Clayton W. Shepard

Curriculum Vitae

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Education

2018   **Ph.D.**, *Rice University*, Houston, TX, Electrical Engineering.
Advisor: Dr. Lin Zhong
- Built first two Massive MU-MIMO base stations.
- Developed novel Massive MIMO system architectures, beamforming techniques, and control channel designs.
- Mobile systems development and characterization.

2012   **M.S.**, *Rice University*, Houston, TX, Electrical Engineering.
Advisor: Dr. Lin Zhong

2008   **B.S.**, *Rice University*, Houston, TX, Electrical Engineering.

Employment

June 2015 - active   **Founder & CTO**, *Skylark Wireless LLC*, Houston, TX.
- Co-P.I. for NSF SBIR Phase II award #1632565, Sept 2016 - Sept 2018
  "High-Speed TV-Band White Space Networks with Many-Antenna Multi-User Beamforming"
- Lead Engineer for NSF SBIR Phase I award #1520496, July 2015 - Dec 2015
  "Tacet: High-Speed TV-Band White Space Networks with Implicit Multi-User Beamforming"
- First inventor on multiple patents.

Jan 2018 - active   **Faculty Lecturer**, *Rice University*, Houston, TX.
- Developing course material and teaching ELEC 433/536: Digital Wireless Systems

Jun 2013 - Oct 2014   **Engineering Intern and Visiting Researcher**, *Microsoft Research*, Redmond, WA.
- Developed and deployed multi-cell MU-MIMO TV-Whitespace network across Redmond campus with Dr. Victor Bahl.

Jun - Sept 2011, 2012   **Engineering Intern**, *Alcatel-Lucent Bell Labs*, Murray Hill, NJ.
- Developed Massive MIMO Systems with Dr. Erran Li and Dr. Thomas Marzetta.

Mar 2010 - Mar 2011   **General Manager**, *Valhalla, V&W Permits*, Houston, TX.
- Supervising 120 Volunteers
- Inventory Management
- University Relations
- Event Coordination

May 2007 - Jan 2009   **Engineering Intern and Visiting Researcher**, *Motorola Advanced Technology Research Center*, Schaumburg, IL.
- Developed social TV and cross-platform integration with Dr. Venu Vasudevan.

Dec 2006 - May 2009	**Research Assistant**, *Rice University*, Houston, TX.
	○ Mobile Device Content Stabilization
	○ Multimedia Transcoding and Distribution
	○ Gesture Recognition
	○ Webmaster for Rice Efficient Computing Group and ELEC 424
	○ Mobile Device Location Reporting and Social Sharing
Dec 2007 - Apr 2008	**Teaching Assistant**, *Rice University*, Houston, TX.
	○ Assisted with the design and production of educational MSP430 boards
	○ Helped plan and execute lab sessions for ELEC 220 course
Dec 2005 - Mar 2006	**Project Coordinator**, *Rice University*, Houston, TX.
	○ Supervising over 30 contract workers installing new campus-wide IT network (RiceNet2)
Mar 2004 - Dec 2005	**Network Administrator / Executive Administrative Assistant**, *Quadra Health Institute*, Albuquerque, NM.
	○ Assisted in setting up entirely new medical practice.
	○ Built IT infrastructure from scratch and maintained it.

Relevant Experience

Languages	Embedded C, Python, Matlab, Java, Verilog, Assembly, Objective C, PHP, SQL, HTML/CSS/JavaScript, Bash, LATEX, Spanish.
Tools	Xilinx System Generator, Eclipse, Code Composer Studio, Xilinx ISE, EDK, Vivado, DHCP, DNS, Apache, VNC, IIS.
Systems	Skylark Iris, WARP Software-Defined Radio, Lime Microsystems LMS6002D & LMS7002M, SoapySDR, OpenAirInterface, iPhone, Linux, Xen.
Skills	System Design, FPGA Design, Network Administration, Base Station Installation, Web Page Design, Soldering, Microsoft Certified Systems Administrator (MCSA).
Protocols	802.11a/b/g/n/ac/af, LTE, 5G.
Keywords	FPGA, Software-Defined Radio, Television White Spaces, TVWS, Mobile Systems, Communications, Wireless Networks, Massive-MIMO, 5G.

Select Publications

C. Shepard, H. Yu, N. Anand, E. Li, T. Marzetta, R. Yang, and L. Zhong, "Argos: Practical many-antenna base stations," in *Proceedings of the 18th annual international conference on Mobile computing and networking*, pp. 53–64, ACM, 2012.

C. Shepard, A. Javed, and L. Zhong, "Control channel design for many-antenna MU-MIMO," in *Proceedings of the 21st Annual International Conference on Mobile Computing and Networking*, pp. 578–591, ACM, 2015.

C. Shepard, J. Ding, R. Guerra, and L. Zhong, "Understanding real many-antenna MU-MIMO channels," in *Proceedings of the IEEE Asilomar Conference on Signals, Systems, and Computers*, 2016.

C. Shepard, N. Anand, and L. Zhong, "Practical performance of MU-MIMO precoding in many-antenna base stations," in *Proceeding of the 2013 workshop on Cellular networks: operations, challenges, and future design*, pp. 13–18, ACM, 2013.

C. Shepard, A. Rahmati, C. Tossell, L. Zhong, and P. Kortum, "LiveLab: measuring wireless networks and smartphone users in the field," *ACM SIGMETRICS Performance Evaluation Review*, vol. 38, no. 3, pp. 15–20, 2011.

C. Shepard, A. Rahmati, and L. Zhong, "NoShake: Content stabilization for shaking screens of mobile devices," in *IEEE International Conference on Pervasive Computing and Communications (PerCom)*, 2009.

Other Publications and Patents

C. Shepard, R. Doost-Mohammady, J. Ding, R. E. Guerra, and L. Zhong, "ArgosNet: A multi-cell many-antenna MU-MIMO platform," in *Signals, Systems and Computers, 2017 51st Asilomar Conference on*, IEEE, 2017.

E. Everett, C. Shepard, L. Zhong, and A. Sabharwal, "SoftNull: Many-antenna full-duplex wireless via digital beamforming," *IEEE Transactions on Wireless Communications*, vol. 15, no. 12, pp. 8077–8092, 2016.

R. E. Guerra, N. Anand, C. Shepard, and E. W. Knightly, "Opportunistic Channel Estimation for Implicit 802.11af MU-MIMO," *In Proc. of ITC28*, September 2016.

C. Shepard, H. Yu, and L. Zhong, "ArgosV2: A flexible many-antenna research platform," in *Proceedings of the 19th annual international conference on Mobile computing & networking*, pp. 163–166, ACM, 2013.

E. Everett, C. Shepard, L. Zhong, and A. Sabharwal, "Measurement-driven evaluation of all-digital many-antenna full-duplex communication," *preprint arXiv:1508.03765*, 2015.

C. Shepard, "Argos: Practical base stations for large-scale beamforming," Master's thesis, Rice University, 2012.

P. Murphy, C. Shepard, L. Zhong, C. Dick, and A. Sabharwal, "FPGAs help characterize massive-MIMO channels," *Xcell Journal*, October 2014.

A. Rahmati, C. Shepard, C. Tossell, L. Zhong, P. Kortum, A. Nicoara, and J. Singh, "Seamless tcp migration on smartphones without network support," *IEEE Transactions on Mobile Computing*, 2014.

C. Tossell, P. Kortum, C. Shepard, L. H. Barg-Walkow, A. Rahmati, and L. Zhong, "A longitudinal study of emoticon use in text messaging from smartphones," *Computers in Human Behavior*, vol. 28, no. 2, pp. 659–663, 2012.

C. Tossell, P. Kortum, A. Rahmati, C. Shepard, and L. Zhong, "Characterizing web use on smartphones," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 2769–2778, ACM, 2012.

A. Rahmati, C. Tossell, C. Shepard, P. Kortum, and L. Zhong, "Exploring iPhone usage: the influence of socioeconomic differences on smartphone adoption, usage and usability," in *Proceedings of the 14th international conference on Human-computer interaction with mobile devices and services*, pp. 11–20, ACM, 2012.

N. Ding, A. Pathak, D. Koutsonikolas, C. Shepard, Y. C. Hu, and L. Zhong, "Realizing the full potential of psm using proxying," in *Proceedings IEEE INFOCOM*, 2012.

A. Rahmati, C. Shepard, A. Nicoara, L. Zhong, and J. P. Singh, "Mobile tcp usage characteristics and the feasibility of network migration without infrastructure support," *ACM SIGMOBILE Mobile Computing and Communications Review*, 2011.

C. Tossell, P. Kortum, C. Shepard, A. Rahmati, and L. Zhong, "Getting real: a naturalistic methodology for using smartphones to collect mediated communications," *Advances in Human-Computer Interaction*, vol. 2012, p. 10, 2012.

C. Tossell, P. Kortum, C. Shepard, A. Rahmati, and L. Zhong, "An empirical analysis of smartphone personalisation: measurement and user variability," *Behaviour & Information Technology*, vol. 31, no. 10, pp. 995–1010, 2012.

C. Tossell, P. T. Kortum, C. Shepard, A. Rahmati, and L. Zhong, "Assessing the performance of common tasks on handheld mobile computers," in *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, vol. 54, pp. 542–546, SAGE Publications, 2010.

A. Rahmati, C. Shepard, C. Tossell, M. Dong, Z. Wang, L. Zhong, and P. Kortum, "Tales of 34 iPhone users: How they change and why they are different," *arXiv preprint arXiv:1106.5100*, 2011.

C. Tossell, J. R. Jardina, P. T. Kortum, S. C. Peres, C. Shepard, A. Rahmati, and L. Zhong, "Effects of socioeconomic diversity on iPod touch device use in real-world environments," in *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, vol. 55, pp. 1293–1297, SAGE Publications, 2011.

A. Rahmati, C. Shepard, C. Tossell, L. Zhong, and P. Kortum, "Practical context awareness: measuring and utilizing the context dependency of mobile usage," *IEEE Transactions on Mobile Computing*, vol. 14, no. 9, pp. 1932–1946, 2015.

C. Tossell, P. Kortum, C. Shepard, A. Rahmati, and L. Zhong, "You can lead a horse to water but you cannot make him learn: Smartphone use in higher education," *British Journal of Educational Technology*, vol. 46, no. 4, pp. 713–724, 2015.

C. Tossell, P. T. Kortum, C. Shepard, A. Rahmati, and L. Zhong, "Exploring smartphone addiction: Insights from long-term telemetric behavioral measures.," *iJIM*, vol. 9, no. 2, pp. 37–43, 2015.

A. Nicoara, A. Rahmati, C. Shepard, L. Zhong, and J. P. Singh, "Heterogeneous network access on devices with one or more network interfaces," Nov. 4 2014. US Patent 8,880,707.