

ZORAN KOSTIC, Ph.D. - Curriculum Vitae

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CURRENT POSITION

Associate Professor of Professional Practice, Director of the MS EE Program.

Electrical Engineering Department, Columbia University in the City of New York.

SUMMARY OF EXPERTISE

Research, teaching, development and management expertise. Current research in Internet of Things and Neural Networks and Deep Learning. Experience in signal processing, communications, reconfigurable systems, low power SoCs, model-based and embedded design and parallel computing with applications in wireless communications, multimedia, and mobile networking. Theoretical and applied work, notable journal publications and patent record. Leadership role in industrial development of software and application-specific VLSI. Comprehensive understanding of complex system architectures. IEEE Transactions editor, experience with NSF projects, intellectual property consulting and fund raising.

EDUCATION

Ph.D. in Electrical Engineering, Signal Processing and Communications - July '91
University of Rochester, Rochester, New York.

M.S. in Electrical Engineering, Communications and Signal Processing - October 1988, University of Rochester, Rochester, NY.

Dipl. Ing. - Telecommunications and Electronics - May 1987; Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Yugoslavia.

ACADEMIC EXPERIENCE

Columbia University, Electrical Engineering Dept., Associate Prof. of Prof. Practice, New York City, Spring 2014-.

Internet of Things, Heterogeneous Computing, Neural Networks and Deep Learning.

Director of the MS EE program.

Columbia University, Electrical Engineering Department – Adjunct Professor, New York City, 2012-2013. Digital Communications, Wireless Communications.

Columbia University, Electrical Engineering Department - Adjunct Assistant Professor, New York City, Spring 1994. Taught graduate level course on Communications Theory.

University of California at Los Angeles - Instructor for 12 short courses, "Wireless CDMA and IS-95 Digital Cellular Communications" and "Digital Signal Processing in Wireless Communications".

University of California at San Diego - Instructor for 2 short courses, "Digital Cellular Communications"

CEI Europe - Instructor for a short course, "Implementation Aspects of Third Generation Digital Cellular Systems".

INDUSTRIAL RESEARCH AND DEVELOPMENT EXPERIENCE

Broadcom Corporation - Mobile Systems Architecture, Senior Principal Scientist, New Jersey, San Diego, Irvine. 2006-2014.

Lead system architect - development of mobile system-on-chip (SoC) devices: low-power multi-functional communications/multimedia chips with tightly integrated cellular, WLAN, GPS, near-field communication and multimedia co-processors. Technical areas covered: architectural design; algorithms, software/firmware on general purpose ARM processors, design of VLSI-based SIMD graphics accelerator. Partitioning and low-power implementation across software, ASICs and hardware. Research on parallel programmable architectures for high bandwidth wireless and multimedia systems. Customization of multi-core, multi-cluster ARM processor architectures. Program Management role: Managing technical aspects of the cross-functional teams, with focus on multimedia performance, memory bandwidth and power consumption.

The MathWorks - Communications Division - Principal Engineer, Natick, MA, 2004-2006.

Research on architectures and methodologies for model-based communications system development and signal processing applications design. Development of methods, software and tools for automated conversion of algorithms into efficient DSP/VLSI implementations. Development of model-based software defined radio in support of research programs in industry and academia. Reusable code generation for wireless systems. Low density parity check coding for DVB-S.2. Fixed-point analysis. Synchronization and packet communications for advanced wireless systems. Consulting for wireless communications industry - Samsung, Qualcomm, Nokia, BAE, Harris.

Thomson Corporate Research - Principal Member of Research Staff, Princeton, NJ, 2002 - 2004.

Multicast-Broadcast Multimedia Services in mobile communication systems. Architecture of cellular infrastructure optimized for delivery of high data rate video by means of streaming and opportunistic download: caching, video coding resiliency tools, utilization of feedback. Location based service enhancements for mobile communications All-IP network design for cellular and mobile communications. Packet channel use for statistical multiplexing of video content. UMTS terminal evolution for support of H264/JVT high bit rate video codecs. WCDMA terminal transceiver ASIC development in System-C environment: C to RTL.

AT&T Laboratories Research -Wireless Research - Principal Member of Research Staff,

Red Bank and Middletown, NJ, USA, 1997-2002.

Radio Resource Management and QoS for Wireless LANs. Simulcasting and multicasting in OFDM wireless systems. Capacity and performance of mixed voice/data cellular systems based on code-division multiple-access (UMTS-WCDMA with DSH). TCP-aware radio link protocols for wireless communications. Interactions between TCP/IP protocols and lower layers in future cellular systems. OFDM-integrated frequency hopping. Micro/macro cellular systems in single carrier deployments. Dynamic frequency hopping for spectral efficiency improvements in 3G cellular systems. Maximal ratio combining for finger-limited RAKE combining (selective RAKE receivers).

Bell Laboratories, Wireless Systems Research Department - Senior Member of Research Staff,

Holmdel, NJ, USA, 1995-1997.

Diversity, modulation and synchronization for packet data evolution of TDMA systems.

Real-time custom HW/SW base-station and mobile transceiver design and implementation for data evolution for the TDMA American digital cellular system -based on digital receiver architecture, quad-boards TI DSP boards, custom RF.

Experimental studies of enhanced IS-136 performance - diversity demonstration with minimally spaced antennas.

AT&T Bell Laboratories, Advanced Wireless Terminals Division - Member of Technical Staff and Project Leader, Holmdel, NJ '91-95.

Advanced Digital Cellular Terminal Development: Analysis, algorithm, system and DSP/ASIC Design Leader.

IS-95 CDMA mobile transceiver and low-power chipset design: Algorithms and fixed point DSP code for synchronization and RAKE receiver control. Algorithms and VLSI design for RAKE receiver. Synchronization, timing, demodulation algorithms. Design of the DSP kernel, interfaces to ASIC and uC, task scheduling. System specification, timing analysis, functional partitioning into uC, DSP and ASIC. Experimental work on DSP/FPGA and DSP/ASIC platforms.

IS-136 TDMA Algorithm design: Low complexity POCS-based equalizer for IS-136: analysis, simulation and fixed point implementation. SW transceiver architecture.

High resolution channel estimation using the method of projection onto convex sets.

Interference minimization in packet-based CDMA systems.

University of Rochester, Electrical Engineering Department - Research and Teaching Assistant in Communications and Signal Processing, Rochester, NY, 1987-1991.

- Coding techniques for CDMA in frequency-hopping, time-hopping and optical communication channels. New codes that enable the computation of exact probability distribution functions representing interference
- Developed a technique for high resolution estimation of specular multipath channels based on the set-theoretic deconvolution, with applications to wideband systems with RAKE receivers.
- Research on the time-frequency signal representation and channel measurement for radar and sonar channels

MENTORING

Mentoring of research activities of graduate students at Columbia University:

COSMOS advanced wireless research platform.

Smart city intersections - cloud connected vehicle monitoring and control

Deep learning applications for peripheral edema measurement and monitoring.

Internet of Things – Smart city applications, Indoor Localization.

Modeling of latency distributions in LTE networks.

Internet of Things Data Analytics.

Co-supervised research of 5 Ph.D. level internship students, as a mentor from industry:

Rutgers University - Multipath Estimation based on POCS.

Columbia University - Synchronization in TDMA systems.

Rutgers University - Dynamic Frequency Hopping.

Princeton University - Theory of Dynamic Frequency Hopping in OFDM.

Princeton University - Applications of Information Theory in wireless systems.

TECHNICAL SKILLS

Software and Hardware Experience

Programming Languages and Frameworks: Tensorflow, PyTorch, JAVA, C, C++, System-C, Fortran, DSP16xx & TI DSP Assemblers, Pascal, Z-80 Assembly, DBaseII+.

Operating System: Linux, Unix, Windows, DOS, VMS, CMS.

Computers: SUN, PC, VAX, IBM, Honeywell, Alliant.

Software Packages: Matlab/Simulink, SPW, IMSL, DISSPLA, IEEE DSP, Mathematica, Synopsis.

Real Time Development Platforms: TI and Lucent floating and fixed point DSPs, Xilinx-Aptex FPGA boards, Pentek, custom designed ASIC/DSP boards, logic analyzers.

Automation tools for model-based communications system design: derivatives of Simulink, component based design.

STANDARDS

Contributed to IETF header compression and IEEE 802.11h standards. Involved in 3GPP standardization process and 802.11 standards. Khronos OpenXX standardization, MIPI interface standards.

MEMBERSHIPS, AWARDS AND ACTIVITIES

US National Science Foundation - participant in grant proposal evaluation for information technologies area - wireless. Large grant evaluation.

IEEE Transactions on Communications - Editor Emeritus for Wireless Systems.

IEEE Communications Letters, Editor Emeritus.

IEEE JSAC, IEEE Wireless transactions, Signal Processing, Vehicular Technologies, other archival journals - reviewer.

IEEE Senior Member.

Organizer and chairman for more than two dozen conference sessions: ICC, Globecom, PIMRC, other.

Workshop Chair, "Internet of Things - Physical Data Analytics," IEEE Secon 2016.

Broadband wireless - Symposium Chair for ICC2003.

Panelist on dozen sessions on wireless and software defined radio.

Merit fellowship recipient, University of Novi Sad (1983-1986); Honorary Awards for Academic Excellence, University of Novi Sad, ('84,'85,'86).

Amateur radio operator, KF2KB; Amateur glider pilot.

PROJECTS

2018-2023: "COSMOS: Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment", NSF/PAWR grant, \$22.5 Million, Co-PI.

2019" Verizon 5G EdTech - 5G COVET (5G COSMOS Verizon Education Toolkit) Challenge, \$100,000.

2018-2019: "Deep Learning for Phenotyping of Peripheral Edema," HFSA Nursing Mini Grant, \$5,000, PI.

2017-2018: "Elucidating complexity and characterizing phenotypes of peripheral edema", Phase I Grant: Collaborative and Multidisciplinary Pilot Research (CaMPR) Award, Columbia Irving Institute for Clinical and Translational Research, \$15,000, Co-PI.

2003-2004: Participated in writing proposal and raising money for research programs for collaboration between Thomson Corporate Research and sponsored universities.

2001-2002: One of two principal authors of the proposal which obtained US\$3.5 million funding for research and implementation of reconfigurable wireless processors. On technical advisory board of the startup which developed multi-antenna, diversity-enabled WCDMA-3G mobile terminal ASIC.

PATENTS

Two dozen patents granted or in process.

Selected patents:

- Combined simulcasting and dedicated services in a wireless communication system.
- Method and apparatus for implementing measurement based dynamic frequency hopping in wireless communication systems.
- TDMA communication system having enhanced power control.
- Dynamic frequency hopping.
- Technique for minimizing the variance of interference in packetized interference-limited wireless

communication systems.

- CDMA rake receiver with sub-chip resolution.
- Equalization technique for compensating for degradation to the transmission of digitally modulated signals.
- Combined simulcasting and dedicated services in a wireless communication system.
- TDMA communication system having enhanced power control.
- Adaptive MAC fragmentation and rate selection for 802.11 wireless networks.
- WLAN having load balancing based on access point loading.
- WLAN having load balancing by access point admission/termination.
- Packet shaping for mixed rate 802.11 wireless networks.
- Method and apparatus for implementing measurement based dynamic frequency hopping in wireless communication systems.
- Combined simulcasting and dedicated services in a wireless communication system.

JOURNAL PUBLICATIONS

Kin K. Leung, Martin V. Clark, Bruce McNair, Zoran Kostic, Leonard J. Cimini, Jr., and Jack H. Winters, "Outdoor IEEE 802.11 Cellular Networks: Radio and MAC Design, and Their Performance", *IEEE Trans. on Vehicular Technology*, vol. 56, No. 5, pp. 2673 - 2684, Sep. 2007.

Neelesh Mehta, Zoran Kostic et al., "Orthogonality Factor in WCDMA Downlink," *IEEE Transactions on Wireless Communications*, Vol. 2, No. 6, pp. 1138 - 1149, Nov. 2003.

Zoran Kostic and Nelson Sollenberger, "Dynamic Frequency Hopping in limited bandwidth cellular systems," *IEEE Transactions on Wireless Communications*, vol. 20, No. 1, January 2002.

Zoran Kostic, Xiaodong Wang and Ivana Maric, "Theory of Dynamic Frequency Hopping," *IEEE Journal on Special Areas in Communications - Wireless Systems*, Vol. 19, No. 11, pp. 2254-2266, November 2001.

Moe Win and Zoran Kostic, "Impact of Spreading Bandwidth on Rake Reception in Dense Multipath Environments," *IEEE Journal on Special Areas in Communications*, Vol. 17, No. 10, pp. 1794-1806, Oct. 1999.

Moe Win and Zoran Kostic, "Virtual Path Technique for Rake Receiver Analysis," *IEEE Communications Letters*, Vol. 3, No. 11, pp. 308-310, Nov. 1999.

Z. Kostic, "TCP/IP in Cellular Systems - Network Performance," submitted to *IEEE Transactions*.

Kostic and G. Pavlovic, "Resolving Sub-chip Spaced Multipath Components in CDMA Communication Systems," *IEEE Transactions of Vehicular Technologies*, Vol. 48, No. 6, pp. 1803-1808, Nov. 1999.

Z. Kostic, "Low Complexity Equalization for $\pi/4$ DQPSK Signals Based on the Method of Projection onto Convex Sets," appeared in *IEEE Transactions of Vehicular Technologies*, Vol. 48, No. 6, pp. 1916-1922, Nov. 1999.

Z. Kostic, E. L. Titlebaum and Gordana Pavlovic, "Cyclical Coincidence Arrays: Deriving Exact Expressions for Interference Between Users in CDMA Systems," *European Transactions on Telecommunications*, 1997.

Z. Kostic and S. Seetharaman, "Digital Signal Processors in Wireless Communications," *IEEE*

Communications Magazine, Dec. 1997.

Z. Kotic and E. L. Titlebaum, "The Design and Performance Analysis for Several New Classes of Codes for Optical Synchronous CDMA and for Arbitrary-Medium Time-Hopping Synchronous CDMA Communication Systems," *IEEE Transactions on Communications*, Vol. 42, pp. 2608-2618, August 1994.

S. V. Maric, Z. Kotic and E. L. Titlebaum, "A New Family of Code Sequences for Use in Spread Spectrum Fiber-Optic Local Area Networks," *IEEE Transactions on Communications*, Vol. 41, pp. 1217-1222, August 1993.

Z. Kotic, M. I. Sezan and E. L. Titlebaum, "Estimation of the Parameters of a Multipath Channel Using Set-Theoretic Deconvolution," *IEEE Transactions on Communications*, vol. 40, pp. 1006-1011, June 1992.

CONFERENCE PUBLICATIONS

T. Mao, W. Zhang, H. He, Y. Lin, V. Kale, A. Stein, Z. Kotic, "AIC2018 Report: Traffic Surveillance Research," accepted for *IEEE / CVF CVPR2018, NVIDIA AI CITY CHALLENGE Workshop*, Salt Lake City, June 18, 2018.

J. Chen, T. Mao, Y. Qiu, D. Zhou, R. Masterson Creber, Z. Kotic, "Camera-Based Peripheral Edema Measurement Using Machine Learning," *Sixth IEEE International Conference on Healthcare Informatics (ICHI 2018)*, June 4- June 7, NYC, 2018.

Zoran Kotic, "Smart City: Deep Learning Models for Car-Pedestrian Interaction," NVIDIA GPU Technology Conference, San Jose, March 25-29, 2018.

K. K. Leung, M.V. Clark, B. McNair, Z. Kotic, L. J. Cimini, Jr., and J. H. Winters, "Outdoor IEEE 802.11 Cellular Networks: Radio and MAC Design and Their Performance," *IEEE Trans. on Vehicular Tech.*, vol. 56, no. 5, part 1, pp. 2673-2684, September 2007.

Z. Kotic and A. Rodriguez, "Embeddable Transceiver Code Generation for SDR Applications by Matlab and Simulink - FM3TR Example," *Forty-Fourth SDR Meeting*, June 20-24, 2005.

Z. Kotic and A. Rodriguez, "SDR-Targeted Design Flow: From Executable Specification to Signal Processing Subsystem Code Generation and SCA-Focused Tool Integration," *Software Defined Radio Technical Conference*, November 14-18, 2005, Anaheim, California.

M. Clark, Zoran Kotic, et al., "Outdoor IEEE 802.11 Cellular Networks: Radio Link Performance," *ICC2002*.

Zoran Kotic, et al., "Performance results for the Downlink Shared Channel in WCDMA," *ICC2002*.

Zoran Kotic, "The Performance of the WWW Traffic due to Interactions Between TCP and RLP Protocols in a Cellular System," *Vehicular Technology Conference VTC'2001 Fall*, Atlantic City, New Jersey, October 2001.

Zoran Kotic, "Interaction between radio link protocols and TCP in cellular systems," *Vehicular Technology Conference VTC'2001 Spring*, Rhodes, Greece, May 2001.

Zoran Kotic et al., "Dynamic Frequency Hopping for Limited-Bandwidth Cellular Systems", *ICCCN 2000*,

Las Vegas.

Zoran Kostic et al., "Impact of TCP/IP header compression on the performance of a cellular system," *WCNC 2000*, Chicago.

Z. Kostic et al., "Dynamic Frequency Hopping in Cellular Systems with Network Assisted Resource Allocation," *VTC 2000*, Tokyo.

Z. Kostic and Nelson Sollenberger, "Channel Estimation for IS-136+ Packet Data Communications," *IEEE VTC'99*.

Z. Kostic and Ivana Maric, "Dynamic Frequency Hopping in Digital Cellular Systems - Simulation Studies," *IEEE VTC'99*.

B. McNair, Z. Kostic et al, "Coherent Modulation for IS-136+," *IEEE VTC'99*.

Z. Kostic and Bruce McNair, " Experimental Performance Results of an Indoor Wireless Extension of IS-136 Based on PI/8-8DPSK and Coded Modulation," *1998 Vehicular Technology Conference*.

Z. Kostic and X. Wang, "Dynamic Frequency Hopping in Cellular Communications," *Globecom 1998*.

Z. Kostic and Naeem Abbasi, " Effects of Transmitter, Receiver and Channel Impairments on the Performance of the Enhanced IS-136 Digital Cellular System for Transmission of High-Quality Speech," *1997 Vehicular Technology Conference*.

Z. Kostic, G. Pavlovic and E. Titlebaum, "A Technique for Minimizing the Variance of Interference in Packetized Interference-Limited Wireless Communication Systems," *IEEE Globecom 1996, Communication Theory Mini Conference*, pp. 121-126, London, England, Nov. 1996.

Z. Kostic and G. Pavlovic, "Resolving Sub-chip Spaced Multipath Components in CDMA Communication Systems," *43rd Vehicular Technology Conference*, Secaucus, New Jersey, May 1993.

Z. Kostic, "Low Complexity Equalization for $\pi/4$ DQPSK Signals Based on the Method of Projection onto Convex Sets," *1993 Conference on Information Sciences and Systems*, John Hopkins University, Baltimore, Maryland, March 1993.

G. Pavlovic and Z. Kostic, "Multiframe Identification of Image and Blur Parameters Using Maximum Likelihood Approach," *1993 Conference on Information Sciences and Systems*, John Hopkins University, Baltimore, Maryland, March 1993.

Z. Kostic and E. L. Titlebaum, "Computation of Exact Interference and Probability of Error for Several CDMA Communication Systems," *1992 IEEE International Communications Conference*, pp. 652-656, Chicago, Illinois, June 1992.

Z. Kostic, G. Pavlovic and E. L. Titlebaum, "Cyclical Coincidence Arrays: Derivation of New Properties of Signature Sequences and Interference Computation for Some CDMA Communication Systems," *26th Annual Conference on Information Sciences and Systems*, pp. 1073-1077, Princeton, NJ, March 1992.

G. Pavlovic and Z. Kostic, "Multiframe Maximum Likelihood Parameter Identification for Image Sequences," *26th Annual Conference on Information Sciences and Systems*, pp. 134-137, Princeton, NJ, March 1992.

Z. Kostic and E. L. Titlebaum, "New Families of Codes Applicable to Synchronous Fiber-Optics Code-Division Multiple-Access Systems and to Arbitrary Synchronous Time-Hopping Code-Division Multiple-Access Communication Systems," in *Proceedings of the 1991 IEEE International Symposium on Information Theory*, pp. 343, Budapest, Hungary, June 1991.

Z. Kostic, E. L. Titlebaum and S. Maric, "The Design of New Optical Codes and Time-Hopping Patterns for Synchronous Spread-Spectrum Code-Division Multiple-Access Communication Systems," in *Proceedings of the 1991 International Communications Conference*, pp. 585-589, Denver, Colorado, June 1991.

Z. Kostic, M. I. Sezan and E. L. Titlebaum, "Estimation of the Parameters of a Multipath Channel Using Set-Theoretic Deconvolution," in *Proceedings of the 1991 International Conference on Acoustics, Speech and Signal Processing*, pp. 1449-1452, Toronto, May 1991.

S. Maric, Z. Kostic and E. L. Titlebaum, "A New Family of Code Sequences for Use in Spread Spectrum Fiber-Optic Local Area Networks," *International Symposium on Information Theory Applications*, Waikiki, Hawaii, November 1990.

Z. Kostic, E. L. Titlebaum and M. I. Sezan, "The Application of Projection Onto Convex Sets (POCS) to Multipath Channel Estimation," in *Proceedings of the Twenty Eight Annual Allerton Conference on Communications, Control, and Computing*, University of Illinois at Urbana Champaign, October 1990.

Z. Kostic, S. Maric and E. L. Titlebaum, "A New Family of Algebraically Designed Optical Orthogonal Codes," in *Proceedings of the Twenty Eight Annual Allerton Conference on Communications, Control, and Computing*, University of Illinois at Urbana Champaign, October 1990.

Z. Kostic and E. L. Titlebaum, "Codes Based on Quadratic Congruences and Their Implementation in Frequency-Hop Spread-Spectrum Communications," in *Proceedings of the 1990 IEEE International Symposium on Information Theory*, pg. 3, San Diego, Jan. 1990

S. Maric, E. L. Titlebaum and Z. Kostic, "Address Assignment for Multiple-Access Systems Based Upon the Theory of Congruence Equations," in *Proceedings of the IEEE Globecom 1989 conference*, pp. 283-287, Nov. 1989.

PROFESSIONAL ACTIVITIES AFTER 2015

Zoran Kostic, "Internet of Things - Physical Data Analytics," Workshop Chair, IEEE International Conference on Sensing, Communication and Networking, 27-30 JUNE 2016, LONDON, UK.

Zoran Kostic, "The Next Big Revolution: Internet of Things," Invited talk and panel moderator, Japan Society, September 26, 2016, NYC.

SELECTION OF PROFESSIONAL ACTIVITIES BEFORE 2015

Editor for IEEE Transactions on Wireless Communications

Editor for IEEE Transactions on Communications

Editor for IEEE Letters on Communications

Organizer and Chair of two dozen of conference sessions in mobile and wireless communications.

Participant in NSF panels.

