

Dr. Cesar A. Santivanez

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EDUCATION

NORTHEASTERN UNIVERSITY, Boston, Massachusetts-Nov. 2001

Ph.D. in Electrical Engineering. GPA 4.0/4.0.

Research topic: Routing in mobile ad hoc networks.

NORTHEASTERN UNIVERSITY, Boston, Massachusetts-Sept. 1998.

Master of Science in Electrical Engineering (Communications and Signal Processing). GPA 4.0/4.0.

PONTIFICIA UNIVERSIDAD CATOLICA DEL PERU, Lima, Peru - Jun 1993

Bachelor of Science in Electrical Engineering. First-in-class honors.

RESEARCH INTEREST

Scalable and efficient resource allocation architectures and algorithms for dynamic reconfigurable networks. Current emphasis in SDN, Cloud Networking, and cyber-security.

HONORS & AWARDS

BEST STUDENT PAPER AWARD at the Fifth International Workshop on Mobile Multimedia Communication MoMuC'98, Oct. 12-14, 1998, Berlin, Germany.

FULBRIGHT SCHOLARSHIP to pursue graduate studies in U.S.A.

BEST STUDENT of the Electrical Engineering promotion of 1993.

Peruvian GPA 16.4. (GPA above 15 are considered exceptional).

Equivalent to "*Summa Cum Laude*".

SILVER MEDAL in the IV IBEROAMERICAN MATHEMATICS OLYMPICS.

At HAVANA-CUBA. As a member of the Peruvian delegation. April 1989.

FIRST PLACE among the 10000 applicants at the Pontificia Universidad Catolica del Peru's admission exam.

MEMBER of the Phi Kapa Phi Interdisciplinary and Phi Beta Delta International Scholars honors society.

WORK EXPERIENCE

PROFESSOR, Pontificia Universidad Católica del Perú, March 2013 - Present

Lead the "Advance Networking Research Lab" (Grupo GIRA) at the PUCP.

- The GIRA group conducts applied research in data networking, with an emphasis on Software Defined Networks, cybersecurity, cloud networking, and wireless networks.
- GIRA currently has 19 members, including 3 PhD candidates and has so far produced 9 undergraduate thesis (7 graded as "Outstanding", and 2 graded as "Very Good") and 5 conference papers (ANDESCON'16, ANDESCON2018, LATINCOM2018, and EDUNINE 2022).
- GIRA is the host of the TIP Community Lab for the Andean Region at PUCP
- Some projects:

- Design and prototype implementation of a SDN/OpenFlow Switch-based shared protection system for a bank on N:1 firewalls.
- Design and prototype implementation of a SDN controller (PUCPLight) for an layer 2 academic campus network that scales to tens of thousand of nodes and supports Tbps of traffic (i.e., HPC).
- Design and implementation of a high fidelity network emulator (powered by OpenStack).
- Implementation of a ExoGENI rack (ORCA orchestrating several substrates such as storage, networking across sites, and compute/ OpenStack) integrated to the group's SDN testbed (of actual physical devices).

NETWORK SCIENTIST, BBN Technologies, April 2001 – Feb. 2013.

Some relevant projects:

- *2012 – 2013: Principal investigator*, DoE Terabits, a DoE's Office of Advanced Scientific Computing Research (ASCR)-sponsored project developing a framework for supporting survivability, network planning and cross-layer optimization in future multi-domain Terabit DoE networks.
 - Lead a team formed by BBN Technologies and the RENaissance Computing Institute (RENCI) of the University of North Carolina at Chapel Hill.
- *2010 – 2013: Principal Investigator*, PHAROS-E, an international collaboration effort with a commercial equipage vendor designing architecture and algorithms for energy-efficient multi-terabit networking.
- *2008-2009: Key Researcher*, Petabit Highly Agile Robust Optical System (PHAROS) – a multi-million dollars DARPA project aimed at providing global high-capacity fiber-optic core services with unprecedented speed, agility, and survivability.
 - Lead multi-disciplinary consortium members in the design of a centralized but scalable architecture for unified control of multi-vendor multi-domain devices.
 - Personally responsible for the design of the agile, technology-agnostic, and highly efficient **cross-layer resource allocator** (CRA) module that reconfigures the network resources (IP routers, OTN switches, ROADMs, etc.) to efficiently satisfy diverse demands with different QoS, call setup, and protection requirements as well as diverse timescales and blocking probability targets. The CRA is responsible – among other things -- for working path selection, share protection computation, resource assignment and equipment configuration.
- *2007-2009: Key Researcher*, International Technology Alliance (ITA), an US ARL and UK MoD led consortium of government, academy, and industry to perform joint research in network centric systems. Performing fundamental research on network science.
- *2008: Key Researcher*, Policy-based Information centric Reliable Ad hoc Network (PIRANA), -- a multi-million DARPA STO research project part of the Wireless Network After Next (WNAN) Program. Designing routing algorithms to scale up to one million nodes.
- *2005-2006: Principal Investigator* for the BBN tasks in the Army Research Office (ARO) “Stochastic Optimal Control Algorithms and Next Generation Technologies for Dynamic Resource Allocation in Mobile Communications

Networks” project, for which BBN was a subcontractor to Scientific Systems Company, Inc (SSCI).

- *2003-2004:Key Researcher*, Medium Access Control for XG Communications (XMAC & XAP) – a \$2.2M DARPA ATO research project. Developing an architecture and protocol set for XG communication.
- *2002-2003: Designer/Architect*, Joint Tactical Radio System, Ground Mobile radios (JTRS GMR, formerly Cluster 1) – a multi-billion dollar joint-forces effort planned to be the next-generation voice-and-data radio used by the U.S. military. JTRS is a software-defined radio that will work with many existing military and civilian radios. It includes integrated encryption and Wideband Networking Software to create mobile ad hoc networks (MANETs). I co-designed MALSR, WNW’s subnet routing protocol, proved to scale to JTRS cluster 1 stringent constraints (e.g. scalability to 1600+ nodes). I was also a co-author of the scalable multicast mesh algorithm used for sparse mode multicast traffic.
- *2001-2002:Designer/Implementer*, Utilizing Directional Antennas for Ad Hoc Networks (UDAAN) – a \$1.5M DARPA ATO research project. Developed and implemented novel technologies to support and exploit beamforming antennas in ad hoc networks, including the first MAC protocol for beamforming antennas.

CONSULTANT, BBN Technologies, 1999- 2000

- *Researcher/Designer/Implementer*, Density- and Asymmetry-adaptive Wireless Network (DAWN) -- a \$1.4M DARPA ATO research project. Invented, analyzed, and implemented HSLS, the first ad hoc routing protocol that scale with network size. HSLS is an easy-to-implement link state variant that does not require complex hierarchies.

RESEARCH ASSISTANT, ECE dept. at Northeastern University, 1998 - 1999,

- Invented the first self-organizing routing protocols that learns and adapts to large network’s mobility and traffic patterns.

PROJECT ENGINEER at Tele2000 (now Bell South Peru). 1994 - 1996.

Assistant to the Vice President of the TELEVAN (Value Added Services) business unit. Main responsibilities:

- CDPD wireless data network-based projects: design, integration, and execution supervision. Support pre- and post-sell.
- Design and implementation of Computer Telephony projects. Debit card system and International call management for cellular phones.
- Advise the departments of INFORMATION SYSTEMS, DEVELOPMENT and TELEVAN on topics related to Digital Networks and Internetworking.

ASSISTANT SALES MANAGER, COASIN PERU. 1994

Developed customer-specific telecommunication projects in order to sell telecommunication equipment.

SELECTED PUBLICATIONS

Book chapter:

- K. Rauschenbach and C. Santivanez, “Convergence of IP and Optical Networking,” in *Optical Fiber Telecommunications Volume VIB, Systems and Networks*, ed. I. P. Kaminow, T. Li, and A. E. Willner. Academic Press/Elsevier Publishers. May 2013.
- I. Baldine, A. W. Jackson, J. Jacob, W. E. Leland, J. H. Lowry, W. C. Milliken, P. P. Pal, R. Ramanathan, K. Rauschenbach, C. A. Santivanez, and D. M. Wood, “PHAROS: An architecture for next-generation core optical networks,” in *Next-Generation Internet: Architectures and Protocols*, ed. B. Ramamurthy, G. Rouskas, and K. M. Sivalingam. Cambridge University Press, New York, 2011.
- C. Santivanez, and S. Ramanathan, “Scalability of Routing in Ad Hoc Networks: Principles and Practice”, in *Ad Hoc Wireless Networking*, X. Cheng, X. Huang, and D.-Z. Du (eds.), Kluwer Academic Publishers, Boston, Dec. 2003.

Journals:

- G. Troxel et. Al., “Enabling open-source cognitively-controlled collaboration among software-defined radio nodes,” *Computer Networks*, Vol. 52 (2008), No. 4, pp. 898–911, March 2008.
- R. Ramanathan, J. Redi, C. Santivanez, D. Wiggins, S. Polit, “Ad Hoc Networking with Directional Antennas: A Complete System Solution”, *IEEE Journal of Selected Areas in Communications*, Vol. 23, No. 3, pp. 496-506, March 2005.
- C. Santivanez and I. Stavrakakis. "Study of various TDMA Schemes for Wireless Networks in the Presence of Deadlines and Overhead". *IEEE Journal of Selected Areas in Communications*, Vol. 17, No. 7, July 1999.

Conferences:

- A. Huamantuma & C. Santivanez, “A NS-3-based Cloud Wireless Network’s Emulator for Undergraduate Teaching,” *In Proceedings of 2022 IEEE World Engineering Education Conference (EDUNINE 2022)*, Santos, Brazil, March 2022.
- C. Santivanez, “Exploiting Multi-User Detection (MUD) Radio Capabilities to Improve Stability of CSMA/CA for MANETs,” *In Proceedings of 10th IEEE Latin-American Conference on Communications (LATINCOM 2018)*, Guadalajara, Mexico, Nov. 2018.
- C. Quispe & C. Santivanez, “Cost-effective N:1 Firewall Array via subnet-level load balancing by SDN/OpenFlow switches,” *In Proceedings of 2018 IEEE Andean Council International Conference (ANDESCON’18)*, Cali, Colombia, Aug. 2018.
- R. Cordova, A. Marcovich, and C. Santivanez, “An efficient method for ontology-based multi-vendor firewall misconfiguration detection: A real-case study,” *In Proceedings of 2018 IEEE Andean Council International Conference (ANDESCON’18)*, Cali, Colombia, Aug. 2018.

- G. Cuba, J.M Becerra, G. Bartra, and C. Santivanez, "PUCPLight: a SDN/OpenFlow Controller for an Academic Campus Network," *In Proceedings of 2016 IEEE Andean Council International Conference (ANDESCON'16)*, Arequipa, Peru, Oct. 2016.
- I. Nishioka, C. Santivanez, and S. Ishida, "SDN/OpenFlow enhanced WANs: Benefits and Challenges." Presented in the *8th International Conference on IP + Optical Network (iPOP2012)*, Yokohama, Japan, May 31st - June 1st 2012.
- C. Santivanez et. al., "Quantum Enhanced LIDAR Resolution with Multi-Spatial-Mode Phase Sensitive Amplification (Invited Paper)," *In Proceedings of SPIE Optics+Photonics 2011 Volume 8163: Quantum Communications and Quantum Imaging*, San Diego, CA, Aug. 2011.
- P. A. Wasilousky et. Al., "Quantum Enhancement of a Coherent LADAR Receiver using Phase-Sensitive Amplification (Invited Paper)," *In Proceedings of SPIE Optics+Photonics 2011 Volume 8163: Quantum Communications and Quantum Imaging*, San Diego, CA, Aug. 2011.
- R. Ramanathan, R. Allan, P. Basu, J. Feinberg, G. Jakllari, V. Kawadia , S. Loos, J. Redi, C. Santivanez, J. Freebersyser, "Scalability of Mobile Ad Hoc Networks: Theory vs Practice," *In Proceedings of MILCOM'2010*, San Jose, CA, Nov. 2010.
- J. Chen, C. Santivanez, and K. Rauschenbach, "Dynamic O-O-O Switching in Large Scale Core Optical Networks," *In Proceedings of Photonics in Switching (PS) Conference*, Monterey, CA, July 2010.
- J. Chen, J. Jacob, C Santivanez, J. Ho, K. Rauschenbach, and D. Wood, "En Route to Grouping-Constraint Free, Colorless Directionless ROADMs," *In Proceedings of OFC/NFOEC'10*, San Diego, March 2010.
- K. Rauschenbach, R. Hain, A. Jackson, J. Jacob, W. Leland, J. Lowry, W. Miliken, P. Pal, R. Ramanathan, C. Santivanez, I. Baldine, S. Huang, and D. Wood, "Improved Capacity Utilization via Agile Wavelength Provisioning and Protection Sharing in Global Core Optical Networks," *In Proceedings of International Conference on Photonics in Switching*, THII 2-5, 2009.
- K. Rauschenbach, R. Hain, A. Jackson, J. Jacob, W. Leland, J. Lowry, W. Miliken, P. Pal, R. Ramanathan, C. Santivanez, I. Baldine, S. Huang, and D. Wood, "Dynamic Provisioning System for Bandwith-Scalable Core Optical Networks," *In Proceedings of the Military Communications Conference (MILCOM)*, Boston, MA, October 2009.
- C. Santivanez, "Transport Capacity of Opportunistic Spectrum Access (OSA) MANETs (Invited Paper)," *In Proceedings of 2nd International Conference on Cognitive Radio Oriented Wireless Networks and Communications (CROWNCOM 2007)*, Orlando, FL, Aug. 2007.
- Alden Jackson, Walter Milliken, Cesar Santivanez, Matthew Condell, and W. Timothy Strayer, "A Topological Analysis of Monitor Placement," *In Proceedings of the 6th IEEE International Symposium on Network Computing and Applications (IEEE NCA07)*, Cambridge, MA, July 2007.
- G. Troxel et. al., "Adaptive dynamic radio open-source intelligent team (ADROIT): cognitively-controlled collaboration among SDR nodes (invited

paper),” *In Proceedings of the First IEEE Workshop on Networking Technologies for Software Defined Radio (SDR) Networks*, Reston, VA, 2006.

- C. Santivanez, R. Ramanathan, C. Partridge, R. Krishnan, M. Condell, and S. Polit, “Opportunistic Spectrum Access: Challenges, Architecture, Protocols,” *In Proceedings of the 2nd Annual International Wireless Internet Conference (WICON)*, Boston, MA, August 2006.
- R. K. Prasanth, J. B. D. Cabrera, C. Santivanez, and R. Ramanathan, “A Cross-Layer Design Approach to Opportunistic Resource Allocation in Mobile Wireless Networks,” *In Proceedings of 11th U.S. Army Conference On Applied Statistics (ACAS’05)*, Naval Postgraduate School, Monterey, CA, October 2005.
- C. Santivanez and I. Stavrakakis, “Towards Adaptable Ad Hoc Networks: the Routing Experience”, *In Proceedings of 1st International Workshop on Autonomic Communication (WAC 2004)*, Berlin, Germany, October 2004.
- R. Ramanathan, J. Redi, C. Santivanez, D. Wiggins, S. Polit, “Ad Hoc Networking with Directional Antennas: A Complete System Solution”, *In Proceedings of IEEE WCNC 2004*, Atlanta, GA, March 2004.
- C. Santivanez & J. Redi. “On the Use of Directional Antennas for Sensor Networks”, *In Proc. of MILCOM’03*, Boston, MA, October 2003.
- C. Santivanez, and B. McDonald, “Progressive Scaling: A Methodology for Efficient Validation and Parameter Tuning of Large Ad Hoc Network Simulations”, *In Proceedings of CNDS’03*, Orlando, FL, January 2003.
- C. Santivanez, B. McDonald, I. Stavrakakis, and S. Ramanathan, “On the Scalability of Ad Hoc Routing Protocols,” *In Proceedings of IEEE INFOCOM 2002*, New York, NY, 2002.
- C. Santivanez, S. Ramanathan, and I. Stavrakakis, “Making Link-State Routing Scale for Ad Hoc Networks,” *In Proceedings of ACM MOBIHOC 2001*, Long Beach, CA, 2001.
- C. Santivanez, and I. Stavrakakis, “A Framework for a Multi-mode Routing Protocol for (MANET) Networks,” *In Proceedings of IEEE Wireless Communications and Networking Conference WCNC’99*, New Orleans, LO, September 1999.
- C. Santivanez, and I. Stavrakakis, “Achievable Dropping Rates under Variable Frame TDMA schemes in the Presence of Deadlines and Overhead,” *In Proceedings of Fifth International workshop in Mobile Multimedia Communications MoMuC’98*, Berlin, Germany, October 1998.

INVENTIONS

- Hazy Sighted Link State (HSLS) routing protocol, the first scalable ad hoc routing protocol with respect to network size.
- U. S. Patent number 7321580, "Directional carrier sense medium access for wireless nodes".
- U.S. Patent No. 7532623, “Methods for wireless mesh multicasting”.
- U.S. Patent No. 8406175, “Carrier Sense Multiple Access (CSMA) protocol with Multi-Packet Reception (MPR) in a wireless ad hoc network”.

OTHERS

- My work on routing scalability is currently used as a basis for the Internet Research Task Force on ad hoc network scalability.
- HSLs has been widely utilized by both the military and the commercial sector. For the military, HSLs has become a building block in many large-scale radio projects (JTRS WNW, as well as WNaN's PIRANA). It is likely that 10 years from today, there is a version of HSLs running in every military radio. For the commercial sector, there are currently 3rd party open software implementations of HSLs that are being used to built community wireless mesh networks in as diverse places as the USA, Ghana, and Peru.
- Reviewer for the European Commission, evaluating proposals submitted in response to the Information Society Technologies (IST)'s Future and Emerging Technologies (FET) call for proposals on Situated and Autonomic Communications.
- Reviewer for the most important conferences and journals in the field such as the Journal of Selected Areas in Communications, Transactions on Networking, Wireless Network Journal, etc.
- Evaluator for the June-2012 IEEE's Senior Member Review Panel.
- Senior member of the Institute of Electrical and Electronics Engineers (IEEE).