M. Devarakonda
Diploma Theses HS 2008		
Marcel Favini	Acoustic Headtracking	L. Bolliger Ch. Reller
Jonas Sonnenmoser	Akkustiksensor	L. Bolliger Ch. Reller

3. Research

3.1 Research Areas

The Signal and Information Processing Lab focusses on research and teaching in the following areas:

Information Theory and Coding

Information theory, error correcting codes, and their application to communication systems.

Current topics:

- Combined source-channel coding for multi-access networks
- Multi-access channels with noisy feedback
- Network coding
- Capacity of fading channels
- Broadcasting correlated sources
- Multi-path channels
- Interference networks
- Optical channels

Digital Signal Processing

Current topics:

- Fundamentals and applications of graphical models (factor graphs)
- Model-based detection & estimation
- Digital calibration of analog circuits

Analog and Hybrid Signal Processing

Current topics:

- Digital-to-analog conversion and analog-to-digital conversion
- Joint synchronization and decoding

3.2 Current Research Projects

Information Theory and Coding

Prof. Dr. Amos Lapidoth

The Poisson Channel at High Intensities

The study of the Poisson channel has a long history, as it is one of the key models for optical communication. Of special interest is channel capacity, which is the highest rate at which reliable communication is achievable over this channel. Since, the model is highly non-linear (with the output being a Poisson random variable of a mean that is proportional to the input), no closed-form expression for the capacity is known. In this project we study the asymptotic behavior of channel capacity at high intensities. Our approach is based on a new paradigm - a paradigm based on the notion of capacity achieving input distributions that escape to infinity - that we have introduced for the study of channels at high signal-to-noise ratios.

Bounds on the Capacity of Free-Space Optical Intensity Channels

Channel capacity is an extremely important quantity, which is, alas, typically very difficult to compute precisely (even numerically). To address this problem, we have recently developed a new technique which can provide very tight upper bounds on channel capacity. This technique has been employed very successfully to the study of the capacity of fading channels and of phase noise channels. This project addresses a different channel, namely an optical transmission channel throughplain air, the so called "free-space optical intensity channel". Applying our new bounding technique we hope to reach the goal of finding some new upper and lower bounds on the capacity of free-space optical intensity channels.

On the Asymptotic Capacity of Multiple-Input Single-Output Fading Chanels with Memory

In this project we study the capacity of Gaussian fading channels with memory where neither the transmitter nor the receiver has access to the realization of the fading process. The emphasis is on the high signal-to-noise ratio (SNR) regime.

Robust Communication over Fading Channels

We study the robustness of the information theoretic analysis of fading channels with respect to the assumptions on the fading law. Of special interest to us is the pre-log, which is defined as the limiting ratio of channel capacity to the logarithm of the signal-to-noise ratio (SNR).

Transmitting a Gaussian Source on the Gaussian Channel

We revisit the classical problem of sending a memoryless Gaussian source over the additive discrete-time Gaussian noise channel. We propose a continuum of

asymptotically optimal schemes that include, as special cases, the classical source-channel separation approach and Goblick's uncoded scheme.

Sending a Bi-Variate Gaussian Source over the Gaussian MAC

We study a distributed communication problem where each component of a bi-variate Gaussian source is observed by a different user. The users communicate to a single receiver via a Gaussian multiple-access channel. We study the optima achievable distortions. Source-channel separation is sub-optimal.

A Linear Interference Network with Local Transmitter Side Information

To study the role of local information on the throughput of a global wireless network we consider a linear model where each node suffers from interference caused by the previous J users. The node knows the interfering messages, but not signals. We study the high SNR throughput & degrees of freedom.

The Capacity of a Channel that Heats Up

Motivated by on-chip communication scenarios, we study the capacity of a Gaussian channel corrupted by thermal noise, where the temperature is not only governed by the ambient room temperature but also by the amplitude of the previously-transmitted signals.

A Sensor Network with Feedback

We study the optimal mean squared-error in the transmission of a bi-variate Gaussian source over a Gaussian multiple-access channel. Transmitter 1 (resp. 2) computes the symbol to send at time k based on the first (resp. second) component of the source vector and on previous channel outputs.

On the Capacity of a Gaussian MAC with Noisy Feedback

We study the capacity of the Gaussian MAC with noisy feedback. We prove that feedback strictly increases the capacity region irrespective of how noisy it is. Settling a longstanding open problem, we also show that the Cover-Leung region is sub-optimal even for the Gaussian MAC with partial feedback.

Broadcasting Correlated Gaussians

We study a one-to-two Gaussian broadcasting problem where the transmitter observes a bi-variate Gaussian source and each receiver wishes to estimate one of the source components subject to expected squared-error distortion. Communication is via an average power constrained broadcast channel.

A Channel that Heats Up

We study information theoretic limits on point-to-point communication between two terminals that are located on the same chip. In particular, we study channel capacity when the allowed transmit power is low.

Discrete Memoryless Relay Channel with Receiver-Transmitter Feedback

We consider a communication scenario with a relay and with feedback from the receiver to the transmitter. For this scenario we propose new coding schemes which outperform all previously known schemes in terms of achievable rates.

On Cognitive Interference Networks

We study general interference networks with cognitive transmitters. More precisely, we assume that each transmitter besides its own message knows a subset of other transmitters' messages. For such a scenario we study the high SNR asymptotics of the maximum achievable throughput.

A Hot Channel

We study capacity limits on point-to-point communication between two terminals that are located on the same chip. Conditions are determined under which the capacity is bounded in the input power, i.e., under which the capacity does not grow to infinity as the allowed transmit power increase.

The pre-log of Gaussian broadcast with feedback can be two

We give an example of a two-user Gaussian broadcast channel with a single antenna at the transmitter and at both receivers where perfect feedback allows to achieve pre-log 2. The result can also be extended to a two-user Gaussian interference channel.

The Gaussian MAC with Conferencing Encoders

We derive the capacity region of the Gaussian MAC with conferencing encoders. To this end we propose a novel technique to show the optimiality of Gaussian input distributions under a Markov condition.

Multipath Channels of Bounded Capacity

We investigate the capacity of discrete-time, non-coherent, multipath fading channels where the number of paths is infinite in the sense that the channel output is influenced by all previous channel inputs. We study conditions under which channel capacity is bounded in the allowed transmit power.

The Free-Space Optical Intensity Channel at Low SNR

Free-space optical intensity channels are used to model infrared communication in an environment with strong ambient light. Hence of particular interest is the capacity at low SNR. We derive the asymptotic growth of the channel capacity at low SNR under average and/or peak power constraints.

On Multipath Fading Channels at High SNR

We the study a discrete-time, non-coherent, multipath fading channel where the number of paths is finite. The focus is on capacity at high signal-to-ratios (SNR). In particular, we investigate the capacity pre-loglog, defined as the limiting ratio of capacity to loglog SNR as SNR tends to infinity.

The Entropy of the Sum and of the Difference of Independent Random Variables

By how much can the entropy of the sum of independent random variables differ from the entropy of their difference? Can the gap between the two entropies be arbitrarily large? We study both regular entropies as well as differential entropies.

Multipath Channels of Unbounded Capacity

We investigate the capacity of discrete-time, non-coherent, multipath fading channels. We study conditions under which channel capacity is unbounded in the allowed transmit power.

The Poisson Channel at Low Input Powers

We study the asymptotic capacity at low input powers of an average-power limited or an average- and peak-power limited discrete-time Poisson channel. We consider channels whose dark currents are proportional to the input powers as well as channels whose dark currents are constant.

Wyner's Interference Network with Side-Information at Transmitters and Receivers

We consider a linear interference network modeling the communication in wireless cellular systems. For this network we explore a duality regarding transmitter side-information (cognition of other transmitters' messages) and receiver side-information (observation of other receivers' signals).

Digital Signal Processing

Prof. Dr. Hans-Andrea Loeliger

Fundamentals and Applications of Graphical Models

Most of our research is somehow related to graphical models (factor graphs) and to message passing algorithms on such graphs. We are interested in a wide variety of conceptual and algorithmical issues.
Examples include
- model-based signal processing
- adaptation and learning
- local formulation of Kalman filtering, expectation maximization, Monte Carlo particle methods, etc.

Modeling and Denoising of Almost-Periodic Signals

We use time-varying Fourier series for modeling and denoising of almost-periodic signals.

Multipath Sequential Decoding

We study near-ML decoding of LDPC codes and other codes by generalizations of sequential decoding.

Joint Demodulation, Synchronization, and Decoding

We study dynamical systems for joint demodulation, synchronization, and decoding.

Computational Information Theory

We use Monte-Carlo methods to compute information rates of source/channel models with a nontrivial Markov structure.

Robust Analog Circuits

We investigate large-scale analog circuits that can be built with small (high-mismatch) transistors.

Digital Calibration of Analog Circuits

We study the use of digital calibration techniques to reduce the area and the power consumption of analog circuits such as, e.g., analog-to-digital converters and digital-to-analog converters.

3.3 Completed Projects

HU Junli

On Gaussian Approximations in Message Passing Algorithms with Application to Equalisation

ETH-Diss. Nr. 17804 (Referee: Prof. Dr. Hans-Andrea Loeliger)

Data estimation appears in many areas of the signal processing: digital communication, data extraction in biomedical applications, parameter estimation and tracking in control systems, and data save and read on magnetic storage devices. Depending on the system model and estimation criteria, we use different algorithms or their combinations for this challenging task.

Based on a graphical model, the factor graphs, we initiate the discussion by addressing the data estimation in digital communication, which is also known as equalization. We generalize the discrete-time system model, used in the communication to other applications by recognizing that we can often describe a data source by a sequence of discrete valued, e.g. binary, random variable. This sequence is sent through a discretetime channel model and at the channel output, we get a sequence of observations which is corrupted by an additive white Gaussian noise process. The equalization means, given the observation and the system model, including the knowledge on the stochastic processes of the input source and the noise at the output, we estimate the input sequence.
In the factor graph notation, we describe two well-known algorithms: the BCJR and the Kalman filtering or LMMSE (linear minimum mean squared error) algorithms. The BCJR algorithm delivers the maximum a-posteriori (MAP) estimation, which is the optimum for the above systemsetting. However, its exponential computational complexity is prohibitive for many applications, when the alphabet size of the discrete input source and/or the channel order is large. The LMMSE algorithm does not give the exact MAP estimation for the discrete data input. The equalization result, expressed in the error percentage of the estimated symbol, has usually a huge gap to that by the BCJR algorithm. The complexity of the LMMSE estimation is cubic in the channel order. Therefore, it is widely used in many applications.

As one of the main contributions, we propose a Gaussian approximation for a discrete random variable. This is inspired by the assumed density filtering (ADF) and the expectation propagation (EP), both discussed by Th. Minka in his thesis. We apply this new Gaussian approximation to the Kalman filtering and get an iterative scheme. We can show that this iterative Kalman filter delivers a much better result than the pure LMMSE solution, when the input data sequence is uncoded. The complexity remains cubic in the channel order. In some uncoded cases, it almost close the gap of the result to the one by the BCJR algorithm. For coded input data, this new approximation method does not seem to help much. Therefore, it is suitable to some applications, e.g., some biomedical applications, where we have only prior knowledge over the input stochastic process. To applications in the communication, where the input data are mostly coded, this

new approximation is not very interesting.

In another contribution, we study the multiplier (scalar product) node in a factor graph. We propose two Gaussian approximations: one for the forward message of the scalar output variable, the other for the backward message of one of the input vectors. The approximation of the backward message is compared with the sum-product message and the traditional expectation maximization (EM) approximation. The Gaussian approximation of the forward message is compared with the true distribution of the output random variable experimentally.

WIGGER Michèle Angela

Cooperation on the Multiple-Access Channel

ETH-Diss. Nr. 17991 (Referee: Prof. Dr. Amos Lapidoth)

We study the two-user additive white Gaussian noise (AWGN) multiple access channel (MAC), i.e., a scenario where two transmitters communicate with a common receiver and where the receiver observes the sum of the two transmitted signals in additive white Gaussian noise. In the classical MAC the transmitters can cooperate only through the choice of the codebooks but not based on the messages since the transmitters are completely ignorant of each other's message. Here, we consider two variations of this theme where the transmitters have some additional means to cooperate. The first variation involves that the two transmitters observe imperfect feedback from the channel outputs. Thus, the transmitters can generate their signals also depending on the feedback outputs and through this also depending on the other transmitter's message. The second variation involves that prior to each transmission block the two transmitters can communicate over perfect bit-pipes of given capacities. Thus, the transmitters can generate their signals also depending on the observed pipe outputs, and through them also depending on the other transmitter's message.

For the first variation, i.e., the AWGN MAC with imperfect feedback, we study four different kinds of imperfect feedback: 1.) noisy feedback, where both transmitters have feedback that is corrupted by additive white Gaussian noise; 2.) noisy partial feedback, where one transmitter has noisy feedback and the other no feedback; 3.) perfect partial feedback, where one transmitter has perfect feedback and the other no feedback; and 4.) noisy feedback with the receiver being perfectly cognizant of the feedback noises.

For all four kinds of feedback we derive new achievable rate regions. These regions exhibit that, irrespective of the Gaussian feedback-noise variances, for all four kinds of feedback the capacity region with feedback strictly larger than without. Moreover, for certain channel parameters our new achievable region for perfect partial feedback is strictly larger than the Cover-Leung region. This answers in the negative the question posed by van der Meulen as to whether the Cover-Leung region equals the capacity region of the AWGN MAC with perfect partial feedback. Finally, our achievable region for noisy feedback converges to the perfect feedback capacity region as the feedback-noise variances on both links tend to 0.

For the second variation, i.e., the two-user AWGN MAC with conferencing encoders,we derive the capacity region. Our derivation introduces a new technique for proving optimality of Gaussian distributions in certain optimization problems involving mutual information expressions with a Markovity constraint. This technique is fairly general and can also be used to establish the optimality of jointly Gaussian Markov distributions for the Slepian-Wolf capacity region for the Gaussian MAC with a common message and for the Cover-Leung achievable region for the Gaussian MAC with noise-free feedback.

We also consider a Costa-type extension of the Gaussian MAC with conferencing encoders. In this setting the received signal suffers not only from Gaussian noise

but also from Gaussian interference that is known acausally to the transmitters (but not the receiver). We show that in this setting the interference sequence can perfectly be canceled, i.e., the capacity region without interference can also be achieved in the setting with interference. This holds irrespective of whether the transmitters learn the interference sequence before or after the conference. As a corollary it follows that also for the Gaussian MAC with degraded message sets—which corresponds to a special case of the MAC with conferencing encoders—the transmitters can perfectly cancel a Gaussian interference if they know the interference acausally.

TINGUELY Stéphane

Transmitting Correlated Sources over Wireless Networks

ETH-Diss. Nr. 18112 (Referee: Prof. Dr. Amos Lapidoth)

This dissertation addresses the problem of transmitting correlated sources over wireless networks. More precisely, it studies the Shannon-theoretic limits in the power-distortion trade-off for two elementary Gaussian scenarios: a multiple-access scenario and a broadcast scenario.

The two considered models can be described as follows. In the multiple-access case, a memoryless bi-variate Gaussian source is to be transmitted over an average-power constrained Gaussian two-to-one multiple-access channel. The source is observed distributedly by the two transmitters; Transmitter 1 observes the first source component and Transmitter 2 observes the second source component. Each transmitter then describes its source component to the central receiver which wishes to reconstruct each source component subject to expected squared-error distortion. In the broadcast case, a memoryless bi-variate Gaussian source is to be transmitted over an average-power constrained Gaussian one-to-two broadcast channel. The source is observed by the central transmitter and is to be reconstructed distributedly by the two receivers which both observe the same transmitted signal corrupted by different additive white Gaussian noise. From its observation, Receiver 1 wishes to estimate the first source component and Receiver 2 wishes to estimate the second source component. For both scenarios we seek to characterize the pairs of expected squared-error distortions that are simultaneously achievable on the two source components. In the multiple-access scenario the problem is additionally studied for the case with perfect feedback from the channel output to the two receivers.

The main results of this dissertation are sufficient conditions and necessary conditions for the achievability of a distortion pair expressed as a function of the channel SNR and of the source correlation. In several cases these necessary conditions and sufficient conditions are shown to agree. In particular, for each considered scenario (multiple-access, multiple-access with feedback, and broadcast) we show that if the channel SNR is below a certain threshold, then the minimal distortion pairs are achieved by an uncoded transmission scheme. In each case, the SNR-threshold is expressed as a function of the source correlation. Moreover, for the multiple-access scenarios, with feedback and without feedback, we additionally evaluate the precise high-SNR asymptotics of the optimal distortion pairs.

3.4 Completed Dissertations

HU Junli

On Gaussian Approximations in Message Passing Algorithms with Application to Equalization

ETH Diss. Nr. 17804
Referee: Prof. Dr. Hans-Andrea Loeliger
Co-referee: Prof. A. Eckford, York University

WIGGER Michèle Angela

Cooperation on the Multiple-Access Channel

ETH-Diss. Nr. 17991
Referee: Prof. Dr. Amos Lapidoth
Co-referees: Prof. M. Gastpar, UC Berkeley
Dr. G. Kramer, Alcatel

TINGUELY Stéphane

Transmitting Correlated Sources over Wireless Networks

ETH-Diss. Nr. 18112
Referee: Prof. Dr. Amos Lapidoth
Co-referee: Prof. Dr. S. Diggavi, EPFL

4. Conferences, Meetings and Committees

4.1 Conference Organization

Prof. Lapidoth

Co-Chair, 2008 International Zurich Seminar on Communications, Zurich, Switzerland, March 4-18, 2008.

Co-Organizer of Information & Communication Mini-Symposium on Computational Optimization, held in Zurich from March 19-23, 2008.

Prof. Loeliger

Co-Chair, 2008 International Zurich Seminar on Communications, Zurich, Switzerland, March 14-18, 2008.

TPC Chair, 2008 International Symposium on Turbo Codes & Related Topics, Lausanne, Switzerland, September 1-5, 2008.

4.2 Participation in Congresses and Meetings

Devarakonda Murti	5th International Symposium on Turbo Codes and Related Topics, EPFL Lausanne, Switzerland, 1.-5.9.2008.
Koch Tobias	2008 International Zurich Seminar on Communications (IZS), Zurich, Switzerland, 14.-18.3.2008.
Koch Tobias	IEEE Information Theory Workshop (ITW), Porto, Portugal, 5.-9.5. 2008.
Koch Tobias	IEEE International Symposium on Information Theory (ISIT 2008), Toronto, Canada, 6.-11.7.2008.
Koch Tobias	2008 IEEE 25th Convention of Electrical and Electronics Engineers in Israel, Eilat, Israel, 3.-5.12.2008.
Lapidoth Amos	IEEE Information Theory Workshop (ITW), Porto, Portugal, 5.-9.5.2008.
Lapidoth Amos	Elements of Information Theory Workshop, Standford University, USA, 16.5.2008.
Lapidoth Amos	IEEE International Symposium on Information Theory (ISIT 2008), Toronto, Canada, 6.-11.7.2008.
Lapidoth Amos	2008 IEEE 25th Convention of Electrical and Electronics Engineers, Eilat, Israel, 3.-5.12.2008.
Loeliger H.-A.	2008 Information Theory and Applications Workshop (ITA), UCSD, La Jolla, CA., USA, 27.1.-1.2.2008.
Loeliger H.-A.	IEEE Information Theory Workshop (ITW), Porto, Portugal, 5.-9.5.2008.
Loeliger H.-A.	IEEE International Symposium on Information Theory (ISIT 2008), Toronto, Canada, 6.-11.7.2008.
Loeliger H.-A.	5th International Symposium on Turbo Codes & Related Topics, EPF Lausanne, Switzerland, 1.-5.9.2008.
Loeliger H.-A.	Joint Workshop on Coding and Communications (JWCC), Napa Valley, CA., USA, 26.-28.10.2008.
Tinguely Stéphane	2008 International Zurich Seminar on Communications (IZS), Zurich, Switzerland, 14.-18.3.2008.
Tinguely Stéphane	IEEE International Symposium on Information Theory (ISIT 2008), Toronto, Canada, 6.-11.7.2008.
Vogel Christian	International Symposium on Circuits and Systems (ISCAS 2008), Seattle, USA, 17.-22.5.2008.

Vogel Christian	The 6th Symposium on Communication Systems, Networks and Digital Signal Processing (CSNDSP 2008), Graz, Austria, 22.-25.7.2008.
Vogel Christian	The International Conference on Signal and Electronic Systems (ICSES 2008), Krakow, Poland, 13.-18.9.2008.
Wang Ligong	2008 IEEE 25th Convention of Electrical and Electronics Engineers, Eilat, Israel, 3.-5.12.2008.
Wigger Michèle	IEEE International Symposium on Information Theory (ISIT 2008), Toronto, Canada, 6.-11.7.2008

4.3 Service Activities and Society Memberships

Prof. Lapidoth

Fellow of the IEEE

Member of the IMS Institute of Mathematical Statistics, Bethesda, USA

Co-Chair, 2008 International Zurich Seminar on Communications

Research Affiliate in the Research Laboratory of Electronics (RLE) at the Massachusetts Institute of Technology (MIT)

Member of the Center for Communication and Information Technologies (CCIT), Technion, Haifa, Israel

Prof. Loeliger

Fellow of the IEEE

Associate Editor, IEEE Transactions on Information Theory

Co-Chair, 2008 International Zurich Seminar on Communications

TPC Chair, Conference on Turbo Coding & Related Topics 2008

Chair, IEEE Switzerland Chapter on Digital Communication

Member, Board of Governors, IEEE Information Theory Society

Dr. Heutschi

Member, Acoustical Society of America

Member, Audio Engineering Society

Member, Swiss Acoustical Society (SGA)

Member, German Acoustical Society (DEGA)

4.4 Presentations by Institute Members

Koch Tobias	"Multipath Channels of Bounded Capacity", IEEE Information Theory Workshop (ITW), Porto, Portugal, 12.3.2008.
Koch Tobias	"On Multipath Fading Channels at High SNR", IEEE International Symposium on Information Theory (ISIT), Toronto, Canada, 10.7.2008.
Koch Tobias	"Multipath Channels of Unbounded Capacity", 2008 IEEE 25th Convention of Electrical and Electronics Engineers, Eilat, Israel, 5.12.2008.
Lapidoth Amos	"The Matched Filter Done Right", Bar-Ilan University, Ramat Gan, Israel, 17.3.2008.
Loeliger H.-A.	"On Analog-to Digital Conversion with Low-Precision Components", 2008 Information Theory and Applications Workshop (ITA), UCSD, La Jolla, CA., USA, 27.1.-1.2.2008.
Loeliger H.-A.	"An Introduction to Factor Graphs", Machine Learning in Structural Bioinformatics, Copenhagen, Denmark, 23.4.2008.
Loeliger H.-A.	"On the Static Accuracy of Analog-to Digital Converters and Digital-to-Analog Converters with Low-Precision Components", EPF Lausanne, Switzerland, 28.5.2008.
Loeliger H.-A.	"Localizing and Forgetting: New Tricks and Applications for the Forward-Backward Algorithm", JWCC, St. Helena, Napa Valley, USA, 26.-28.10.2008.
Tinguely Stéphane	"Broadcasting Correlated Gaussians", IEEE International Symposium on Information Theory (ISIT 2008), Toronto, Canada, 8.7.2008.
Vogel Christian	"Compensation of Distortions Caused by Periodic Nonuniform Holding Signals", 6th Symposium on Communication Systems, Networks and Digital Signal Processing, Krakow, Poland, 22.7.2008.
Vogel Christian	"Compensation of Two-periodic Nonuniform Holding Signal Distortions by Using a Variable FIR Filter", International Conference on Signals and Electronic Systems, Graz, Austria, 14.9.2008.
Wang Ligong	"The Poisson Channel at Low Input Powers", 2008 IEEE 25th Convention of Electrical and Electronics Engineers, Eilat, Israel, 5.12.2008.
Wigger Michèle	"Wireless Networks with Imperfect Side-Information", KTH Stockholm, Sweden, 11.3.2008.

Wigger Michèle	"Wireless Networks with Imperfect Side-Information", Chalmers University of Technology, Göteborg, Sweden, 4.6.2008.
Wigger Michèle	"Wireless Networks with Imperfect Side-Information", KTH Stockholm, Sweden, 30.6.2008.
Wigger Michèle	"The Prelog of Gaussian Broadcast with Feedback can be Two", IEEE International Symposium on Information Theory (ISIT 2008), Toronto, Canada, 8.7.2008.
Wigger Michèle	"The Gaussian MAC with Conferencing Encoders", IEEE International Symposium on Information Theory (ISIT 2008), Toronto, Canada, 11.7.2008.
Wigger Michèle	"Cooperation on the Multiple-Access Channel", Calmers University of Technology, Göteborg, Sweden, 21.10.2008.
Wigger Michèle	"Wireless Networks with Imperfect Side-Information", Supelec, Gif-sur-Yvette, France, 20.11.2008.

4.5 Organization of Lectures, Seminars, and Colloquia

Speakers invited by Prof. Lapidoth:

02.09.08 **Yossef Steinberg,** Technion, Haifa, Israel
"The Role of Side Information in Channel and Source Coding.

09.09.08 **Emre Telatar,** EPF Lausanne, Switzerland
"On the Rate of Channel Polarization".

09.09.08 **Mikhal Shemer,** Tel Aviv University, Tel Aviv, Israel
"A Korner-Marton Approach for Low Complexity Video Encoding".

17.09.08 **Gerhard Kramer,** Bell Laboratories, Murray Hill, NJ, USA
"Recent Results on Gaussian Interference Channel Capacity".

22.09.08 **Michael Gastpar,** UC Berkeley, CA., USA
"Computation Codes – A New Tool for Multi-user Communication".

24.09.08 **Amir Leshem,** Bar-Ilan University, Ramat Gan, Israel
"Game Theory and the Frequency Selective Gaussian Interference Channel".

27.11.08 **Suhas Diggavi,** EPF Lausanne, Switzerland
"A Bit of Network Information Theory".

Invited by Prof. Loeliger:

25.02.08 **Pascal Vontobel,** Hewlett-Packard Laboratories, Palo Alto, CA., USA
"A Factor Graph Approach to Universal Channel Decoding".

13.05.08 **Andrew Eckford,** York University, Toronto, Ontario, Canada
"Information Theoretic Aspects of Molecular Communication".

11.06.08 **Justin Dauwels,** MIT, Cambridge, MA, USA
"Machine Learning Techniques for Quantifying Neural Synchrony: Application to the Early Diagnosis of Alzheimer's Disease from EEG".

16.06.08 **Bernard Fleury,** Aalborg University, Aalborg, Denmark
"Recent Developments in Iterative Techniques for Joint Channel Estimation and Data Decoding in Multi-User Communication Systems".

31.07.08 **Boris Murmann,** Stanford University, Stanford, USA
"Digitally Assisted A/D Converters and Sensor Interface Circuits".

24.11.08 **Negar Kiyavsh,** University of Illinois at Urbana-Champaign, USA
"Time is of the Essence; Exploiting an Unused Degree of Freedom in Packet Networks".

08.12.08 **Emina Soljanin,** Bell-Labs, Alcatel-Lucent, Murray Hill, NJ, USA
"Two Non-Standard(ized) Applications of Fountain Codes".

Colloquium Speakers for the Colloquium “Acoustics” were:

Invited by Dr. Heutschi:

07.05.08 **Martin Lachmann,** Dipl. Akustiker SGA und
Reto Pieren, Acoustics GmbH, Gelterkinden, Switzerland
“Entwicklung, Test und Anwendung eines Simulationswerkzeugs für tieffrequente Schallfelder in Räumen – Erkenntnisse für die raumakustische Praxis”.

21.05.08 **Kurt Eggenschwiler,** EMPA Dübendorf, Switzerland
“Akustische Gestaltung in Schulen”.

22.10.08 **Daniel Bisig,** University of the Arts, Zurich, Switzerland
“Interactive Swarm Orchestra – Untersuchungen in schwarmbasierter Musik”.

12.11.08 **Peter Graf,** Fachstelle Lärmschutz, Kanton Zürich
“35 Jahre Lärmbekämpfung im Kanton Zürich – von der Bretterwand am Autobahnrand zum umfassenden Lärmschutzprojekt”.

10.12.08 **Gert Notbohm,** Heinrich-Heine-Universität Düsseldorf, Germany
Personenspezifische Einstellungen und Wertungen in der Wahrnehmung der akustischen Umwelt”.

5. Publications

Biveroni Jonas Loeliger Hans-Andrea	"On Sequential Analog-to-Digital Conversion with Low-Precision Components", 2008 Information Theory and Applications Workshop (ITA), UCSD, La Jolla, CA., USA January 27-February 1, 2008.
Bross S. Lapidoth Amos Tinguely Stephane	"Broadcasting Correlated Gaussians", Proceedings IEEE International Symposium on Information Theory 2008, (ISIT), Toronto, Canada, July 6-11, 2008
Dauwels Justin Loeliger Hans-Andrea	"Computation of Information Rates by Particle Methods", IEEE Transactions on Information Theory, January 2008, Vol. 54, No. 1, pp. 406-409.
Gastpar Michael Wigger Michèle	"The Pre-log of Gaussian Broadcast with Feedback can be Two", Proc. Of 2008 Information Theory and Application Workshop, University of California, San Diego, USA, Jan. 27-Feb. 1, 2008
Koch Tobias Lapidoth Amos	"Multipath Channels of Unbounded Capacity", IEEE 25th Convention of Electrical and Electronics Engineers in Israel, Eilat, Israel, December 3-5, 2008, pp. 640-644.
Koch Tobias Lapidoth Amos	"Multipath Channels of Bounded Capacity", Information Theory Workshop (ITW), Porto, Portugal, May 5-9, 2008
Koch Tobias Lapidoth Amos	"On Multipath Fading Channels at High SNR, IEEE International Symposium on Information Theory (ISIT), Toronto, Canada, July 6-11, 2008
Lapidoth Amos Moser Stefan Wigger Michèle	"On the Capacity of Free-Space Optical Intensity Channels", Proceedings of International Symposium on Information Theory 2008, Toronto, Canada, July 6-11, 2008.
Lapidoth Amos Pete G.	"On the Entropy of the Sum and of the Difference of Independent Random Variables", Proceedings of the 25th IEEE Convention Electrical & Electronics Engineers in Israel (IEEEI), Eilat, Israel, December 2008, pp. 623-625.
Lapidoth Amos Shapiro Jeffrey H. Venkatesan Vinodh Wang Ligong	"The Poisson Channel at Low Input Powers", Proceedings of the 25th Convention of Electrical & Electronics Engineers in Israel, Eilat, Israel, Dec. 3-5, 2008, pp. 654-658.
Loeliger Hans-Andrea Molkaraie Mehdi	"Simulation-based Estimation of the Partition Function and the Information Rate of Two-Dimensional Models", Proceedings 2008 IEEE International Symposium on Information Theory, Toronto, Canada, July 6-11, 2008,
Mendel Stefan Vogel Christian	"Improved Lock-Time in All-Digital Phase-Locked Loops due to Binary Search Acquisition", Proceedings of 14th International Conference on Electronics, Circuits and

	Systems (ICECS 2008), St. Julians, Malta, September 1-3, 2008, pp. 384-387.
Murmann Boris Vogel Christian Koeppl Heinz	"Digitally Enhanced Analog circuits: System Aspects", Proceedings of 2008 IEEE International Symposium on Circuits and Systems (ISCAS 2008), Seattle, USA, May 18-21, 2008, pp. 560-563.
Nefedov Nikolai	"On Application of Coupled NEMS for Spectral Sensing" Proceedings 2nd International Conference on Nanoscience and Nanotechnology, Melbourne, Australia, February 2008.
Nefedov Nikolai	"Decentralized Synchronization and Estimation in Wireless Networks", Lecture Notes in Computer Science, Springer-Verlag Berlin, Germany, 2008, vol. 5174, pp. 1-12.
Tinguely Stephan	"Transmitting Correlated Sources over Wireless Networks", Proceedings IEEE International Symposium on Information Theory, Toronto, Canada, July 6-11, 2008.
Vogel Christian Krall Christoph	"Compensation of Distortions Caused by Periodic Nonuniform Holding Signals", Proceedings of 6th Symposium on Communications Systems, Networks and Digital Signal Processing (CSNDSP 2008), Graz, Austria, July 22-25, 2008, pp. 152-155.
Vogel Christian Saleem Shahzad Mendel Stefan	"Adaptive Blind Compensation of Gain and Timing Mismatches in M-Channel Time-Interleaved ADSs", Proceedings of 14th International Conference on Electronics, Circuits and Systems (ICECS 2008), St. Julians, Malta, Sepember 1-3, 2008, pp. 49-42.
Vogel Christian	"Compensation of Two-periodic Nonuniform Holding Signal Distortions by Using a Variable FIR Filter", Proceedings of the International Conference on Signals and Electronic Systems (ICSES 2008), Krakow, Poland, September 14-17, 2008, pp. 323-326.
Shraga Boss Lapidoth Amos Tinguely Stephan	"Broadcasting Correlated Gaussians", IEEE International Symposium of Information Theory (ISIT), Toronto, Canada, July 6-11, 2008
Shraga Boss Lapidoth Amos Wigger Michèle	"The Gaussian MAC with Conferencing Encoders", Proceedings of International Symposium on Information Theory, Toronto, Canada, July 6-11, 2008
Tertinek Stefan Vogel Christian	"Reconstruction of Nonuniformly Sampled Bandlimited Signals Using a Differentiator-Multiplier Cascade", IEEE Transactions on Circuits and Systems I: Regular Papers, September 2008, Vol. 55, Issue 8, pp. 2273-2286.

Vontobel Pascal Kavcic Alek Arnold Dieter Loeliger Hans-Andrea	"A Generalization of the Blahut-Arimoto Algorithm to Finite-State Channels", IEEE Transactions Information Theory, Vol. 54, No. 5, pp. 1887-1918.
Wigger Michèle Gastpar Michael	"The Pre-Log of Gaussian Broadcast with Feedback can b Two", Proceedings of International Symposium on Information Theory, Toronto Canada, July 6-11, 2008

6. Guests, Visitors

6.1 Activies of Academic Guests at the Institute

Guests of Prof. Lapidoth:

Prof. Ciamac C. Moallemi
Columbia University, New York, USA
held a talk on the occasion of the Mini-Symposium
on Computational Optimization 19.05.– 3.05.2008

Prof. Chandra Nair
Chinese University of Hongkong, China
held a talk on the occasion of the Mini-Symposium
on Computational Optimization 19.05.-23.05.2008

Prof. Venkat Anantharam
UC Berkeley, CA., USA
held a talk on the occasion of the Mini-Symposium
on Computational Optimization 19.05.-23.05.2008

Prof. Shraga Bross
Bar-Ilan University, Ramat Gan, Israel
collaboration with Prof. A. Lapidoth 13.08.-13.09.2008

Prof. Yossef Steinberg
Technion – Israel Institute of Technology, Technion City, Haifa, Israel
collaboration with Prof. A. Lapidoth and
held two talks on “The Role of Side Information in
Channel Source Coding”, (Part I and II) 20.08.-10.09.2008

Guest of Prof. Loeliger:

Dr. Christian Vogel
Technical University, Graz, Austria
Postdoctoral student, collaboration with
Prof. H.-A. Loeliger 01.01.-31.12.2008

Prof. Andrew Eckford
York University, Toronto, Ontario, Canada
held a talk on “Information Theoretic Aspects of
Molecular Communication” and co-referee for
PhD thesis of Junli Hu. 11.05.-16.05.2008

Prof. Willi-Hans Steeb
University of Johannesburg, Auckland Park,
South Africa
Collaboration with Prof. H.-A. Loeliger 15.05.-15.08.2008

Prof. Ram Zamir
Tel Aviv University, Tel Aviv, Israel
collaboration with Prof. H.-A. Loeliger and held
lectures on “Lattices Are Everywhere” 01.08.-30.09.2008