Professional Statement of Muriel Médard

The motivation of my work is the fact that communications have moved away from point-to-point, or link, models, to networked models. Moreover, the nature of these networks is increasingly heterogeneous, relying on a federation of different physical layers, ranging from optical fiber communications to wireless links. This heterogeneity allows for flexibility and quasi-ubiquitous access to networked systems, but often at the expense of robustness and reliability. Growing societal reliance on networked services renders an interruption or degradation of service, whether by malicious attack or inherent variability of the physical layer, particularly grievous. I seek to determine, in my research, a means of providing effective and reliable networked communications, with strong consideration of the physical layer.

My research interests lie in three main areas: wireless communications, particularly the information-theoretic investigation of fading channels; high-speed networks, particularly in the areas of robustness and security; and network coding, which brings together coding and networking to change dramatically the way in which networks operate. Both of these areas relate to end-to-end transmission reliability and efficient use of resources. My goals in the areas of research and education are:

- Contribute to the understanding of the fundamental limits of reliable communications in networked environments.

- Establish, based upon theoretical understanding, applications to enhance the reliability of networks

- Provide teaching and research services which will train our future engineers in a way that directly connects theoretical understanding to practical implementations.

My research style lies at the juncture of theory and practice. While much of my work tends to be mathematical in terms of the tools I use, the problems I seek to solve originate from practical engineering considerations in communications and networks. I am particularly interested in determining the theoretical limitations of systems, and in determining how these theoretical limitations guide the architecture of new communication systems.

The transition from link-based system design to network-based design has posed for me an unique opportunity to merge communications and networking. My work in the area of fading channels has led to better understanding of the fundamental limits of wireless channels. My work on the effect of channel estimation error was recognized by the IEEE Leon K. Kirchmayer Prize Paper Award 2002 for my paper, "The Effect Upon Channel Capacity in Wireless Communications of Perfect and Imperfect Knowledge of the Channel," which appeared in the IEEE Transactions in Information Theory. The IEEE Leon K. Kirchmayer Prize Paper Award was established in 1997 as the successor to the Browder J. Thompson Memorial Prize Award. It is presented by the IEEE Board of Directors for the most outstanding paper by an author(s) under 30 years of age, at the date of submission of the original manuscript. The paper established a relation among channel estimation error, channel variation, and the fundamental limitations of wireless channels. This work showed that communications in wireless environments are fundamentally limited by the fact that changes in the transmission conditions lead to unavoidable uncertainty in the measurement of the channel. Channel variations are therefore as intrinsic as energy or spectrum to determining the limitations of wireless networks. An excerpt of the IEEE announcement of the prize reads that I am "credited by her colleagues with changing the fundamental understanding of communication difficulties over wireless, time-varying channels".

I have continued to study how time variations affect the fundamental limits of communications. For communications at high carrier frequency, where the traditional decoupling of inter-symbol interference (ISI) and channel variations no longer hold, my work with A. Goldsmith at Stanford has given a framework for designing codes that withstand both ISI and time variations. My recent work with R. Srikant at UIUC has analyzed the effect of decoupling fast and slow fades. My joint work with U. Madhow at UC Santa Barbara and I. Abou-Faycal at MIT (Now at American University of Beirut) in the area of signaling to

adapt to channel error has for the first time shown that significant gains can be reaped from adapting coding and signaling to channel error at the receiver, even in the absence of feedback

A second significant area of my research in wireless communications is my work with R. G. Gallager at MIT on wideband channel capacity, which is widely recognized as being the first to show that ultra-wideband fading channels, when used with the type of signals that achieve optimum results in non-fading channels, perform very poorly. These results in particular mean that the types of systems that are currently in use for commercial wireless applications cannot be extended to ultra-wideband systems. This work showed that ultra-wideband channels require an entirely different approach, using impulsive signals. My work in ultra-wideband channels has led to extensive follow-on work at the University of California at Berkeley, Bell Labs and the University of Illinois Urbana-Champaign (UIUC). My joint work with D. Tse at UC Berkeley and my student C. Zheng at MIT in signaling over ultra-wideband channels established, from an information-theoretic point of view, the region in which current commercial spread-spectrum systems can achieve good results. My work in this area with my students C. Luo and D. Lun and with postdoctoral lecturer I. Abou-Faycal, all at MIT, and with J Huang and S. Meyn, both at UIUC, has included proposing practical near-optimal schemes and showing that optimal schemes designed for the infinite-bandwidth regime are not applicable in practical regimes. Recently, my work with L. Zheng at MIT and D. Tse at UC Berkeley has characterized in terms of both energy and channel characteristics the capacity of channels in the low energy regime. We have been able to extend this work, with my student S. Ray, to the case of multiple-input, multiple-output channels.

My interest does only lie in characterizing the performance of wideband channels, but also in determining practical means of attaining near-optimal performance. My recent work with L. Zheng and our student C. Luo has shown that performance of the order of the theoretical optimal can be achieved over wideband channels using multi-tone frequency-shift keying with simple coding. This method, which differs sharply from the current schemes proposed for wideband channels, may provide a new and effective manner to use such channels effectively.

A third area for my research in wireless networks capacity of packetized wireless networks. The theoretical literature in the area of multi-user systems is concerned almost exclusively with systems in which there is a constant stream of bits to be communicated at any time. However, the vast majority of wireless data systems rely on packetized schemes, which are intrinsically bursty. One of my contributions in this area, in conjunction with two of my students (J. Huang at UIUC and T. Coleman at MIT) and my collaborators (A. Goldsmith at Stanford and S. Meyn at UIUC), has been to show that burstiness does not affect capacity. This means in effect that burstiness affects only delay but not the reliably achievable throughput of a system. Also, we described a vast family of codes that achieve the capacity region. This research is an unusual mix of coding, information theory and control to solve a problem which connects the practice of packetized networks with the study of fundamental limitations of networks.

In the area of network reliability, I am an author of much of the original work in the area of optical network reliability and security. I am a frequent invited speaker, invited author, conference organizer and editor in this area, as well as a consultant to the industry. I am the author of several widely referenced papers in optical network reliability. In particular, my collaborators and I were the first to introduce generalized loopback and thereby show that mesh networks may recover from link failures without the use of rings, in a bandwidth-efficient manner solutions (joint work with R. Gallager at MIT, R. Barry of Sycamore Networks S. Finn of MIT LL, S. Lumetta at UIUC and our students Y.C. Tseng and W. He of UIUC).Until then, network recovery was done through the use of rings or overlay of rings, leading to very complicated solutions and placing significant restrictions on the physical topology of networks. My contributions in this area have blended practical applications with different areas of graph theory. This work, along with my work in reliable trees solutions (joint work with R. Gallager at MIT, R. Barry of Sycamore Networks and S. Finn of MIT LL), has been the source of much follow-on work at several universities and Bell Labs, as well as leading to patents. The Advances in Circuits and Systems (quarterly news service of the IEEE Circuits and Systems Society) of August 2004 recently pointed our papers as important new research. My work in network robustness has expanded to consider area how physical layer information affects recovery (joint work with E. Modiano at MIT and our student H.J. Wang) and in the reliability of random graphs (joint work with my student M. Kim at MIT). My recent work in the area of high-speed networking has been

mostly in the area of robust and reliable access to optical networks, such as robust optical local area networks (LANs) with simple access (joint work with S. Lumetta at UIUC), robust access overlay networks (joint work with my student A. Libarikian at MIT). With V. Chan and our student G. Weichenberg, I have considered the reliability of optical LANs under stress, for such applications as airplane networks. Our work in this area recently received the Best Paper award at the Fourth International Workshop on the Design of Reliable Communication Networks (DRCN 2003).

My contributions in the area of optical network security have shown how physical layer parameters affect the reliability of networks and have shown how countermeasures can alleviate the deleterious effects induced by lower layers. With my student P. Saengudomlert at MIT, I developed theoretical limits to the detectability of security attacks at the physical layer rather than the software layer, with which almost the entirety of the security work is concerned. My work in countermeasures encompasses devices to detect failures (joint work with S. Chinn at MIT Lincoln Laboratory (LL), my student P. Saengudomlert at MIT and D. Marquis at MIT LL), algorithms to localize failures (joint work with R. Bergman at MIT LL and our student S. Chan at MIT) and to recover from failures. The latter class of countermeasures has significant impact in the management of high-speed networks. My work with my collaborators constituted the whole session on optical network security at the 1998 Internet Society's Network and Distributed Systems Security Conference, a conference generally concerned with security at higher layers.

Recently, I have combined my interests in network reliability and in information theory to work in the area of network coding. My work in this area has led, with my students T. Ho, D. Lun, S. Ray at MIT, with my Postdoctoral Researcher S. Deb, my colleagues D. Karger at MIT, R. Koetter at UIUC, M. Effros at Caltech, to my taking a fresh look at the issue of network capacity, using an algebraic approach. Our approach allows the succinct characterization of the load that a network can carry in an optimized environment. This work moves away from using the network simply to route traffic and allows coding to be performed within the network. Moreover, with T. Ho, we have found clear conditions for network recovery, protection against network failures, and the amount of overhead necessary to protect a network from failing links. This work, which will appear in the IEEE Transactions on Information Theory, holds the promise of being a significant stepping stone towards a deeper understanding of optimal network operation and management, thus leading to improved efficiency networks in scenarios as widely varying as ad hoc sensor networks and the Internet backbone. Our work in an algebraic approach to network capacity has received much attention and was selected as one of the two top papers of the 2002 IEEE Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM), which recently appeared in the IEEE/ACM Transactions on Networking. One of our reviewers pointed out that: "it could be one of the papers which will eventually lead to a whole area of network algebraic theory."

We recently have created the concept of random network coding, by having nodes independently take random algebraic combinations of their inputs over large enough fields and mapping those combinations to their outputs, they can with probability very close to one equal or outperform any multicast routing scheme. This approach entirely flies in the face of every approach ever taken to disseminate information. Instead of coordination and control, it allows complete decentralization and randomness. In October 2003, a few months after our presentation at the International Symposium of Information Theory, Microsoft demonstrated their implementation of distributed random network coding over several networks. They showed in practice that naive distributed random network coding very clearly outperformed current sophisticated multicast systems. Such a very rapid turn-around from theory to practice is very unusual. We have recently demonstrated, along with students B. Leong and Y. Chan of MIT, that such random codes are very useful in wireless settings. Our work in this area recently received the Best Student Paper Award at the 2004 International Workshop on Wireless Ad-hoc Networks.

We have recently shown that this distributed coding approach can be combined with a distributed cost minimization algorithm, which we designed with my student D. Lun at MIT, my collaborators R. Koetter and his student R. Ratnakar at MIT. This algorithm not only outperforms, through the use of the properties of coded networks, optimum multicast trees, but is computationally simple and distributed, while multicast trees require centralized processing and are known to be NP-complete.

There are now whole sessions at several major conferences (Communication Theory Workshop, Conference on Information Sciences and Systems, International Symposium on Information Theory, Allerton Conference on Communication, Control, and Computing) devoted to the subject of network coding. Almost every paper that appears in this topic since 2002 cite our work, often as a starting point.

My research in network coding has naturally led me, along with my students T. Coleman, A. Lee, T. Ho and my colleague M. Effros at Caltech, to investigate new ways of implementing compression in networks. Our work uses random coding approaches, as well as recent developments in channel coding, to establish new ways to perform compression in a parallelized and distributed way.

My research program actively involves students in a variety of research projects backed by industry (Intel, Lucent and Hewlett Packard (HP)) and by government sources (National Science Foundation, which granted me a CAREER award, Defense Advanced Projects Agency, Air Force Office for Sponsored Research, and National Reconnaissance Office, two ITR awards). In particular, I am actively involved in the new Hewlett Packard Wireless Center, a joint endeavor among the Research Laboratory for Electronics, the Laboratory for Information and Decision Systems, and the Microsystems Technology.

My research program is tightly integrated with my educational activities. I oversee a dynamic and accomplished research group of 12 graduate students and 1 undergraduate. At the graduate level, my students have received recognition for their work both within MIT and outside MIT. For example, in 2002, my students received two out of a total of nine Masterworks awards for the whole of EECS (one thesis is in the area of capacity for wireless packetized channels, the other in robust optical local area networks), including the first prize. My students publish widely and contribute to the intellectual life of our research community. One of my doctoral students, T. Ho, is rapidly becoming a recognized authority on network coding in her own right.

I also regularly oversee research with MIT undergraduate students and am involved in research projects with high school students through the Center for Excellence in Education, to encourage promising students to pursue careers in science and engineering. I have recently been recognized as an “Outstanding Mentor” by Siemens for my work with high school students. Last year, two of them were semi-finalists in the competition. I strive to play a strong role in mentoring my students' careers, whether it be through interaction with industry or with other faculty at MIT and other universities.

My teaching and advising philosophy has been considerably shaped by my experience as an educator over the last four years. During my first year at UIUC, I was fortunate, as a GE Fellow, to have the opportunity to participate in the Faculty Teaching College. Through that program, I took a year-long class from the Academy for Excellence in Engineering Education, led by professors in the School of Engineering and the School of Education. The class is designed for academics to learn more about teaching. Although it was a considerable time commitment, this class helped me understand the different types of learning styles of students and the way to motivate students. In particular, I started to realize that most students had very different learning styles from my own and that a syllabus was not in itself motivation.

My three main goals in teaching and advising are:

- Create intrinsic motivation for performance

- Encourage collaboration while maintaining individual accountability

- Recognize the different learning styles of students.

In order to encourage collaboration, I introduced group exercises and group projects in class. Individual testing allows me to maintain individual accountability. I have also tried to present material in more than one way, when possible, in order to engage students with different learning styles. I have found this last endeavor to be the most challenging of my three goals.

I play a very active role in the teaching activities of the Department. In particular, I have taught and am currently teaching 6.041/6.431 (Probabilistic Systems Analysis and Applied Probability), one of the largest classes in EECS, with an enrollment of about 300 undergraduate students and 50 graduate students. This class is of particular importance to the Institute at large, as it is taken not only by most students in EECS, but is also a required class for undergraduate students in the Department of Management and in the Department of Aeronautics and Astronautics. At the graduate level, I am in charge of 6.441 (Transmission of Information), and have done significant curriculum development for the class. In particular, I have changed the approach of the class so that it integrates tightly our curriculum in the areas of communications and of estimation theory. I have also introduced much material from the recent research literature in a way that is simple, yet rigorous, so that our students are aware of some of the most exciting areas of current research in information theory. These changes have led to my revising the curriculum fundamentally and creating a full set of notes for the class, as well as an extensive set of supplementary readings of research papers in the topic, thematically linked to different lectures and arranged according to difficulty. I am significantly involved with students in 6.441, personally supervising individual projects with all of them. The students have responded very well to this approach to a challenging but very exciting field and gave me a rating of 6.4 / 7 in the class teaching evaluations. In collaboration with D. Katabi, I have significantly revised the material for 6.263 (Data Networks), introducing new material, readings and student projects.

My long term teaching plan at MIT is to have regular rotating involvement in one undergraduate core course (6.041 -probability), one undergraduate elective (such as a wireless or networks course), one graduate course for 1st-2nd year graduate students (6.263 - data networks), one more advanced graduate course (6.441 - information theory) and a graduate seminar-type course (advanced topics in information theory and networking), with other occasional assignments.

My mentoring role to both undergraduate and graduate students extends well beyond the classroom. My husband and I are Associate Housemasters at Simmons Hall, the new undergraduate dormitory, in whose opening I have been heavily involved. We live in the dormitory, along with our three daughters. We are able to have the type of general, open-ended discussions, with undergraduates that would very seldom occur in the context of a class or of academic advising. We hold weekly events for undergraduates and are always available to counsel, support and advise them on how to balance their academic and personal lives. We also work with visiting scholars program, in which five scholars visiting MIT live at Simmons and participate in the life of the undergraduates, to establish weekly residence-based academic and cultural events. I have also been House Fellow for Green Hall, the women's graduate dormitory, holding discussion events regarding several topics of interest to women in science and engineering. Recently, my various contributions to the MIT community were recognized by my being a co-recipient of the Harold E. Edgerton Faculty 2004 Achievement Award, established in 1982 to honor junior faculty members "for distinction in research, teaching and service to the MIT community."

I have also been very active in my service to the profession, both in the information-theoretic and optical networking arenas. I am an Associate Editor for Communications for the IEEE Transactions in Information Theory. I am also an Associate Editor for the Optical Communications and Networking Series of the IEEE Journal on Selected Areas in Communications. I was a guest editor for the IEEE Journal of Lightwave Technology special issue in Optical Networks. I was associate editor of the Optical Society of America Journal on Optical Networks. I shall be a guest editor for a special issue of the IEEE Transactions in Information Theory, organized jointly with the IEEE/ACM Transactions on Networking, on the topic of Networks and Information Theory, which was recently approved. I have also served on many program committees for conferences in information theory and in networks. For instance, I am on the technical committee for the 2004 International Symposium on Information Theory, the main conference in information theory, and for the 2004 Information Theory Workshop. I assist the profession in non-technical arenas as well, for instance by being Treasurer of the IEEE Information Theory Society. Finally, I am also active in advising industry and government in technical matters, for instance be being a member of the Information Science and Technology group (ISAT), or providing briefings for DARPA or the Pentagon.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
School of Engineering Faculty Personnel Record.

Date: August, 2004

Name: Muriel Médard
Department: Electrical Engineering and Computer Science

1. Date of Birth: February 1, 1968

2. Citizenship: US

3. Education:

School	Degree	Date
MIT	Bachelor of Science in Electrical Engineering	1989
MIT	Bachelor of Science in Mathematics	1989
MIT	Master of Science in Electrical Engineering	1991
MIT	Bachelor of Science in Humanities (Russian Studies)	1991
MIT	Doctor of Science in Electrical Engineering (minor in Management)	1995

4. Title of Sc.D. Thesis:

   The Capacity of Multiple User Time Varying Channels in Wireless Communications.

5. Principal Fields of Interest:

   Information Theory. Networks, Communications.

6. Name and Rank of Other Faculty in the Same Field:

   Vincent W. S. Chan, Professor
   Robert G. Gallager, Professor
   Jeffrey H. Shapiro, Professor
   G. David Forney, Adjunct Professor
   David Karger, Associate Professor
   Gregory W. Wornell, Professor
   Lizhong Zheng, Assistant Professor

7. Name and Rank of Faculty in Other Departments in the Same Field

   Eytan Modiano, Associate Professor without tenure (Aeronautics and Astronautics)
   Moe Win, Associate Professor without tenure (Aeronautics and Astronautics)

8. Non-MIT experience:

Employer	Position	Beginning	Ending

University of Illinois Urbana-Champaign	Assistant Professor	August 1998	December 1999
NYNEX Science & Technology	Intern/consultant	June 1989	December 1989

9. History of MIT Appointments:

Rank	Beginning	Ending
MIT Lincoln Laboratory Staff Member	September 1995	June 1998
Assistant Professor	January 2000	present

10. Consulting Record:

Firm	Beginning	Ending
NYNEX Science and Technology	September 1989	December 1989
Sycamore Networks	March 2000	June 2000
Pebbles Technologies/Malachite Technologies	June 2000	present
Vanu Incorporated	June 2002	present

11. Department and Institute Committees, Other Assigned Duties:

Activity	Beginning	Ending
Graduate Counselor (Dept)	September 2000	present
Graduate Admissions Reader (Dept) (domestic and international, for different years: Africa and Australia; Korea; China and Taiwan)	December 2000	present
House Fellow, Green Hall (Institute)	September 2001	August 2002
Associate House Master, Simmons Hall (Institute)	March 2002	present
Undergraduate Admissions Reader (Institute)	January 2004	present
Organized “Meet Course VI” outreach event (Dept)	Fall 2003	
Lemelson Prize Committee (Institute)	Fall 2000	
Sprowls Award Committee (Dept)	Spring 2003	

12. Professional Service:

Activity	Beginning	Ending
Program Committee Member for International Society for Optical Engineering (SPIE), Conference on Computer and Network Security	1996	1997
Co-organizer of session for Miniconference on Information Theory at the 1999 International Conference on Communications	1998	1999
Co-organizer of the new optical networking track for the Allerton Conference on Communication, Control, and Computing, 1999, 2000, 2001, 2002, 2003	1998	present

Associate Editor for Networks, Journal of Optical Networks of the Optical Society of America	2001	2002
Member of the Information Science and Technology (ISAT) study group for DARPA on "Robust Networks for Critical Missions and Critical Infrastructure"	2002	2002
Organizer of the Optical Networks session for the 17thIEEE Computer Communications Workshop	2002	2002
Technical Program Committee member for the High Speed Networking Conference, 2002	2001	2002
Technical Program Committee member for the 2004 IEEE International Symposium on Information Theory	2002	present
Session Organizer, Wireless Communications and Networking Conference, 2003	2002	2002
Technical Program Committee member for the International Workshop on Design of Reliable Communication Networks (DCRN) 2003 (IEEE)	2002	present
Technical Program Committee member for ITCom 2003 (SPIE)	2002	present
Guest Editor, IEEE Journal of Lightwave Technology Special Issue on Optical Networks.	2002	present
NSF Career review panelist	2002, 2003	
Co-organizer of the new Network Coding track for the Allerton Conference on Communication, Control, and Computing, 2003	2003	present
Program Committee Member, 2003 International Workshop on Optical Networks Control and Management (ONCM'03) (in conjunction with the 32nd International Conference on Parallel Processing)	2003	present
Associate Editor, Optical Communications and Networking Series of the IEEE Journal on Selected Areas in Communications	2003	present
Technical Program Committee Member, 2004 International Workshop on Wireless Ad-hoc Networks (IWWAN)	2003	present
Associate Editor, Communications, for the IEEE Transactions on Information Theory	2003	present
Treasurer, IEEE Information Theory Society	2004	present

Co-organizer of an invited session on Network Coding for the 38th Annual Conference on Information Sciences and Systems, Princeton University	2003	present
Co-organizer of an invited session on Network Coding for the Communication Theory Workshop	2003	present
Member of the Information Science and Technology (ISAT), an advisory group to DARPA	2003	present
Technical Program Committee member for Globecom 2004 Workshop on GMPLS	2004	present
Technical Program Committee Member for the 2004 Information Theory Workshop	2003	present
Technical Program Committee Member, 2005 International Workshop on Wireless Ad-hoc Networks (IWWAN)	2004	present
Technical Program Committee member for the 2006 IEEE International Symposium on Information Theory	2004	present

13. Awards Received:

Awards	Date
NSF Career Award	2001
IEEE Leon K. Kirchmayer Prize Paper Award, presented by the IEEE Board of Directors for the most outstanding paper by an author(s) under 30 years of age, at the date of submission of the original manuscript for M. Médard, "The Effect Upon Channel Capacity in Wireless Communications of Perfect and Imperfect Knowledge of the Channel," IEEE Transactions on Information Theory, Volume 46 Issue 3, May 2000, Pages: 935-946.	2002
Recipient of a 2003 Esther and Harold E. Edgerton MIT Chair	2002
Best Paper Award for G. Weichenberg, V. Chan, M. Médard, "Reliable Architectures for Networks Under Stress", Fourth International Workshop on the Design of Reliable Communication Networks (DRCN 2003), October 2003, Banff, Alberta, Canada.	2003
Co-recipient of the Harold E. Edgerton Faculty Achievement Award, established in 1982 to honor junior faculty members "for distinction in research,	2004

teaching and service to the MIT community."

Recognized in 2004 as a Siemens “outstanding mentor” for my work with high school students in science and engineering — 2004

14. Current Organization Membership:

Organization	Offices Held
IEEE Information Theory Society	Treasurer, starting January 2004
IEEE (senior member)	
Eta Kappa Nu	
Tau Beta Pi	
Sigma Xi	

15. Patents and Patent Applications Pending:

1) M. Médard, S.G. Finn, R.A. Barry, R.G. Gallager., “Method and Apparatus for Automatic Protection Switching”, Patent # 6,047,331
2) M. Médard et al. “A Pseudorandom Noise Sequence Noise Generator”, patent # 6,201,870
3) M. Médard, S.R. Chinn., “Method and Apparatus for Detecting Security Attacks in Communication Networks”, Patent # 6,507,012 and # 6,507,012 B1
4) M. Médard, S.R. Chinn., “Method and Apparatus for Detecting Security Attacks in Communication Networks”, Patent # 6,603,112
5) R. Bergman, M. Médard, “Fault Isolation for Communication Networks for Isolating the Source of Faults Comprising Attacks, Failures, and Other Network Propagating Errors”, Patent # 6,442,694.
6) S. Lumetta, M. Médard, “Fault Tolerant Optical Data Communication Network”, filed 2002, Application #10/186,178
7) S.R. Chinn, S. Lumetta, M. Médard, “An Integrated System and Method for Controlling Telecommunication Network Data Communicated over a Local Area Network and Storage Data Communicated over a Storage Area Network”, filed 2002, patent pending
8) G. Ciancaglini et al., “Fault Tolerant Optical Data Communication Network Having Auto Discovery”, filed 2002, patent pending
9) M. Garofalo et al., “Multiple Switch Protected Architecture”, filed 2002, patent pending
10) M. Médard et al., "Method and Apparatus for Medium Access Control for a Communications Network", filed 2003, patent pending.
11) T. Ho, R. Koetter, M. Médard, D. Karger, N. Effros, “Randomized Distributed Network Coding Method and Apparatus”, provisional patent application
12) D.S. Lun, M. Médard, T. Ho, R. Koetter, “Minimum Cost Routing with Network Coding”, provisional patent application
13) S. Deb, M. Médard, “A Network Coding Approach to Rapid Information Dissemination”, provisional patent application
14) S. Deb, M. Médard, “A Network Coding Approach to Rapid Information Dissemination”,

provisional patent application

15) S. Deb, M. Médard, R. Koetter, “A Random Linear Coding Approach to Distributed Data Storage”, provisional patent application

16) G. Ciancaglini et al., “Method and Apparatus for Provisioning Connection Oriented, Quality of Service Capabilities and Services”, patent application

16. Professional Registration: NA

17. Major New Products: NA

Teaching and Educational Contributions of Muriel Médard

1. Teaching Experience

Term	Subject Number	Title	Role	Course Type	Course evaluation survey given
FT 98	ECE 434 (University of Illinois Urbana-Champaign)	Random Processes	Lecturer, in charge	Graduate Course	
ST 99	ECE467 (UIUC)	Communication Network Analysis	Lecturer, in charge	Graduate Course	
FT 99	ECE 313 (UIUC)	Probability with Engineering Applications	Lecturer, co-in charge	Undergraduate Course	
ST 00	6.441	Transmission of Information	Lecturer, in charge	Graduate Course	Yes
FT 00	6.263/16.37	Data Communication Networks	Lecturer, co-in charge	Graduate Course	Yes
FT 01	6.041/6.431	Probabilistic Systems Analysis & Applied Probability	Lecturer, in-charge	Undergraduate and Graduate Course	Yes
ST 02	6.441	Transmission of Information	Lecturer, in charge	Graduate Course	Yes
FT 02	6.041/6.431	Probabilistic Systems Analysis & Applied Probability	Lecturer, in-charge	Undergraduate and Graduate Course	Yes
FT 03	6.263/16.37	Data Communication Networks	Lecturer, co-in charge	Graduate Course	Yes
ST 04	6.441	Transmission of Information	Lecturer, in charge	Graduate Course	Yes
FT 04	6.041/6.431	Probabilistic Systems Analysis & Applied Probability	Recitation instructor	Undergraduate and Graduate Course	

2. Teaching Evaluation Data

Term	Subject Number	Total # students registered	Total # survey responses	Survey Form Used	Instructor Teaching Quality Average	Overall Course Quality Average
FT 00	6.263/16.37	30	28	EECS	4.0	4.8
FT 01	6.041/6.431	256	117	EECS	3.9	4.6
ST 02	6.441	30	14	EECS	6.4	6.4
FT 02	6.041/6.431	229	54	EECS	4.4	4.6
FT 03	6.041/6.431	17	11	EECS	6.0	5.6
ST 04	6.441			EECS	5.7	5.5

3. Other Educational Contributions
   a) Teaching materials
      i. In 6.441, developed in Latex an all new set of lecture handouts, completely re-designed the syllabus, developed a substantial set of supplementary readings of relevant research papers, organized by relevance to different topics and by difficulty, introduced a research project on major papers in the literature
      ii. In 6.263, significantly revised the course, in particular in the areas of the use of transforms in analyzing queuing systems, of switching theory, of rerouting, of wireless networks and coding (including network coding); introduced a research design project and reading of major papers in the area.

Publications of Muriel Médard

1. Books: N.A.

2. Papers in Refereed Journals:

1) D. Karger, M. Médard, "Toward Using the Network as a Switch", accepted to *IEEE Journal on Selected Areas in Communications: Optical Communications and Networking Series*

2) G. E. Weichenberg, V. W. S. Chan, M. Médard, "High-Reliability Topological Architectures for Networks under Stress", accepted to *IEEE Journal on Selected Areas in Communications: Optical Communications and Networking Series***

3) T. Ho, M. Médard, R. Koetter, "An Information Theoretic View of Network Management", accepted to *IEEE Transactions on Information Theory* **

4) T.P. Coleman, M. Médard, "A Distributed Scheme for Achieving Energy-Delay Tradeoffs with Multiple Service Classes over a Dynamically Varying Network", *IEEE Journal on Selected Areas in Communications: Advanced Mobility Management and QoS Protocols for Wireless Internet*, vol. 22, No. 5, June 2004, pp: 929-941 **

5) D. S. Lun, M. Médard, I. C. Abou-Faycal, "On the Performance of Peaky Capacity-achieving Signaling on Multipath Fading Channels," *IEEE Transactions on Communications*, Volume: 52 , Issue: 6 , June 2004, pp: 931 - 938**

6) M. Médard, J. Huang, A. Goldsmith, S. Meyn, T.P. Coleman, "Capacity of Time-slotted ALOHA Packetized Multiple-Access Systems over the AWGN Channel", *IEEE Transactions on Wireless Communications*, Volume: 3 , Issue: 2 , March 2004 , pp: 486 - 499 **

7) M. Médard, "Channel Uncertainty in Communications", **invited** paper in *IEEE Information Theory Society Newsletter*, June 2003

8) M. Jinno, F.J. Leonberger, M. Médard, N. Ransom, A. Von Lehmen, "Guest editorial: Optical networks", *IEEE Journal of Lightwave Technology*, Volume: 21 , Issue: 11 , Nov. 2003, pp:2452 – 2454

9) R. Koetter, M. Médard. "Beyond Routing: An Algebraic Approach to Network Coding", *IEEE/ACM Transactions on Networking*, Volume 11, Number 5, October 2003, pp. 782-796 **(SELECTED AS ONE OF THE OUTSTANDING PAPERS FROM INFOCOM FOR TRANSFER TO *IEEE/ACM TRANSACTIONS ON NETWORKING*)**

10) M. Médard, S.S. Lumetta, L. Li, "A Network Management Architecture for Robust Packet Routing in Mesh Optical Access Networks", **invited** paper in *IEEE Journal on Selected Areas in Communications*, Volume 20, Issue 4, May 2002, pp. 822-833

11) P. Saengudomlert, M. Médard, "Guaranteeing BER in Transparent Optical Networks Using OOK Signaling", *IEEE Journal on Selected Areas in Communications*, Volume 20, Issue 4, May 2002, pp. 786-799 **

12) M. Médard, R.G. Gallager, "Bandwidth Scaling For Fading Multipath Channels", *IEEE Transactions on Information Theory*, Volume 48, Issue 4 , Apr. 2002 , pp. 840 -852

13) M. Médard, R.A. Barry, S.G. Finn, W. He, S.S. Lumetta, "Generalized Loop-back Recovery in Optical Mesh Networks", *IEEE/ACM Transactions on Networking*, Volume: 10, Issue: 1, February 2002, pp. 153-164 **

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14) M. Médard, S.S. Lumetta, "Architectural Issues for Robust Optical Access", *IEEE Communications Magazine*, Volume 39, Issue 7, July 2001, Pages 116-220

15) M. Médard, S.R. Chinn, P. Saengudomlert, "Node Wrappers for QoS Monitoring in Transparent Optical Nodes", *Journal of High Speed Networks*, 2001 (yearly publication) , IOS Press, pp. 247-268 **

16) S. Lumetta, M. Médard, Y. Tseng, "Capacity Versus Robustness: A Tradeoff for Link Restoration in Mesh Networks", *IEEE Journal of Lightwave Technology,* Volume: 18, No: 12 , March 2001 Pages: 1765 -1775 **

17) M. Médard, "The Effect Upon Channel Capacity in Wireless Communications of Perfect and Imperfect Knowledge of the Channel", *IEEE Transactions on Information Theory,* Volume:46, No: 3, May 2000, Pages: 935-946 (**WINNER OF THE IEEE 2002 LEON KIRCHMAYER PRIZE PAPER AWARD)**

18) M. Médard, S.G.Finn, R.A. Barry, R.G. Gallager, "Redundant Trees for Preplanned Recovery in Arbitrary Vertex-Redundant or Edge-Redundant Graphs", *IEEE/ACM Transactions on Networks,* Volume: 7, No: 5 , Oct. 1999 , Pages: 641 -652

19) M. Médard, R.A. Barry, S.G. Finn, R.G. Gallager, "Automatic Protection Switching for Multicasting in Optical Mesh Networks", in *Trends in Optics and Photonics Series (TOPS)* - Volume:20 - *Optical Networks and their Applications*, R.A. Barry, editor, published by the Optical Society of America, 1998

20) S.G. Finn, M. Médard, R.A. Barry, "A New Algorithm for Bi-directional Link Self-Healing for Arbitrary Redundant Networks", in *TOPS* - Volume:20 - *Optical Networks and their Applications*, R.A. Barry, editor, published by the Optical Society of America, 1998

21) M. Médard, S.R. Chinn, P. Saengudomlert, "Attack Detection in All-Optical Networks", in *TOPS* - Volume:20 - *Optical Networks and their Applications*, R.A. Barry, editor, published by the Optical Society of America, 1998 **

22) M. Médard, D. Marquis, R.A. Barry, S.G. Finn, "Security Issues in All-Optical Networks", *IEEE Network Magazine*, vol. 11, no. 3, May 1997, pp. 42-48.

3. Proceedings of Refereed Conferences:

1) D.S. Lun, N. Ratnakar, R. Koetter, M. Médard, E. Ahmed, H. Lee "Achieving Minimum-Cost Multicast: A Decentralized Approach Based on Network Coding", accepted to *INFOCOM*, March 2005 **

2) J.K. Sundararajan, F. Zhao, P.G. Massaad, M. Médard, "A Modification to RED AQM for CIOQ Switches", *IEEE Global Telecommunications Conference (Globecom),* December 2004 **

3) S. Ray, M. Médard and L. Zheng, "On MIMO in the Wideband Limit", **invited** paper, *Asilomar Conference on Signals, Systems, and Computers*, November 2004 **

4) L. Zheng, D. Tse, M. Médard, "On the Costs of Channel State Information", **invited** paper, *Information Theory Workshop*, October 2004

5) M. Effros, R. Koetter, A. Goldsmith, M. Médard, "On Source and Channel Codes for Multiple Inputs and Outputs: Does Multiple Description Meet Space Time?" **invited** paper, *Information Theory Workshop*, October 2004

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Publications of Muriel Médard

6) D.S. Lun, M. Médard , T. Ho. R. Koetter, "Network Coding with a Cost Criterion", *International Symposium on Information Theory and its Applications (ISITA 2004)*, October 2004 **

7) P.G. Massaad, M. Médard and L. Zheng, "Impact of Processing Energy on the Capacity of Wireless Channels", *International Symposium on Information Theory and its Applications (ISITA 2004)*, October 2004 **

8) S. Ray, M. Médard and L. Zheng, "On the Sublinear Behavior of MIMO Channel Capacity at low SNR", *International Symposium on Information Theory and its Applications (ISITA 2004)*, October 2004 **

9) S. Deb, M. Médard, "Algebraic Gossip: A Network Coding Approach to Optimal Multiple Rumor Mongering", *42nd Allerton Annual Conference on Communication, Control and Computing*, October 2004

10) P.G. Youssef-Massaad, M. Médard and L. Zheng, "On the Capacity of Multiple-access Channels with Processing Power", **invited** paper, *42nd Allerton Annual Conference on Communication, Control and Computing*, October 2004**

11) D.S. Lun, M. Médard, "On-Coding-for-Reliable-Communication-over-Packet-Networks ,-**invited** paper, *42nd Allerton Annual Conference on Communication, Control and Computing*, October 2004**

12) D.S. Lun, M. Médard , "On the Sufficiency of Power Control for a Class of Channels with Feedback", *IEEE International Symposium on Information Theory*, June 2004 **

13) J. Huang, S. Meyn, M. Médard , "Error Exponents for Channel Coding and Signal Constellation Design", *IEEE International Symposium on Information Theory*, June 2004

14) L. Zheng, D.N.C. Tse, M. Médard , "Channel Coherence in the Low SNR Regime", *IEEE International Symposium on Information Theory*, June 2004

15) T.P. Coleman, A.H. Lee, M. Médard, M. Effros, "A New Source-Splitting Approach to the Slepian-Wolf Problem", *IEEE International Symposium on Information Theory*, June 2004 **

16) T. Ho, B. Leong, R. Koetter, M. Médard, M. Effros, "Byzantine Modification Detection in Multicast Networks using Randomized Network Coding", *IEEE International Symposium on Information Theory*, June 2004 **

17) I. Abou-Faycal, M. Médard , "Optimal Uncoded Regeneration for Binary Antipodal Signaling", *Communication Theory Symposium of the IEEE International Conference on Communications (ICC 2004)*, June 2004

18) A. Bdeir, I. Abou-Faycal, M. Médard, " Power Allocation Schemes for Pilot Symbol Assisted Modulation over Rayleigh Fading Channels with no Feedback", *Communication Theory Symposium of the IEEE International Conference on Communications (ICC 2004)* June 2004 **

19) T. Ho, B. Leong, M. Médard, R. Koetter, Y. Chang, M. Effros, "On the utility of network coding in dynamic environments", *International Workshop on Wireless Ad-hoc Networks (IWWAN)*, June 2004 ** **(WINNER OF THE BEST STUDENT PAPER AWARD)**

20) D.S. Lun, M. Médard, T. Ho, R. Koetter, "Network Coding with a Cost Criterion", **invited** paper, *Communication Theory Workshop*, May 2004**

21) L. Zheng, D.N.C. Tse, M. Médard , "Channel Coherence in the Low SNR Regime", **invited**

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paper, *38th Annual Conference on Information Sciences and Systems*, Princeton, March 2004 **

22) T. Ho, M. Médard, M. Effros, R. Koetter, "Network coding for correlated sources", **invited** paper, *38th Annual Conference on Information Sciences and Systems*, Princeton, March 2004 **

23) R. Koetter, M. Effros, T. Ho, M. Médard, "Network Codes as Codes on Graphs", ", **invited** paper, *38th Annual Conference on Information Sciences and Systems*, Princeton, March 2004 **

24) T. P. Coleman, A. H. Lee, M. Médard, M. Effros, "On Some New Approaches to Practical Slepian-Wolf Compression Inspired by Channel Coding", 2004 *IEEE Data Compression Conference*, Snowbird Utah, March 2004**

25) G. Weichenberg, M. Médard, V. Chan, "Designing for Resilience to Multiple Failures", **invited** paper, *Optical Fiber Communication Conference (OFC),* sponsored by the Optical Society of America, March 2004**

26) G. Weichenberg, V. Chan, M. Médard, "High-Reliability Architectures for Networks Under Stress", *INFOCOM 2004, ,* March 2004**

27) M. Kim, M. Médard, "Robustness in Large-Scale Random Networks", *INFOCOM 2004,* March 2004**

28) C. Luo, M. Médard, L. Zheng, "Error Exponents for Multi-tone Frequency Shift Keying on Wideband Rayleigh Fading Channels", *IEEE Global Telecommunications Conference (Globecom) Wireless Communications Workshop,* December 2003**

29) C. Zheng, M. Médard, "How Far Should We Spread Using DS-CDMA in Time and Frequency Selective Fading Channels?", *IEEE Global Telecommunications Conference (Globecom) Communication Theory Workshop*, December 2003**

30) S. Ray, M. Médard, J. Abounadi, "Random Coding in Noise-Free Multiple Access Networks over Finite Fields", *IEEE Global Telecommunications Conference (Globecom) Communication Theory Workshop,* December 2003**

31) G. Weichenberg, V. Chan, M. Médard, "Reliable Architectures for Networks Under Stress", *Fourth International Workshop on the Design of Reliable Communication Networks (DRCN),* October 2003** (**WINNER OF THE BEST PAPER AWARD)**

32) M. Médard, M. Effros, T. Ho, D. Karger, "On Coding for Non-Multicast Networks", **invited** paper, *41st Allerton Annual Conference on Communication, Control and Computing*, October 2003**

33) T. Ho, M. Médard, M. Effros, D. Karger, "On Randomized Network Coding" ", **invited** paper, *41st Allerton Annual Conference on Communication, Control and Computing*, October 2003**

34) L. Zheng, M. Médard, D.N.C. Tse, C. Luo, "On the Interplay Between SNR and Coherence in Wideband Channels", **invited** paper, *41st Allerton Annual Conference on Communication, Control and Computing*, October 2003**

35) S. Ray, M. Médard, J. Abounadi, "Noise-Free Multiple Access Networks Over Finite Fields", *41st Allerton Annual Conference on Communication, Control and Computing*, October 2003**

36) A.F. Dana, R. Gowaikar, B. Hassibi, M. Effros and M. Médard, "Should we break a wireless network into subnetworks?**",** *41st Allerton Annual Conference on Communication, Control and Computing*, October 2003

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Publications of Muriel Médard

37) N. Peranginangin, M. Médard, R. Gallager, "Capacity of a Multi Output Channel with Distributed Processing", *IEEE International Symposium on Information Theory (ISIT), Yokohoma, Japan*, June 2003**

38) T. Coleman and M. Médard, "The Impact of User Information on Power-Delay Tradeoffs Between in Bursty Packetized Systems", *IEEE International Symposium on Information Theory (ISIT)*, June 2003**

39) T. Ho, D. R. Karger, M. Médard and R. Koetter**,** ``Network Coding from a Network Flow Perspective ", *IEEE International Symposium on Information Theory (ISIT)*, June 2003**

40) T. Ho, R. Koetter, M. Médard, D. R. Karger and M. Effros, ``The Benefits of Coding over Routing in a Randomized Setting", *IEEE International Symposium on Information Theory (ISIT)*, June 2003**

41) T. Ho, M. Médard, R. Koetter, "An Information-Theoretic View of Network Management", *Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM)*, July 2003 **

42) M. Effros, M. Médard, T. Ho, S. Ray, D. Karger, R. Koetter, "Linear Network Codes: A Unified Framework for Source Channel, and Network Coding", **invited** paper to *the DIMACS workshop on Network Information Theory*, 2003 **

43) C. Luo, M. Médard , "Near-optimal Coding Using FSK over Wideband Channels", **invited** paper, *Asilomar Conference on Signals, Systems, and Computers*, November 2002 **

44) I. Abou-Faycal, M. Médard , "Adaptive coding for PSAM without feedback", **invited** paper, *Asilomar Conference on Signals, Systems, and Computers*, November 2002

45) C. Luo, M. Médard, "FSK for Ultrawideband- How Close to Capacity Can We Get?", **invited** paper, *40th Annual Allerton Conference on Communication, Control, and Computing*, October 2002**

46) D.S. Lun, M. Médard, I. Abou-Faycal, "Error Exponents for Capacity-Achieving Signaling on Wideband Rayleigh Fading Channels*", International Symposium on Information Theory and its Applications*, October 2002 **

47) C. Luo, M. Médard, "FSK for Ultrawideband- How Close to Capacity Can We Get?", *International Symposium on Information Theory and its Applications*, October 2002 **

48) D.S. Lun, M. Médard, I. Abou-Faycal, "An Upper Bound on the Error probability of Capacity-Achieving Signaling On Broadband Rayleigh Fading Channels", *IEEE Vehicular Technology Conference*, September 2002 **

49) T. Ho, M. Médard, R. Koetter , "A Coding View of Network Capacity, Recovery and Management", *International Symposium on Information Theory*, July 2002 **

50) H. Wang, E. Modiano, M. Médard, "Partial Path Protection for WDM Networks: End-to-End Recovery Using Local Failure Information", *IEEE Symposium on Computers and Communications* (*ISCC)*, July 2002 **

51) M. Médard. "Optical network survivability beyond the core", **invited** paper to *ITCOM* 2002 (sponsored by SPIE, the international Society for Optical Engineering)

52) T. Ho, M. Médard, R. Koetter, "A coding View of Network Recovery and Management for Single Receiver Communications", *Conference on Information Sciences and Systems* (*CISS)*, Princeton,

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April 2002 **

53) D.S. Lun, M. Médard, I. Abou-Faycal, "Error Exponents for Wideband Multipath Fading Channels – a Strong Coding Theorem", *Conference on Information Sciences and Systems* (*CISS),* Princeton, April 2002 **

54) H. Wang, E. Modiano, M. Médard, "Partial Path Protection for WDM networks", *Sixth Institute for Operations Research and the Management Sciences (INFORMS) Telecommunications Conference* , March 2002 **

55) H. Wang, E. Modiano, , M. Médard, " Using Local Information for WDM Network Protection", **invited** paper, *Symposium on Photonics, Networks and Computing*, March 2002 **

56) R. Koetter, M. Médard. "Beyond Routing: An Algebraic Approach to Network Coding" , *Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM),* July 2002 **(selected as one of the outstanding papers from INFOCOM for transfer to *IEEE/ACM Transactions on Networking*)**

57) T.P. Coleman, M. Médard, "Trade-off Between Power Consumption and Delay in Wireless Packetized Systems", **invited** paper, *39th Annual Allerton Conference on Communication, Control, and Computing*, October 2001**

58) A.L. Libarikian, M. Médard, "A Robust Optical Folded Bus Architecture for Overlay Access Networks", ", **invited** paper, *39th Annual Allerton Conference on Communication, Control, and Computing*, October 2001**

59) R. Koetter, M. Médard, "An algebraic approach to network coding and robust networks", *IEEE International Symposium on Information Theory (ISIT)*, June 2001

60) S. Lumetta, M. Médard, "Towards a Deeper Understanding of Link Restoration Algorithms for Mesh Networks", *Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM)* , April 2001

61) A. Narula-Tam, S.G. Finn, M. Médard, "Analysis of Reconfiguration of IP over WDM Access Networks", *Optical Fiber Communication Conference (OFC),* sponsored by the Optical Society of America, Paper MN4, March 2001

62) S.S. Lumetta, M. Médard, "Classification of Two-link Failures in All-optical Networks", *Optical Fiber Communication Conference (OFC),* Paper TuO3, March 2001

63) M. Médard, R. Srikant, "The Effect on Capacity of Decoupling Slow Fades from Fast Fades in Channels with Asymmetric Channel Information", *IEEE International Symposium on Information Theory and its Applications*, November 2000

64) M. Médard, I. Abou- Faycal, U. Madhow, "Adaptive Coding with Pilot Signals", **invited** paper, *38th Annual Allerton Conference on Communication, Control, and Computing*, October 2000**

65) P. Saengudomlert, M. Médard, "Limits of BER Guarantees in Transparent Optical Networks Using OOK Signalling", **invited** paper, *38th Annual Allerton Conference on Communication, Control, and Computing*, October 2000**

66) M. Médard, D.N.C. Tse, "Spreading in Block-Fading Channels", *Asilomar Conference on Signals, Systems, and Computers*, November 2000

67) M. Médard, S. Lumetta, Y. Tseng, "Capacity-Efficient Restoration for Optical Networks", *Optical Fiber Communication Conference (OFC),* paper ThO2, March 2000**

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Publications of Muriel Médard

68) S. S. Lumetta, M. Médard, "Robust routing for Local Area Optical Access Networks", *IEEE Lasers and Electro-Optics Society (LEOS) SummerTopical Meeting*, July 2000

69) M. Médard, R. Srikant, "Capacity of Nearly-decomposable Markovian Fading Channels under Asymmetric Receiver-Sender Side Information", *IEEE International Symposium on Information Theory (ISIT)*, June 2000

70) M. Médard, J. Huang, S.P. Meyn, A. Goldsmith, "Capacity of Time-Slotted ALOHA Systems", *IEEE International Symposium on Information Theory (ISIT),* June 2000**

71) Médard, A. Goldsmith, "Capacity of Time-Slotted ALOHA Systems", **invited** paper, *IEEE Wireless Communications and Networking Conference (WCNC),* September 1999

72) M. Médard, "Processing of Wireless Signals to Preserve Wireline Network Resources", **invited** paper, *IEEE Wireless Communications and Networking Conference (WCNC),* September 1999

73) M. Médard, A.J. Goldsmith, "Capacity of Time-Varying Channels with Side Information at the Sender and the Receiver", *Miniconference on Information Theory, IEEE International Conference on Communications (ICC),* June 1999

74) M. Médard, S.G. Finn, R.A. Barry, "WDM Loop-back in Mesh Networks", *Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM),* March 1999

75) M. Médard, "Secure Optical Communications", **invited** paper, FE3, *Lasers and Electro-Optics Society (LEOS) Annual Meeting*, December 1998

76) M. Médard, "A Coding Theorem for Multiple-Access Decorrelating Channels", *IEEE International Symposium on Information Theory (ISIT),* August 1998

77) J. Yueh, A.H. Chan, M. Médard, "On the Complexity of Reconfigurable Feedback Shift Register Sequences", *IEEE International Symposium on Information Theory (ISIT),* August 1998

78) R.G. Gallager, M. Médard, R.A. Barry, S.G. Finn, "Multicast Automatic Protection Switching in Arbitrary Redundant Graphs", *IEEE International Conference on Communications (ICC),* June 1998

79) M. Médard, A.J. Goldsmith, "Capacity of Time-varying Channels with Channel Side Information", *IEEE International Symposium on Information Theory (ISIT),* July 1998

80) R.A. Barry, M. Médard, "BER Analysis of Low-rate Communications Through a Single Electro-Optic R2 Nonlinear Regenerator", *IEEE Conference on Lasers and Electro-Optics (CLEO),* May 1998

81) M. Médard, D. Marquis, S.R. Chinn, "Attack Detection Methods for All-Optical Networks", *Internet Society Network and Distributed System Security (NDSS) Symposium,* Session 3, paper 2, February 1998

82) R. Bergman, M. Médard, S. Chan, "Distributed Algorithms for Attack Localization in All-Optical Networks", *Internet Society Network and Distributed System Security (NDSS) Symposium*, Session 3, paper 1, February 1998

83) M. Médard, S.R. Chinn, P. Saengudomlert, "Attack Detection in All-optical Networks", *Optical Fiber Communication Conference (OFC),* February 1998**

84) S.G. Finn, M. Médard, R.A. Barry, "A New Algorithm for Bi-directional Self Healing for

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Arbitrary Redundant Networks", *Optical Fiber Communication Conference (OFC)*, February 1998

85) M. Médard, A.H. Chan, J.D. Moores, K.A. Hall, K.R. Rauschenbach, S. Parikh, "Ultrafast Cryptography Using Optical Logic in Reconfigurable Feedback Shift Registers", *Proceedings of the International Society for Optical Engineering (SPIE)*, vol. 3228, November 1997, pp. 342-345

86) D. Marquis, M. Médard, R.A. Barry, S.G. Finn, "Physical Security Considerations in All-Optical Networks", **invited** paper, *Proceedings of the International Society for Optical Engineering (SPIE)*, vol. 3228, November 1997, pp. 260-271

87) M. Médard, "Bound on Mutual Information for DS-CDMA spreading over Independent Channels", **invited** paper, *Asilomar Conference on Signals, Systems and Computers*, October 1997

88) M. Médard, "Capacity of Correlated Jamming Channels", *Allerton Conference on Communication, Control, and Computing*, November 1997

89) A.H. Chan, M. Médard, "Reconfigurable Feedback Shift Registers", *IEEE International Symposium on Information Theory (ISIT)*, July 1997

90) M. Médard, A.J. Goldsmith, "Capacity of Time-Varying Channels with Channel Side Information", *IEEE International Symposium on Information Theory (ISIT)*, July 1997

91) R.G. Gallager, M. Médard, "Bandwidth Scaling for Fading Channels", *IEEE International Symposium on Information Theory (ISIT)*, July 1997

92) S.G. Finn, M. Médard, R.A. Barry, "A Novel Approach to Automatic Protection Switching *IEEE International Conference on Communications (ICC)*, June 1997

93) M. Médard, S.G.Finn, R.A. Barry, "Automatic Protection Switching for Multicasting in Optical Mesh Networks", *Optical Fiber Communication Conference (OFC)*, February 1997

94) M. Médard, "Security Issues for All-Optical Networks", **invited** panelist statement, at the *National Information Systems Security Conference*, October 1996

95) M. Médard, R.G. Gallager, "The Effect of Channel Variations upon Capacity", *IEEE Vehicular Technology Conference (VTC)*, April 1996

96) M. Médard, R.G. Gallager, "The Effect of a Randomly Time-varying Channel on Mutual Information", *IEEE International Symposium on Information Theory (ISIT)*, September 1995

97) M. Médard, R.G. Gallager, "The Issue of Spreading in Multipath Time-Varying Channels", *IEEE Vehicular Technology Conference (VTC)*, July 1995

98) T.P. McGarty, M. Médard, "Wireless Architectural Alternatives: Current Economic Valuations Versus Broadband Options, The Gilder Conjecture", *Telecommunications Policy Research Conference*, October 1994

4. Other publications: Book Chapter: M. Médard, S.S. Lumetta, "Network Reliability and Fault Tolerance", Wiley Encyclopedia of Engineering, Editor: J.G. Proakis

5. Internal Memoranda:

1) D. S. Lun, N. Ratnakar, R. Koetter, M. Médard, E. Ahmed, and H. Lee, "Achieving minimum cost

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multicast: A decentralized approach based on network coding". Technical Report LIDS-P-2629, MIT LIDS, September 2004.

2) J. K. Sundarajan, S. Deb, M. Médard, "To copy or not to copy: Extending the Birkhoff-von Neumann switching strategy to multicast switches," Technical Report LIDS-2624, Aug. 2004

3) J. K. Sundararajan, F. Zhao, P.G. Youssef-Massaad, M. Médard, "A Modification to RED AQM for CIOQ Switches", Technical Report LIDS-2585, April 2004

4) D. S. Lun, M. Médard, T. Ho, and R. Koetter, "Network Coding with a Cost Criterion," Technical Report LIDS-P-2584, Apr. 2004

5) H. Wang, E. Modiano and M. Médard, " Partial Path Protection for WDM Networks – End-to-end Recovery using Local Failure Information", L IDS report 2517, Sept. 2001.

6. Invited Lectures:

1) Spring 1997 "Optical Network Security", Steering Committee Lecture, MIT Lincoln Laboratory

2) Fall 1997 "Spreading and Recovery: topics in communications", **invited** seminar, University of California, Berkeley

3) Fall 1997 "Topics in Communications", **invited** seminar, University of Illinois Urbana-Champaign

4) Spring 1998 "Topics in Optical Network Security", **invited** seminar, University of Maryland and MIT

5) Spring 1998 "Security in Optical Networks", **invited** seminar, RPI

6) Fall 1998 "Restoration in Optical Networks", Coordinated Science Laboratory (CSL) seminar, University of Illinois, Urbana-Champaign

7) Fall 1998 "Spreading in Time-varying Channels", **invited** seminar, University of Michigan

8) Spring 1999 "Capacity of Time-varying Channels with Side Information", **invited** seminar, University of Michigan and MIT

9) Summer 1999 "Capacity of Time-varying Channels with Side Information", **invited** seminar, Northwestern University

10) Fall 1999 "An Overview of Security for Optical Networks", Coordinated Science Laboratory (CSL) Seminar, University of Illinois Urbana-Champaign

11) Fall 1999 "Capacity of Fast Time-varying Channels with Side Information", Coordinated Science Laboratory (CSL) Seminar, University of Illinois Urbana-Champaign

12) Fall 2000 "Restoration in Optical Networks", **invited** seminar, Carnegie-Mellon University

13) February 2001, "Optical and Wireless Communications Perspectives", presentation at Ideastream, MIT workshop

14) Spring 2001 M. Médard, "Robustness and Recovery in Optical Networks", **invited** presentation, *IEEE Gigabit Networking Workshop*, also **invited** seminar at George Washington University

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Publications of Muriel Médard

14) May 2001 “Some different aspects of adaptive coding for wireless communications”, **invited** seminar, Stanford University and **invited** seminar Lucent Bell Labs (June 2001)

15) June 2001, “Robust Optical Communications”, **invited** seminar, Lucent Bell Labs

16) May 2001 and August 2001 “Robustness and Security in Optical Networks”, presentation for AFOSR URI kickoff at Stanford University and AFOSR program review at Wright-Patterson Air Force Base

17) October 2001 “Some New Directions in Communications and Networking”, seminar to the Federal Communications Commission

18) December 2001, “Network Coding for Capacity and Robustness”, **invited** talk at the DIMACS (Center for Discrete Mathematics and Theoretical Computer Science at Rutgers University) Workshop on Codes and Complexity

19) December 2001, “Optical Network Security”, **invited** talk to the DARPA Information Assurance for Optical Networks (OpticIA) Workshop

20) January 2002, “Some Different Aspects of Adaptive Coding for Wireless Communications”, presentation at the Hewlett Packard Wireless Center kick-off

21) March 2002, “When the Physical Layer Matters - a perspective on networking aspects of wireless communications”, **invited** talk to Information Science and Technology (ISAT) study group for DARPA on “Robust Networks for Critical Missions and Critical Infrastructure”

22) April 2002, “Some Aspects of Robustness in Wireless Networks”, **invited** seminar to University of Massachusetts, Amherst

23) June 2002, “Overview of New Results in Optical Access Networks Robustness”, **invited** Photonics Series seminar at the University of Illinois Urbana-Champaign

24) October 2002, M. Médard , M. Kim, “A Bound on Backup Path Lengths Using a Random Graph Approach”, **invited** paper, IEEE Annual Computer Communications Workshop, 2002 **

25) October 2002, “Network Coding and Network Management – Towards Fundamental Limits?”, **invited** seminar to Cornell University, also **invited** seminar to Boston University

26) November 2002, “Security in Optical Networks”, **invited** briefing to the Assistant Secretary of Defense (C3I) (Highland Forum), at the Pentagon (Washington, D.C.)

27) January 2003, “Some Perspectives on Ultrawideband”, presented at “Telecoms at the Edge”, sponsored by the MIT Program on Internet and Telecoms Convergence and the Center for e-Business at MIT, also April 2003 presentation at the MIT ILP workshop “Extreme Communications”

28) Spring 2003, “Network Coding: towards an unified view of routing, network management, coding and compression?”, **invited** seminar to the Applied Mathematics Department, Brown University, also **invited** seminar to ECE Department, Georgia Tech, also **invited** IBM Lecture at Notre Dame University

29) Fall 2004, “Network coding: towards an unified view of routing, recovery, coding and compression?”, **invited** seminar at Harvard University

30) Spring 2004, “Recent Trends in UWB”, ILP executive presentation to TEKES (National Technology Agency of Finland)

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31) Spring 2004, “Coding for Networks”, **invited** presentation for the annual Lee Center Workshop (Caltech's Lee Center for Advanced Networking), in which 4 guest speakers present to Caltech students and alumni

32) May 2004, “Network Coding: an Introduction”, a one-day course given to the Centre for Wireless Communications at the University of Oulu, Finland (co-taught with Ralf Koetter of UIUC)

33) August 2004, “Towards a Random, Distributed Operation of Networks”, **invited** presentation to Lucent Bell Labs, also Colloquium at Northeastern University, October 2004

34) October 2004, “Byzantine Modification Detection in Multicast Networks Using Randomized Network Coding”, seminar to Northeastern University

35) December 2004, “Network Coding”, a one-day tutorial at the IEEE Global Telecommunications Conference (Globecom) (co-taught with Ralf Koetter of UIUC and Phil Chou of Microsoft)

Theses Supervised by Muriel Médard

Summary

	Total	Completed	In Progress
Bachelors			
Master of Engineering	5	3	2
Master's	13	10	3
Engineer's			
Doctoral			
As Supervisor	8	1	7
As Reader	15	9	6

Bachelor's Theses and other student projects

Serena Chan, "Localization of Attacks in Optical Networks", Summer 97 and January, 6-A student at MIT Lincoln Laboratory (Serena is now in the doctoral program at MIT)

Alvin Lin, "Computer Simulation of Algorithms for Creating Minimal weight Redundant Trees in Edge-Redundant Graphs", Summer 00, project through the Research Science Institute, run by the Center for Excellence in Education, to encourage promising U.S. high school students to pursue careers in science and engineering (Alvin is now a student at MIT)

Derrick Chan, "Coding for ALOHA Systems", 6.199 Advanced Undergraduate Project, FT 00

Vijay Divi "Heuristic Methods for Tree Selection", UROP project, ST 01

Rami Abdallah, "Error Probability in Wireless Channels", Summer 01, project through the Research Science Institute

Claudio Frey, "Optimal Spreading Bandwidth in Ultrawideband Channels", Summer 01, project through the Research Science Institute

Jie Tang, "Cycles in Large Networks", Summer 03, project through the Research Science Institute

Paul Ryu, "Distribution of Node Degrees in Large Networks", Summer 03, project through the Research Science Institute

Ayah Bdeir, "SNR adaptation for PSAM systems", Summer 03, undergraduate visiting from American University of Beirut

Anna Lee, "Rate-Splitting Implementation of Slepian-Wolf Source Coding", UROP project, Summer, Fall 03 and Spring 04

Evan Fink, "Random Multicast Network Coding", UROP project, Summer 03

Clifford Choute, “Network Coding in Gossip Networks”, UROP project Spring 04

Hyunjoo (Jenny) Lee, “Network Coding with a Cost Criterion”, AUP Spring 04

Enrique A. Muñoz-Torres, “Cycles and Reliability in Large Random Graphs”, AUP Spring 04

Ebad Ahmed, “Distributed Optimization for Multicast Network Coding”, UROP Summer 04, Fall 04

Master’s of Engineering Theses

Changqing Zheng, “Optimum Spreading Bandwidth for DS-CDMA on Time and Frequency Fading Channels”, May 2002

Pascal Rettig, “Transmit Simulation and Receive Optimization for 802.11b Networks” (6-A student at Qualcomm), May 2002

Cécile Le Cocq, “Delay Improvements from Multiple Wavelengths in an Optical Folded Bus”, September 2003

Clifford Choute, started Summer 2004

Anna Lee, started Summer 2004

Master’s Theses

Poompat Saengudomlert, “Analysis and Detection of Jamming Attacks in an All-optical Network”, June 1998 (co-supervised with Robert G. Gallager)

Jianyi Huang, “Capacity of Time-slotted ALOHA Systems”, June 2000, University of Illinois Urbana-Champaign (co-supervised with Sean P. Meyn)

Wenbo He, “Heuristic Algorithms for Failure Recovery in Mesh Networks”, August 2000, University of Illinois Urbana-Champaign

Hung Jen Wang, “Routing Policy on Robustness in Optical Networks”, March 2002 (co-supervised with Eytan Modiano)

Ari Libarikian, “Robustness of Bus Overlays in Optical Networks”, April 2002, **winner of a MIT Masterworks award (one of 9 in EECS)**

Todd Coleman, “Trade-off Between Power Consumption and Delay in Wireless Packetized Systems”, April 2002, **winner of the Morris J. Levin Award (First Prize) at the MIT Masterworks award**

Desmond Lun, “Error Exponent for Multipath Fading Channels: Strong Coding Theorem”, September 2002 (co-supervised with Ibrahim Abou-Faycal)

Guy Weichenberg, “High-Reliability Architectures for Networks Under Stress”, June 2003 (co-supervised with Vincent Chan)

Minkyu Kim, “Robustness in Large-Scale Random Networks”, June 2003

Siddharth Ray, “Achievable Rates Over Bursty Multiple-Access Noise-Free Channels”, September 2003 (co-supervised with Jinane Abounadi)

Pamela Youssef-Massaad, proposal submitted, started Fall 03 (co-supervised with Lizhong Zheng)

Jay Kumar Sundararajan, started Fall 03 (co-supervised with Supratim Deb)

Doctoral Theses, Supervisor

Tracey Ho, “Networking from a Network Coding Perspective”, May 2004. Committee: David Karger, Ralf Koetter (UIUC), Michelle Effros (Caltech),

Nathanael Peranginangin, “On Capacity of Relay Networks with Finite Memory Relays”, September 2004. Committee: Robert G. Gallager, Ralf Koetter (UIUC), Vincent Chan

Cheng Luo, started Fall 01, proposal submitted, “Communications over Wideband Fading Channels”, (co-supervised with Lizhong Zheng)

Todd Coleman, started Fall 02

Desmond Lun, started Fall 02

Siddharth Ray, started Fall 03 (co-supervised with Lizhong Zheng)

Guy Weichenberg, started Summer 03 (co-supervised with Vincent Chan)

Minkyu Kim, started Summer 03

Fang Zhao, started Fall 03

Doctoral Theses, Reader

Yevgeny Visotsky, “Space-time Transmit Precoding and Interference Suppression for a Wireless Downlink”, June 2000 (supervised by Upamanyu Madhow), University of Illinois Urbana-Champaign

Ibrahim C. Abou-Faycal, “An Information Theoretic Study of Reduced Complexity Receivers for Intersymbol Interference Channels”, January 2001 (supervised by Amos Lapidoth)

Edmund M. Yeh, “Successive Decoding in Multiple-user Communications”, June 2001 (supervised by Robert G. Gallager)

Thierry Klein, “Capacity of Gaussian Noise Channels with Side Information and Feedback”, June 2001 (supervised by Robert G. Gallager)

Nicholas Laneman, “Cooperative Diversity in Wireless Networks: Algorithms and Devices”, July 2002 (supervised by Greg Wornell)

Sandip Roy, “Moment Linear Stochastic Systems and Their Applications”, June 2003 (supervised by George Verghese)

Huan Yao, “Efficient Signal, Code, and Receiver Designs for MIMO Communication Systems”, June 2003 (supervised by Greg Wornell)

Rex Min, “Energy and Quality Scalable Wireless Communication”, June 2003 (supervised by Anantha Chandrakasan)

Nadav Shulman, “Communication over an Unknown Channel via Common Broadcasting”, July 2003 (supervised by Meier Feder), Tel Aviv University

Douglas De Couto, “High-Throughput Routing for Multi-Hop Wireless Networks”, May 2004 (supervised by Robert Morris)

Jianyi Huang (supervised by Sean Meyn), University of Illinois Urbana-Champaign

Sommer Gentry (supervised by Eric Feron)

Xin Zhou Wu (supervised by R. Srikant), University of Illinois Urbana-Champaign

April Rasala-Lehman (supervised by Madhu Sudan)

Yonggang Wen (supervised by Vincent W.S. Chan)