Dear Sir/Madam,

My name is Veeraruna Kavitha and am currently a Post doc at INRIA, FRANCE with Dr. Eitan Altman. I obtained my PhD from Indian Institute of Science, under the guidance of Prof. Vinod Sharma in July 2007. Prior to my PhD, I have been involved in research and development activities in the Telecom industry for about six years.

I am planning to return to India in November 2011 and am looking out for a suitable position. This application is in this regard. Please find below the list of documents enclosed.

Thanks and sincerely,
Veeraruna Kavitha

Documents Enclosed

Curriculum Vitae

Career Objective

To pursue learning and research in the field of networking, communication theory, statistical signal processing, information theory etc.. To form a link between the research and industry communities, by facilitating the research knowledge transfer to the industry in the form of better algorithms and thereby design optimal communication systems. To lead and motivate young engineers while designing and deploying the next generation wireless systems.

Research Interests

Stochastic analysis, Optimal control, Wireless communications, Networking, Queuing Theory, Polling systems, Game theory, Statistical Signal Processing.

Areas of Interest

Design and development of Wireless systems - specially Physical, Network and Cross layer algorithms.

Personal Information

Name	:	Veeraruna Kavitha
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Education

- **Doctorate(2007)**, Indian Institute of Science, India, CGPA 6.3/8.0
  Dissertation: Optimal Wireless Equalizers
  Advisor: Prof. Vinod Sharma, Electrical & Communication Engineering.

- **MSc (Engg.) (2002)**, Indian Institute of Science, India, CGPA 7.0/8.0
  Dissertation: Blind channel estimation and equalization for OFDM systems.
  Advisor: Prof. K R Ramakrishnan, Electrical Engineering.

- **B.E. (1994)**, UVCE, Electronics, Bangalore University, India, GPA 74/100

Course Work: Advanced Digital Communications, Estimation & Detection Theory, Information Theory, Adaptive Signal Processing, Stochastic Processes and Queuing Theory. Topology, Advanced Calculus, Non linear Functional Analysis and applications to Differential equations Part I. Digital Communications, Stochastic Models & and Applications, Digital Image Processing, Linear Algebra and Introduction to Analysis.
Courses Audited: Advanced Digital Communications, Estimation & Detection Theory, Information Theory, Adaptive Signal Processing, ODEs, Complex Analysis, Real Analysis, Functional Analysis, Advanced Probability Theory.

Employment

- **Accord Software and Systems Pvt. Ltd. (09/1994 - 07/2000)**, Project Leader
  Research, design and development of GPS, CDMA-high speed data link and Voice band modems.

- **TIFR, Bangalore (04/2007 - 07/2008)**, Post Doc with Prof. Adimurthy
  L^∞ Control, Energy efficient Change detection algorithm,its analysis in Sensor networks (J.5, C.15)

- **INRIA, France (08/2008 onwards)**, Post Doc with Dr. Eitan Altman
  - Power allocation algorithms in Multicell and Multi-tier networks (C.5)
    - This algorithm has been proposed to be implemented in the ECOSCELLS (energy efficient cooperative small cells) project, an European consortium between industry and research labs working on next generation wireless systems and standardization.
  - Analysis of small cell networks with mobile users, optimal cell dimensioning (J.3,C.8 etc.,)
    - Ideas proposed in this work (to manage high speed users, handovers etc.) have been applied for a patent by Bell Labs and INRIA.
    - Power law as a function of the "average user speed" for wandering users is being considered for another patent.
  - Analysis of Slotted Aloha channel and a distributed algorithm to obtain the equilibrium (C.12)
  - Robust Opportunistic Scheduling algorithms in the presence of noncooperation (J.2,C.3,C.11)
  - Optimal Control of Delay Tolerant Networks using Risk Sensitive MDP tools (C.2)
  - Adversal control of Delay Tolerant Networks in the presence of jammers (C.6)
  - Queuing in Space: Design of optimal message ferry routes (J.1,C.13, etc.,)

Achievements

1. Accord recognition award in 1996. This is an annual award presented to few outstanding employees (about 2 to 3).

2. I was awarded the NBHM (National Board for Higher Mathematics) Fellowship for the year 2007-2008 by the Government of India to carry out Post doctoral research in any of the esteemed mathematical centers within India (for example, TIFR (Tata Institute of Fundamental Research)).

References

1. **Eitan Altman**, MAESTRO, INRIA, France
   Phone: +33 4 92 38 77 86, Email: `Eitan.Altman@sophia.inria.fr`

2. **Prof. Vinod Sharma,** ECE Department, Indian Institute of Science, India
   Phone: : +91 80 2293 2854 , Email: `vinod@ece.iisc.ernet.in`

3. **Prof. Tamer Başar,** ECE Department, University of Illinois, U.S.A
   Phone: : +1 217-333-3607 or +1 217-979-1283, Email: `basar1@illinois.edu`

4. **Prof. Mrouane DEBBAH, SUPELEC, France**
   Phone : +33 (0) 1 69 85 14 47 , Email: `merouane.debbah@supelec.fr`

Professional Activities

- I am a TPC member of Gamesec 2011 and NetGoop 2011 conferences.
- Volunteer for WiOpt 2010.
- Reviewer for many journal and international conference papers.
- Fast Track Editor for Computer Communications Journal, special issue on selected papers from WiOpt 11.

Publications

Journals

J.1 **V. Kavitha**, E. Altman, "Continuous Polling Models and Application to Ferry Assisted WLAN" accepted at Annals of Operations Research.

J.2 **V. Kavitha**, E. Altman, R. Elazouzi and R. Sundaresan "Opportunistic scheduling in cellular systems in the presence of non-cooperative mobiles" accepted at IEEE Trans. Information Theory.

J.3 **Veeraruna Kavitha**, Sreenath Ramanath and Eitan Altman, "Spatial queueing for analysis, design and dimensioning of Picocell networks with mobile users", vol 68, issue 8, Elsevier Performance Evaluation (special issue on selected papers from **WiOpt**, August 2011.

J.4 Eitan Altman, Tamer Başar and **Veeraruna Kavitha**, "Adversarial Control in a Delay Tolerant Network", IEEE ComSoc MMTC E-Letter Special Issue on GameSec and Multimedia Security, June 2011.

J.5 T. Banerjee, V. Sharma, **V. Kavitha** and A. K. JayaPrakasam, "Generalized Analysis of a Distributed Energy Efficient Algorithm for Change Detection", vol 10, pp. 91-101, IEEE Trans. on Wireless Communications, Jan 2011.

Papers published in International Conferences

C.1 **Veeraruna Kavitha** "Continuous Polling with Rerouting and Applications to Ferry Assisted Wireless LANs", accepted in 5th International ICST Conference on Performance Evaluation Methodologies and Tools, ValueTools 2011.

C.2 Eitan Altman, **Veeraruna Kavitha**, Francesco De Pellegrini, Vijay Kamble and Vivek Borkar, "Risk sensitive optimal control framework applied to delay tolerant networks", accepted in IEEE **InfoCom 2011**.

C.3 **Veeraruna Kavitha**, Eitan Altman, Rachid Elazouzi, Rajesh Sundaresan, "Fair scheduling in cellular systems in the presence of noncooperative mobiles", In Proc. **InfoCom 2010**, San Diego, USA.

C.4 Sreenath Ramanath, **Veeraruna Kavitha**, Eitan Altman, "Open Loop Optimal Control of Base Station Activation for Green Networks", accepted in **WiOpt** 2011.

C.5 Sreenath Ramanath, **Veeraruna Kavitha**, Merouane Debbah, "Satisfying Demands in a Multicellular Network: An Universal Power Allocation Algorithm", accepted in **WiOpt** 2011.

C.6 Eitan Altman, Tamer Başar and **Veeraruna Kavitha**, "Adversarial Control in a Delay Tolerant Network", T. Alpcan, L. Buttyan, and J. Baras (Eds.): GameSec 2010, LNCS 6442, pp. 87-106.

C.7 **Veeraruna Kavitha** and Eitan Altman, "Analysis and Design of Message Ferry Routes in Sensor Networks using Polling Models", IEEE Proceedings of the 8th International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (**WiOpt**), pp. 247 - 255, May 31-Jun 04 2010, Avignon, France.

C.8 Sreenath Ramanath, **Veeraruna Kavitha** and Eitan Altman, "Spatial queuing analysis for mobility in pico cell networks", IEEE Proceedings of the 8th International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (**WiOpt**), pp. 152 - 159, May 31-Jun 04 2010, Avignon, France.

C.9 Sreenath Ramanath, **Veeraruna Kavitha**, Eitan Altman, "Impact of mobility on call block, call drops and optimal cell size in small cell networks", IEEE 21st International Symposium on Personal, Indoor and Mobile Radio Communications Workshops (PIMRC Workshops), pp. 157-162, 26-30 Sept. 2010, Istanbul, Turkey.

C.10 **Veeraruna Kavitha**, Eitan Altman, "Opportunistic Scheduling of a Message Ferry in Sensor Networks", Proceedings of the Second International Workshop on Mobile Opportunistic Networking (MobiOpp) 2010, Pisa, Italy.

C.11 **Veeraruna Kavitha**, Eitan Altman, Rachid Elazouzi, Rajesh Sundaresan, "Opportunistic scheduling in cellular systems in the presence of non-cooperative mobiles", Proceedings of 48th IEEE **Conference on Decision and Control (CDC)**, pp. 8581 - 8587, 15-18 Dec. 2009, Shanghai, China.

C.12 Essaid Sabir, Rachid El-Azouzi, **Veeraruna Kavitha**, Yezekael Hayel and El-Houssine Bouyakhf, "Stochastic Learning Solution for Constrained Nash Equilibrium Throughput in Non Saturated Wireless Collision Channels", 3rd ICST/ACM International Workshop on Game Theory in Communication Networks, GameComm 2009, Pisa, Italy.

C.13 **Veeraruna Kavitha**, Eitan Altman, "Queueing in Space: design of Message Ferry Routes in sensor networks", 21st International Teletraffic Congress (ITC 21) 2009, Paris, France.

C.14 Sreenath Ramanath, Eitan Altman, Vinod Kumar, **Veeraruna Kavitha**, Laurent Thomas, "Fair assignment of base stations in cellular networks", 22nd World Wireless Research Forum (WWRF) Conference, May 5-7, 2009, Paris, France

C.15 T. Benerjee, **V. Kavitha** and V. Sharma, "Energy Efficient Change Detection over a MAC using Physical Layer Fusion", 33rd IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 2501 - 2504 , March 31 2008-April 4 2008, Las Vegas, USA.

C.16 **V. Kavitha** and V. Sharma, "Tracking Analysis of an LMS Decision Feedback Equalizer for a Wireless Channel", 13th European Wireless Conference, Paris, France, April 2007.

C.17 **V. Kavitha** and V. Sharma, "Analysis of an LMS Linear Equalizer for Fading Channels in Decision Directed mode", 13th European Wireless Conference, Paris, France, April 2007.

C.18 **V. Kavitha** and V. Sharma, "Tracking performance of an LMS-Linear Equalizer for fading channels", 44th Annual Allerton Conference on Communication, Control and Computing, USA, September 2006.

C.19 **V. Kavitha** and V. Sharma, "LMS versus Wiener filter for a Decision Feedback Equalizer", 44th Annual Allerton Conference on Communication, Control and Computing, USA, September 2006.

C.20 **V. Kavitha** and V. Sharma, "Comparison of training, blind and semiblind equalizers in MIMO fading systems using capacity as measure", IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP '05), 18-23 March 2005 , pp. 589-592, USA.

C.21 **V. Kavitha** and V. Sharma, "Information theoretic comparison of training, blind and semiblind signal separation algorithms in MIMO systems", International Conference on Signal Processing and Communications, 2004. SPCOM '04, 11-14 Dec. 2004, pp. 407 - 411, Bangalore, India.

C.22 Amaranada Reddy, Archana Nayak, Gurucharan, **Veeraruna Kavitha**, Sreenath Ramanath, "Implementation of a Multi-Channel Baseband CDMA Receiver on a ADSP2189M Processor", International Digital Signal Processing Conference 2001, Boston, USA.

Details of my contributions during the Post-Docs

Current Employment (From August 2008)

I am currently working as a Postdoctoral Fellow under the supervision of Dr. Eitan Altman. I am a joint post-doc with INRIA, Sophia Antipolis, France and LIA, University of Avignon, Avignon, France. Some of my activities are in collaboration with Alcatel lucent Bell Labs, Paris. Major on going activities during this period :

Universal Power allocation algorithm in Multicell networks

- Each base station in the network needs to allocate power in a decentralized manner to their respective users so as to meet their demands (when they are within the achievable limits).
- Power to be allocated depends upon system architecture (e.g.,): coding, modulation, transmit precoder, rate allocation algorithm, available knowledge of the interfering channels, etc.
- We propose a universal algorithm: it works for any system architecture.
- The algorithm requires minimal information: every base station needs to know its own users demands, its total power constraint and the transmission rates allocated to its users in every time slot.
- We analyze the proposed algorithm using ordinary differential equation (ODE) framework. Simulations confirm its effectiveness.

Industry Transfer : This algorithm has been proposed to be implemented in the ECOSCELLS (energy efficient cooperative small cells) project, an European consortium between industry and research labs working on next generation wireless systems and standardization.

Small cell networks with mobile users

- Small cell networks are proposed to improve the quality of service of cell edge users.
- We obtain the performance of such networks catering moving users.
- Using queueing theoretic tools, we derive explicit expressions for expected waiting times, service times and drop/block probabilities.
- We also obtain (approximate) closed form expressions for optimal cell sizes as a function of the velocity of the user and conclude that:
  - If the call is long enough, the optimal cell size depends mainly on the velocity profile of the mobiles, its mean and variance;
  - Optimal cell size is independent of the traffic type or call duration;
  - For any fixed power, there exists a maximum velocity beyond which successful communication is not possible;
  - Maximum possible velocity increases with power of transmission;
  - For any given power, the optimal cell size increases when either the mean or the variance of the mobile velocity increases.

Industry Transfer :

- Ideas proposed in this work (to manage high speed users, handovers etc.) have been applied for a patent by Bell Labs and INRIA.
- Power law as a function of the "average user speed" for wandering users is being considered for another patent.

Opportunistic Scheduling algorithms and noncooperation

- The base station (BS) has to schedule one of the awaiting mobiles, based on the current channel gains signaled by the mobiles, so as to fairly share the resources.
- Mobiles can be non-cooperative: they may signal erroneously to improve their utilities.
- Efficient scheduling: maximum priority to the total throughput obtained; this can result in a very unfair allocation on average to a user with bad channel conditions most of the times (for example a far away user).
- General alpha fair schedulers: these also give certain level of importance to the average shares obtained by all the users.
- We show that the existing schedulers are robust against noncooperation only when the scheduler gives maximum weightage to fairness.
- We propose robust fair schedulers, that do not fail in presence of noncooperative users:
  - it is an iterative algorithm that combines estimation and control;
  - it requires additional knowledge: the cooperative shares of the users (the average throughput obtained by users under truthful signaling).

Distributed algorithm for non saturated Aloha channels

- In a collision (slotted aloha) channel, a users's transmission is successful only if no other user attempts transmission simultaneously.
- Packets are retransmitted if there is a collision.
- If packets are available, user attempts transmission with certain probability.
- Each user has a fixed throughput demand and it dynamically adapts its transmission probability to obtain its required demand.
- We obtain the existence of infinite number of Nash equilibria (a notion of optimal solution in a mutli-agent optimization problem).
- We propose a fully distributed algorithm that converges to that equilibrium which is the most energy efficient one.

Delay Tolerant Networks

- Users demanding data transfers, can tolerate delays and this fact is utilized to design cost effective and simple wireless networks, called Delay tolerant Networks (DTNs).
- For example, message is spread across all the contacted (relay) users and it spreads like epidemics till it reaches the destination.
- The epidemics spread has to be controlled.
- New optimal control problems which consider the effect of wireless propagation path loss factor and the power constraints at the source and or the destination are proposed and solved for DTNS using Risk MDP framework.
- The possibility of non-threshold type optimal policies is established for some control problems.
- We also study the effect of a jammer on this success probability via game theoretic framework.

Ferry (moving base station) based Wireless networks

- A number of isolated nodes are scattered over some area.
- Communication between a node and the outer world or the communication between any two nodes, is made possible via a moving message ferry.
- Ferry moves in a predetermined cyclic path and collects/deposits messages from/to a node when it is in the vicinity of the later.
- We obtain appropriate performance measures for these networks using polling models and design optimal ferry routes as well as the stop points.

Continuous polling models

Polling systems are special queuing systems in which a single server attends to more than one queue. Continuous systems are the ones in which arrivals can occur anywhere in a continuum. We obtain the performance (stationary expected workload) of such systems via discrimination approach which is further used in obtaining the performance of ferry based wireless networks.

Post Doc at TIFR, Bangalore (April 2007 - July 2008)

I worked as a Postdoctoral Fellow under NBHM Fellowship at TIFR (Tata Institute of Fundamental Research), Bangalore, India, under the supervision of Prof. Adimurthy. Major activities during this period are:

- Existence of value and a saddle point for zero sum stochastic differential games with L^∞ costs.
- Decentralized change detection at fusion center in a sensor network environment.

Details of my PhD and Masters Thesis

PhD (August 2002 - September 2007)

Topic: Optimal Wireless Equalizers

Res. Supervisor: Prof. Vinod Sharma, ECE Dept., IISc, Bangalore.

Description : We analyze various equalizers operating in wireless channels.

- Using "channel" capacity as the performance measure, we obtain a systematic comparison of the blind, semi-blind and training equalizers. We show that semi-blind equalizers perform best in any given wireless scenario.
- We obtain an ODE approximation for a general system whose components may depend on two previous values.
- Using the above, obtain an ODE approximation for an LMS (Least Mean Square) Linear/ Decision feedback equalizer in training mode or an LMS linear equalizer in decision directed (DD) mode while tracking a wireless channel modeled by an AR (2) process and obtain the following:
  - A training based LMS linear equalizer tracks the instantaneous WF (Wiener filter).
  - A decision directed LMS linear equalizer stays close to the instantaneous Wiener filter whenever the SNR (Signal to Noise Ratio) is high and when the equalizer is properly initialized. However, at low SNRs, the DD attractors are away from the Wiener filter.
  - A training based LMS decision feedback equalizer stays close to the instantaneous Wiener filter at high SNRs.
- We solve some long standing issues in time invariant channels:
  - We obtain the existence of DD-attractors close to the WF at high SNRs.
  - We show that under high SNR, LMS can be used to obtain the MSE optimal DFE (the WF).

MSc Research

Topic: Blind channel estimation and equalization for OFDM systems.

Res. Supervisor: Prof. K R Ramakrishnan, EE Dept., IISc, Bangalore.

Description : We propose a blind channel estimator and a decision feedback equalizer for OFDM systems. The new blind channel estimator works even for OFDM systems with Cyclic Prefix length smaller than the channel length (e.g., DMT systems). The new DFE proposed can be used for any generic system, with "Block Decisions".

Details of my industrial experience

Industrial Experience (Sep 1994 - Jul 2000)

During my tenure of 6 years at Accord, starting from Sep 1994, I held various positions contributing to Global Positioning System (GPS), Voice band modems and CDMA technology.

1. **First single chip DSP based GPS solution:** As a Research and Development Engineer, I developed several signal processing and navigation algorithms for GPS. We were one of the first companies in the world to build a single chip DSP (Digital Signal Processor) based GPS receiver on Analog Devices fixed and floating point DSPs. It was a national startup company and I was part of a small core group which developed the GPS.

2. **More efficient and cost effective GPS solution:** The first solution illustrated only the basic functionality of GPS. As a Senior Engineer, I guided a team of enthusiastic engineers to develop more efficient and cost effective GPS solutions. This work involved the responsibility of handling the complete development life cycle of GPS products. We improved the carrier and code tracking algorithms and designed better signal processing algorithms to significantly improve the signal locking capabilities.

3. **DSP based Modems:** As a project leader, I was responsible for a team working on Voice band Modem technology at Telindus, Belgium. As a part of the Telindus R&D group, I understood the underlying modem technology and was instrumental in developing and validating data and fax modems.

4. **High data rate CDMA based data link:** As a project leader, I led another team which was involved in the design and development of high data rate CDMA links intended for Mission control applications. The high data rates envisaged posed new dimension of problems, which involved robust carrier and code tracking algorithms. The prototypes were built to withstand high mobility air and terrestrial applications. Some of the principles used in the development of the high speed CDMA link technology was published in Analog Devices DSP conference in 2001.