

# dr. narendra anand

Electrical and Computer Engineer

## contact

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## highlights

Embedded software engineer with experience gained from systems-focused PhD research in multi-antenna wireless systems.

PhD research focused on the design and implementation of novel, cross-layer, Multi-user Multiple-Input-Multiple-Output (MU-MIMO) communication protocols. Implementation and evaluation of such protocols on SDR platforms resulted in experience including FPGA development (Verilog, VHDL, Xilinx SystemGenerator), embedded microcontroller development (C), host PC driver and control development (C, MatLab, Python), and high level scripting (MatLab, Python, Bash). Resulting research has been published in and presented at numerous, high-impact, international peer-reviewed conferences (IEEE INFOCOM and ACM MobiCom).

Current work at Accenture Technology involves research and proof-of-concept creation of Software Services and Architectures for Cloud/IoT applications.

## technical skills

Embedded C, Python,  
GoLang, MATLAB,  
Verilog, VHDL, C++,  
assembly, Java

LaTeX, Bash, Awk

Xilinx SysGen/EDK,  
ns2 Network Simulator,  
MSP-430 development,

IoT and Edge Analytics,  
Multi-User MIMO,  
Massive MIMO,  
Software Defined Radio,  
Wireless Communications,  
Signal Processing



## personal



Mother tongue:  
English

Basic proficiency:  
Spanish and Kannada

United States Citizen

References upon request.

## education

2015 **Ph.D.** in Electrical Engineering Rice University, Houston, Texas  
Thesis: *MU-MIMO WLANs in Diverse Bands and Environments*    
Advisor: Dr. Edward W. Knightly GPA: 4.03/4.00

2009 **M.S.** in Electrical Engineering Rice University, Houston, Texas  
Thesis: *Augmenting Wireless Security using Zero-Forcing Beamforming*    
Advisor: Dr. Edward W. Knightly GPA: 4.04/4.00

2005 **B.S.** in Electrical Engineering Rice University, Houston, Texas  
GRE: Quantitative - 800/800 (94%ile) (major) GPA: 3.83/4.00  
Verbal - 610/800 (87%ile) (cumulative) GPA: 3.57/4.00  
Writing - 5.5/6 (90%ile)

## work experience















**Accenture** Houston, Texas  
*R&D Associate Principal, Industry X.0* December 2016 - Present  
Technical lead for Accenture's Houston Innovation Hub's Industry X.0 group. Leads industry-focused research initiatives in areas including IoT, edge analytics, personnel and asset tracking, and next-generation wireless communications. Key deliverables include creation of innovative solutions and proof-of-concept designs to satisfy client needs.

**Cisco Systems** San Jose, California  
*Software Engineer, FAST Program* August 2015 to November 2016  
Research Scientist for Cisco's **F**orward-looking **A**nalytics, **S**oftware, and **T**echnologies program. Conducted industry-focused research in collaboration with academic university partners in areas including network security, IOT, cloud/fog computing, and software services. Key deliverables included papers, patents, and proof-of-concept designs.




**Skylark Wireless LLC** Houston, Texas  
*Hardware Engineer* Fall 2013 to Summer 2015  
Developed hardware calibration protocols, firmware, and host-side software for Skylark Wireless's **W**ideband **U**HF **R**adio **C**ard (WURC), an RF front end for Software Defined Radio platforms. Completed integration with WARP SDR platform to enable long-range wireless research.

## publications

### conference proceedings

- (1) **N. Anand**, A. Chintalapally, C. Puri, T. Tung, "Practical edge analytics: Architectural approach and use cases," in *Proc. of IEEE EDGE 2017*, Honolulu, HI Jun. 2017.  
 
- (2) R. Guerra **N. Anand**, C. Shepard, and E. Knightly, "Opportunistic Channel Estimation for Implicit 802.11af MU-MIMO," in *Proc. of ITC-28 2016*, Würzburg, Germany Sept. 2016.  
  *Accept Rate:* 37/108=34%
- (3) **N. Anand**, J-K. Lee, S-J. Lee, and E. Knightly, "Mode and User Selection for Multi-User MIMO WLANs without CSI," in *Proc. of IEEE INFOCOM 2015*, Hong Kong, Apr. 2015.  
  *Accept Rate:* 316/1640=19%
- (4) **N. Anand**, R. Guerra, and E. Knightly, "The Case for UHF-Band MU-MIMO," in *Proc. of ACM MobiCom 2014*, Maui, HI, Sept. 2014.  
  *Accept Rate:* 36/220=16%
- (5) C. Shepard, H. Yu, **N. Anand**, E. Li, T. Marzetta, R. Yang, and L. Zhong, "Argos: Practical Many-Antenna Base Stations," in *Proc. of ACM MobiCom 2012*, Istanbul, Turkey, Aug. 2012.  
  *Accept Rate:* 32/212=15%
- (6) **N. Anand**, S-J. Lee, and E. Knightly, "STROBE: Actively Securing Wireless Communications using Zero-Forcing Beamforming," in *Proc. of IEEE INFOCOM 2012*, Orlando, FL, Mar. 2012.  
  *Accept Rate:* 278/1547=18%
- (7) E. Aryafar, **N. Anand**, T. Salonidis, and E. Knightly, "Design and Experimental Evaluation of Multi-User Beamforming in Wireless LANs", in *Proc. of ACM MobiCom 2010*, Chicago, IL, Sept. 2010.  
  *Accept Rate:* 32/233=14%

### workshop/demo

- (1) R. Guerra, **N. Anand**, and E. Knightly, "A Platform for At-Scale Wideband UHF MU-MIMO Systems," in *Proc. of USENIX NSDI Demo Session*, Seattle, WA, Apr. 2014. 
- (2) **N. Anand**, C. Shepard, and L. Zhong, "Practical Performance of MU-MIMO Precoding in Many-Antenna Base Stations," in *Proc. of ACM CellNet*, Taipei, Taiwan, Jun. 2013. 
- (3) **N. Anand**, E. Aryafar, and E. Knightly, "WARPLab: A Flexible Framework for Rapid Physical Layer Design," in *Proc. of ACM S3 2012*, Chicago, IL, Sept. 2010. 

### patents

- (1) A. Chintalapally, **N. Anand**, S. Yelisetty, T. Tung, M. Giba. 2018. "Edge computing platform." US Patent Application 15/836557 filed June. 21, 2018. Patent Pending.
- (2) **N. Anand**, S-J. Lee, and E. Knightly. 2012. "Communications security in multiple-antenna wireless networks." US Patent Application 13/440,793 filed Apr. 5, 2012. Patent Pending.

## internship experience

### Hewlett-Packard Laboratories

Visiting Researcher, Networking and Communications Lab

Prototyped hybrid Software Defined Radio platform. Began investigation of wireless channel capture effects in 802.11n.

Palo Alto, California

Summer 2011

### National Instruments

Research Intern, Wireless DAQ Group

Prototyped new battery-operated, 802.11, Wireless Data Acquisition Device. Responsibilities included researching and presenting different permutations of components, and creating an option comprised of 802.11b Radio, low-power FPGA, and ARM 9 microcontroller.

Austin, Texas

Summer 2008

### National Instruments

Research Intern, Portable DAQ Group

Developed production firmware, compliance testing software, and performed hardware validation testing for Wireless Sensor Network Thermocouple node.

Austin, Texas

Summer 2007

### Rice University

Research Intern, Rice Efficient Computing Group

Developed firmware for Ti-MSP430-based, motion-sensing wrist interface for Bluetooth enabled mobile devices.

Houston, Texas

Summer 2006 to Spring 2007

## teaching

**Rice University ECE Dept:** Course Assistant: run lab sessions, hold office hours, grade homework and exams, be available for ad hoc question and answer meetings.

- ❶ ELEC 538: Communication Networks Spring 2012
- ❷ ELEC 438: Wireless Networking for Under-Resourced Communities Fall 2011
- ❸ ELEC 220: Introduction to Computer Engineering Spring 2007, 2010, 2011
- ❹ ELEC 326: Digital Logic Design Fall 2007, 2009, 2010
- ❺ ELEC 226: Microcontroller and Embedded Systems Lab Spring 2006

## academic honors

- ❶ Rice University ECE Affiliates Day 1<sup>st</sup> Place Demo. Spring 2015  
*An Open Development Platform for Long-Range TV White Space Hotspots*
- ❷ Rice University ECE Affiliates Day 1<sup>st</sup> Place Demo. Spring 2014  
*A Platform for At-Scale Wideband UHF MU-MIMO Systems.*
- ❸ Rice University Hershel M. Rich Invention Award Spring 2012  
*STROBE: Simultaneous Transmissions with Orthogonally Blinded Eavesdroppers*
- ❹ Rice University ECE Affiliates Day 1<sup>st</sup> Place Demo. Spring 2012  
*Narrowing the Beam: Improving Efficiency in Wireless Networks by Scaling Up*
- ❺ Rice University ECE Affiliates Day 1<sup>st</sup> Place Demo. Spring 2011  
*STROBE: Actively Securing Wireless Communications using Zero-Forcing Beamforming*
- ❻ Rice University ECE Department 1<sup>st</sup> Place Senior Design Award Spring 2009  
*Smart Antennas: Beamforming on WARP*
- ❼ Rice University President's Honor Roll Spring 2005, Fall 2009
- ❽ Texas Instruments Distinguished Student Fellowship Fall 2009 – Spring 2011
- ❾ Rice University Brown Undergraduate Research Scholarship Spring 2006