

# Allen K. L. Miu

MIT Computer Science and Artificial Intelligence Laboratory  
32 Vassar Street G930  
Cambridge, MA 02139  
(617) 253-8236  
aklmiu@mit.edu  
<http://nms.lcs.mit.edu/~aklmiu/>

## Professional Interests

Wireless networks, mobile/ubiquitous computing, location systems, and networks for audio/video streaming applications.

## Education

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, MA  
PhD candidate in Computer Science (expected completion: December 2005)

*Thesis:* Path Diversity Techniques for Loss-Resilient and Low-Latency  
Packet Delivery in Wireless LANs

*Adviser:* Hari Balakrishnan

We design, implement, and experimentally evaluate Divert, a novel WLAN system that exploits the *path diversity* to improve network performance. In contrast to today's WLAN, our system allows a client to communicate with multiple APs and coordinates the APs to participate in the concerted effort of recovering lost packets in the wireless medium. Divert significantly reduces transmission loss and delay, which helps improve the performance and perceived quality for a variety of delay-sensitive wireless applications that do not run well on today's WLANs such as voice over IP, video conferencing, and online gaming.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, MA  
S.M. in Computer Science, 2002

Cumulative GPA: 5.0/5.0

*Thesis:* Design and Implementation of an Indoor Navigation System

*Adviser:* Hari Balakrishnan

We develop CricketNav, an indoor personal navigation system using Cricket location sensors and experimentally evaluate various position estimation algorithms. We also develop an extensible programming library for Cricket and a spatial information service to support location-aware applications. The contributed software is used in assigned class projects and in numerous medical, industrial, and research institutions to study location-aware applications.

UNIVERSITY OF CALIFORNIA, BERKELEY Berkeley, CA  
Bachelor of Science with *Highest Honors*, 1999

Electrical Engineering and Computer Science Honors Program  
Cumulative GPA: 3.946/4.000

## Proficiencies

Platforms LINUX, Windows

Languages Scheme, Java, HTML, Perl, C/C++, MIPS, Tcl/Tk, VHDL,  
TCP/IP, SQL, Visual Basic/C++, Network Device Driver  
(NDIS) Programming in Windows 2000, Matlab,  
Linux Kernel programming

Courses Computer Architecture, Compiler Design, Computational Geometry, Computer Networking, Embodied Intelligence (Robotics AI), Operating System Design, Programming Languages, Randomized Algorithms, Circuit Analysis, Microelectronic Device design, Digital System Design, Microprocessor Design, Signal & Systems, Macro/Microeconomics, Finance Theory, Marketing, Technical Communication.

## Work and Research Experience

2004—Present **Divert Project** MIT

Divert is my thesis project, which proposes a wireless local area network (WLAN) architecture and heuristics for coordinating transmissions of neighboring access points (AP) to reduce transmission losses and increase efficiency of the network.

In a typical WLAN deployment, different transmission paths to a client exist in places where overlapping coverage is provided by a set of neighboring APs. Using experimental measurements and analysis on a 802.11b testbed, we show that transmission losses are *path-dependent* and that *fine-grained path selection* among a set of neighboring APs can significantly reduce path-dependent losses in WLANs. We design and implement a WLAN distribution system called Divert, which supports fine-grained AP selection for downlink communications, on an 802.11b testbed. Data trace is publicly available (<http://nms.lcs.mit.edu/divert>).

Currently, we are developing a spatial packet combining technique to further reduce link losses in a WLAN. In this technique, we configure multiple APs to listen for client transmissions on the same radio frequency. Thus, we enable the system to receive multiple copies of the same transmission and use them to recover errors via packet combining at a central router core. We are developing an efficient control and feedback mechanism to facilitate efficient packet combining within the Divert architecture.

2004—Present **Astra Project** MIT

We design and evaluate techniques for establishing opportunistic Internet connections with open 802.11 access points deployed in the city for highly mobile terminals such as pedestrians, cars, public and emergency vehicles. Our techniques combine current GPS information with historical connectivity and location information to predict the degree of connectivity and achievable quality of service (throughput and delay) for a mobile terminal at a given location. We are building a client prototype for gathering experimental data from open access points deployed throughout Cambridge, MA.

2001—Present **The Cricket Project** MIT

We develop a robust, scalable, and low-cost indoor location system that provides space, position, and orientation information for mobile devices. Empowered with location information, applications may change their behavior according to the mobile device's physical context. My masters thesis develops CricketNav, an indoor personal navigation system using Cricket location sensors and experimentally evaluate various position estimation algorithms. My thesis also develops an extensible programming library for Cricket and a spatial information service to support location-aware applications. The Cricket Project is part of MIT Project Oxygen.

Presently, I am maintaining the software library and demo applications in the Cricket Software Distribution (<http://nms.lcs.mit.edu/cricket>), which is used in assigned class projects and in numerous medical, industrial, and research institutions.

2002 **Wireless Video Streaming Over 802.11 Using Path Diversity** HP Labs

We developed and evaluated path diversity techniques to improve low-latency (conversational) video communication (H.264/MPEG-4) over 802.11b networks. The system ex-

exploits the potential path diversity between each mobile client and multiple access points in the infrastructure, where we use multiple paths simultaneously or switch between multiple paths (site selection) as a function of channel characteristics. I carried out this work as an intern supervised by Dr. John Apostolopoulos at HP Labs.

2002                    **Teaching Assistant for 6.170 Laboratory in Software Engineering**                    MIT

Held weekly recitations to help students review core concepts and advised student groups in a half-semester-long final project. Other responsibilities included grading, preparing assignments, recitation material, midterm reviews, and exams.

2001                    **The Blueware Project**                    MIT

We developed an incremental algorithm called Tree Scatternet Formation (TSF) for interconnecting Bluetooth piconetworks. TSF forms a tree topology, which, due to its loop-free property, simplifies network addressing, routing, and Bluetooth link-scheduling. My work in the Blueware Project is focused on analyzing various performance aspects of the TSF algorithm including scatternet formation delay, and topology efficiency for routing traffic.

2000                    **The Choice Network Project**                    Microsoft Research

We designed a software beaconing system that manages mobility for wireless clients that roam between private and public (hotspot) 802.11 networks. Additionally, our solution provides load balancing and location services and fail-over mechanisms for authentication and verification services in the public network. The system was deployed and tested in a public wireless network operating in a shopping mall in Bellevue, WA. I carried out this work as an intern supervised by Dr. Victor Bahl at Microsoft Research.

1999-2000            **Comet**                    MIT

We studied the idea of increasing Internet web transfer performance and robustness by applying traditional striping techniques to wide area HTTP networks. In what we termed *paraloading*, a receiver node downloads different stripes of large volume archive from a set of replica servers in parallel. I implemented a Java-based paraloading client that performs dynamic load balancing to increase performance and evaluated its performance using 21 mirror sites deployed on the Internet.

1998-1999            **SmartDust Simulator**                    UC Berkeley

Design and implementation of a Java-based sensor network simulator (using Ptolemy II), which is used to study the behavior of an ad hoc wireless communication network. I carried out this work as an undergraduate research assistant supervised by Professor Kris Pister at UC Berkeley.

1998                    **Service Time Measurements of the Operation and Management System in Cellular Phone Networks**                    Motorola

Analyzed the performance of the operation and management system in a cellular phone network.

1997-1998            **Java Network Animator (JAM)**                    UC Berkeley

Developed a web-based graphical user interface for the ns-Network Animator (NAM), which is part of the Network Simulator (ns) software package used for networking simulations in the research community. I carried out this work as an undergraduate research assistant supervised by Dr. Steve McCanne.

## Selected Graduate Class Project Descriptions

2000                    Network Neighborhood Size Estimation Using Distributed Random Sampling                    6.856  
Randomized Algorithms

One beneficial piece of information that can increase the efficiency of the MAC layer of wireless networks is the neighborhood size. Given a set of  $N$  wireless nodes randomly scattered over some terrain, we designed and evaluated a parallel, randomized algorithm to estimate the number of neighbors  $n$  for each node with a  $O(\log N^2)$  running time.

2000 Centipede 6.836 Embodied Intelligence

We studied multi-robot interaction by building and programming three mobile robots that would start from a random location within a confined space and autonomously arrange themselves into a chain configuration. The project involved characterizing the response of infrared sensors and emitters, designing and building circuitry for modulating signals, and programming 68HC11-based controller board. Extensive documentation, code, and video demonstration is published online (<http://nms.lcs.mit.edu/~eugene/education/courses/6.836/>).

## Selected Undergraduate Class Project Descriptions

1998 Computer Architecture class project (taught by Prof. B. Brodersen). Designed and simulated a 7-stage deeply pipelined MIPS-compatible processor with 4-state branch prediction, non-blocking load, CAM-based cache, and burst-mode, interleaved memory architecture.

1998 Digital Design class project (co-taught by Prof. R. Newton and Assistant Prof. K. Pister). Proposed, designed, and implemented a "smart" camera turntable that adjusts the camera's angle to keep a moving target object within the camera's line of view. More specifically, the system is designed for the application of filming lectures, where it tracks a lecturer walking across a row of blackboards in front of the classroom (i.e. the stage). The solution involved designing digital circuits for performing triangulation arithmetic and controlling ultrasonic sensors and beacons. The design is implemented on the Xilinx FPGA and a demonstration of the working system is given.

## Publications

- Allen K. Miu, Hari Balakrishnan, and Can Emre Koksak. Improving Loss Resilience with Multi-Radio Diversity in Wireless Networks. In *Proc. of ACM MobiCom*, Cologne, Germany, September 2005.
- Allen K. Miu, Godfrey Tan, Hari Balakrishnan, and John Apostolopoulos. Divert: Fine-grained Path Selection for Wireless LANs. In *Proc. of ACM MobiSys*, Boston, USA, June 2004.
- Allen K. Miu, John Apostolopoulos, Wai tian Tan, and Mitchell Trott. Low-Latency Wireless Video Over 802.11 Networks Using Path Diversity. In *IEEE ICME*, Baltimore, USA, July 2003.
- John Gutttag Godfrey Tan, Allen Miu and Hari Balakrishnan. An Efficient Scatternet Formation Algorithm for Dynamic Environmnets. In *Proc. of IASTED CCN*, Cambridge, MA, July 2002.
- Allen Miu. Design and Implementation of an Indoor Mobile Navigation System. Master's thesis, Massachusetts Institute of Technology, Cambridge, MA, January 2002.
- Bahl, P. and Balachandran, A. and Miu, A. and Russell, W. and Voelker, G. and Wang, Y. M. PAWNs: Satisfying the Need for Ubiquitous Connectivity and Location Services. *IEEE Personal Communications Magazine*. To appear.
- N. Priyantha, A. Miu, H. Balakrishnan, and S. Teller. The Cricket Compass for Context-Aware Mobile Applications. In *Proc. of ACM MobiCom*, Rome, Italy, July 2001.
- Allen Miu and Paramvir (Victor) Bahl. Dynamic Host Configuration for Managing Mobility Between Public and Private Networks. In *Proc. of USENIX USITS*, March 2001.

## Patents

- Allen Miu, John Apostolopoulos, Wai tian (Dan) Tan, and Mitchell Trott. Low-latency wireless video over 802.11 networks by using path diversity from multiple 802.11 access points. Patent Pending, Sept 2003.
- Seth J. Teller, Nissanka B. Priyantha, Allen K. L. Miu, and Hari Balakrishnan. Method and apparatus for determining orientation. US Patent No. 6,816,437, July 2002.
- Paramvir Bahl and Allen Miu. Systems and methods for managing network connectivity for mobile users. US Patent Application No. 20030061363, Sept 2001.

## Demonstrations

2004                    A Demonstration of Tracking the Position of a Moving LEGO Train using the Cricket Indoor Location System. 10th ACM Mobicom, Philadelphia, PA, 2004. I developed an application that demonstrated how Cricket can be deployed and configured quickly in ad hoc locations and how it is used to track the position of a moving LEGO train in real time. (<http://nms.lcs.mit.edu/~aklmiu/mobicom04demo.pdf>)

## Services and Other Activities

                          Reviewer for MobiCom, MobiSys, SenSys, SOSP, Sigcomm, Infocom, HotNets, USITS  
2002—Present        Boston Open Tournament Planning Committee  
1999—Present        MIT Badminton Club President (00-02), Officer, Member of Intecollegiate League Team

## Selected Honors and Awards

2002                    Winner of a Masterworks Award  
1999                    EECS Honors Program with Highest Honors Distinction  
1997                    Member, Eta Kappa Nu (HKN) EE Honor Society  
1997                    Bailey, L&V Grant at UC Berkeley  
1995                    Canadian Governor General Bronze Medal Award academic achievement  
1994                    Shad Valley Summer Program at the University of Calgary, Canada (1994)

## References

Hari Balakrishnan  
Associate Professor  
MIT CSAIL  
32 Vassar St G940  
Cambridge, MA 02139  
hari@mit.edu  
(617) 253-8713

Victor Bahl  
Senior Researcher/Group Manager  
Microsoft Research  
One Microsoft Way  
Redmond, WA 98052  
bahl@microsoft.com  
(425) 706-1021

John Apostolopoulos  
Senior Research Scientist  
Hewlett-Packard Laboratories  
1501 Page Mill Rd. M/S 3u-4  
Palo Alto, CA 94304  
japos@hpl.hp.com  
650-857-4416

John Ankcorn  
Principal Research Scientist  
Hewlett-Packard Laboratories  
1501 Page Mill Rd. M/S 1181  
Palo Alto, CA 94304  
jca@hp.com  
650-236-2323

July 4, 2005