CURRICULUM VITAE

Dr. Markku Juntti
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Family name: Juntti **Given names**: Markku Johannes **Gender:** male **Nationality**: Finland
Year of birth: 1969 **Place of birth**: Kemi, Finland **Place of residence**: Oulu, Finland
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Education, Degrees and Language Skills

1997 ***Doctor of Science in Technology*** (**with distinction**), Department of Electrical Engineering, Faculty of Technology, University of Oulu, Oulu, Finland.
Major subject: **communication engineering**,
Minor subject: **digital and statistical signal processing**
Thesis title: "Multiuser demodulation for DS-CDMA systems in fading channels".

1993 ***Master of Science in Engineering*** (**with distinction**) Department of Electrical Engineering, Faculty of Technology, University of Oulu, Oulu, Finland.
Major subject: **communication engineering**,
Minor subject: **digital transmission techniques** and **electronics design**
Thesis title: "Methods of DS/CDMA signal detection".

1988 ***Matriculation Examination*** (with general degree *laudatur* (the highest degree)), from Upper Secondary School of Kemi, Kemi, Finland in **1988**.

Mother tongue: Finnish. **Excellent** (written and oral): English. **Basic**: Swedish, German.

Professional Appointments

Present Position

1/3/2000– ***Professor*** **of Communications Engineering**, at Centre for Wireless Communications (CWC) and Department of Communications (DCE) Engineering, Faculty of Information Technology and Electrical Engineering (ITEE), University of Oulu.
Currently also *Head* of Communications Signal Processing (CSP) Research Group at DCE&CWC of about 30 persons.
Dean, University of Oulu Graduate School (UniOGS) 2014–2017.

Previous Positions

1/1/1999–31/5/2000 *Senior Specialist* at Nokia Networks, Radio Access Systems, Oulu.

1/1/1998–31/12/1998 *Acting Associate Professor and Professor*, University of Oulu.

1/8/1998–31/12/2006 *Senior Teaching Assistant* (on leave), University of Oulu.

1/11/1996–31/7/1998 *Teaching Assistant* (on leave), University of Oulu.

1/6/1996–31/12/1997 *Research Project Manager*, University of Oulu.

1/9/1995–31/5/1996 *Research Scientist*, University of Oulu.

1/9/1994–31/8/1995 *Visiting Scholar* at Department of Electrical and Computer Engineering, Rice University, Houston, Texas, USA.

1/8/1993–31/8/1994 *Research Scientist*, University of Oulu.

1/4/1993–31/7/1993 *Assistant Research Scientist*, University of Oulu.

(11/8/1992–7/4/1993 Military Service, Finnish Air Force)

1/1/1992–10/8/1992 *Acting Teaching Assistant*, University of Oulu.

Adjunct Positions

1/9/2006–30/6/2013 *Adjunct Professor* at Department of Electrical and Computer Engineering, Rice University, Houston, Texas, USA.

Part-Time Positions

1/1/1999–31/5/1999 Part-time *Research Scientist* at Telecommunication Laboratory and Centre for Wireless Communication (CWC), Department of Electrical Engineering, University of Oulu.

1997–2001 Lecturer on numerous intensive on-site courses on code-division multiple-access (CDMA) technology given to several Finnish telecommunication companies.

Research Funding and Merits

Field of research: *wireless communications engineering and related signal processing*.

Projects Funded by Tekes, the Finnish Funding Agency for Technology and Innovation

Principal Investigator in *Baseband and System Technologies for Wireless Evolution (BaSE)* project 2013–2014; 7 person years. Other partners: Renesas Mobile Europe, Nokia Siemens Networks, Xilinx.

Co-Principal Investigator (PI Dr. Antti Tölli under my supervision) in *Energy-Efficient Wireless Networks and Connectivity of Devices – Densification (EWINE-D)* project 2013–2015; 1.5 person years per year. Other partners: Nokia, Renesas Mobile Europe, Huawei. Joint project with Aalto University, Espoo, Finland, Tampere University of Technology, Tampere, Finland and VTT, Oulu, Finland. Part of China-Finland Strategic ICT Alliance.

Principal Investigator in *Cross-Layer Modeling and Design of Energy-Aware Cognitive Radio Networks (CREAM)* project 2013–2014;2 person years per year for University of Oulu. Funded by Tekes and National Science Foundation (NSF) under joint program and virtual institute on Wireless Innovation between Finland and US (WIFIUS). Companies in Steering Group: Nokia, Nokia Siemens Networks, Ericsson, Renesas Mobile Europe, Elektrobit, EXFO-NetHawk, Texas Instruments. Joint project with Tampere University of Technology, Rice University, Houston, Texas, USA and University of Maryland College Park, Maryland, USA.

Principal Investigator in *Networks of 2020 (NETS2020)* project 2009–2013; 2.5 person years per year. Other partners: Nokia, Nokia Siemens Networks, Ericsson, Renesas Mobile Europe, Elektrobit, NetHawk. Joint project with Aalto University, Espoo, Finland. Part of China-Finland Strategic ICT Alliance.

Principal Investigator in *Cooperative MIMO Techniques for Cellular System Evolution (CoMIT)* project 2010–2012; 10 person years per year. Other partners: Renesas Mobile Europe, Nokia Siemens Networks, Nokia, Elektrobit, Xilinx.

Principal Investigator in *MIMO Techniques for 3G System and Standard Evolution (MITSE)* project 2005–2010; 4.5–10 person years per year. Other partners: Nokia, Nokia Siemens Networks, Elektrobit, Texas Instruments, Uninord.

Scientific advisor, a member of management and steering groups in *Packet Access Networks with Flexible Spectrum Use (PANU)* project 2005–2007. Other partners: Nokia, Finnish Defence Forces, Elektrobit.

Research area leader, scientific advisor for more than ten researchers, a member of management and steering groups in *Future Radio Access (FUTURA)* project, which is one and the largest of four spearhead projects of NETS Technology Program of Tekes 2002–2004. Other partners: Nokia, Finnish Defence Forces, Elektrobit, Instrumentointi.

Principal Investigator in *Downlink Capacity Enhancement in WCDMA System via Transmit Diversity (DOCENT)* project 2000–2001. Other partners: Sonera, Nemo Technologies.

Project manager and scientific advisor in *Advanced Wireless Communications Systems (AWICS)* project 1998, 2000–2001. Other partners: Nokia, Finnish Defense Forces, Elektrobit.

European Union Funded Projects

Principal Investigator in EU FP7 *Links-on-the-fly Technology for Robust, Efficient and Smart Communication in Unpredictable Environments* (*RESCUE)* Specific Targeted Research Project (STREP) 2013–2016.

Principal Investigator in EU FP7 *Full-Duplex Radios for Local Accesss* (*DUPLO)* Specific Targeted Research Project (STREP) 2012–2015.

Principal Investigator in EU FP7 *uBiquitous, secUre inTernet-of-things with Location and contExawaReness* (*BUTLER)* Integrating Project (IP) 2011–2014.

Scientific advisor within CWC Oulu in *Wireless World Initiative – New Radio (WINNER)* IST integrated project 2004–2007.

Research scientist in *Future Radio Wideband Multiple Access Systems (FRAMES)* EU/ACTS project 1996–1997.

Principal Investigator in Academy of Finland Funding

Energy-Efficient Wireless System Design and Optimization (EEWiS) project 2013–2014; 249 709 euros. Academy of Finland and Korean National Research Fund (NRF) joint program on Nanoscience and ICT. Joint project with School of Electronics and Information at the Kuyng Hee University, Seoul, Republic of Korea.

Sensing, Compression, Communications and Data Fusion in Wireless Sensor Networks (SeCoFu) project 2012–2016; 752 877euros.

Robust and Secure Cognitive Radio Networks (RoSeCoRN) project 2012–2013; 139 344 euros. Academy of Finland and National Science Foundation (NSF) joint program and virtual institute on Wireless Innovation between Finland and US (WiFiUS). Joint project with University of Maryland, College Park, Maryland, USA, Northwestern University, Chicago, Illinois, USA, and Aalto University, Espoo, Finland.

Collaborative Multiuser MIMO Networks (CoMuNet) project 2010–2012; 474 000 euros. Academy of Finland and National Science Foundation of China (NSFC) joint program on Computational Sciences and Signal Processing. Joint project with Beijing University of Posts and Telecommunications (BUPT), Beijing, China.

Beamforming and Radio Resource Management in Co-Operative Wireless Networks (BeCON) project 2009–2012; 440 000 euros.

Network Coding Techniques for Wireless Communications (NetCo) project 2006–2008; 128 400 euros.

Capacity Analysis and Signal Design for Wireless MIMO Communications (CASWi) project 2004–2006; 120 000 euros.

Co-PI in *Advanced space-time coding, modulation and signal processing for future communication systems (STICS)* project 2001–2003.

Scholarship from the Academy of Finland for "Researcher training abroad" for one year visit to Rice University in academic year 1994–95.

Principal Investigator in Private Company Funded Projects

Principal Investigator in *Multicell Scheduling with 3D Antenna Arrays (MuSA)* project 2008–2011. Partner: Nokia Siemens Networks. Volume: 1.5–2 person years per year.

Principal Investigator in *Fixed Wireless Access (FixWire), EUTRAN Simulator and Solution Development (ESSo)* and *Broadband Wireless Access Simulator and Solution (BASSo)* projects 2003–2008. Partner: Elektrobit. Volume: about 1–3 person years per year.

Principal Investigator in *Future Receiver Baseband Algorithms for High Data Rates in WCDMA Systems (FuBRaS)* project 2003–2004. Partners: Nokia, Texas Instruments. Volume: 2 person years per year.

Principal Investigator in *Advanced Base band Receivers Algorithms for WCDMA Systems (ABRAS)* project 2000–2002. Partners: Nokia, Texas Instruments. Volume: 2–4 person years per year.

Principal Investigator in *MultiUser Receivers for Shortcode Uplink (MURSU)* project 2001. Partner: Nokia. Volume: 2 person years per year.

Principal Investigator in European Space Agency (ESA) Projects

Principal Investigator in a *MIMO Hardware Demonstrator (MIMO-HW)* project 2010–2011. Prime Partner: Elektrobit. Volume: 2 person years.

Principal Investigator in Finnish Defense Forces Projects

Principal Investigator in a project on signal detection techniques 2003–2007. Volume: 1–2.5 person years per year.

Others

Nokia Visiting Fellow Scholarship from Nokia Foundation to invite Prof. Joseph R. Cavallaro to Finland, 2004.

Nokia Visiting Fellow Scholarship from Nokia Foundation to invite Assoc. Prof. Marcello Luiz Rodrigues de Campos to Finland, 2002.

In total six scholarships from various Finnish foundations in 1994–96 for doctoral thesis study.

Doctoral Theses Supervised at University of Oulu

X. Lu (co-supervised by A. Tölli), “Resource allocation in uplink coordinated multicell MIMO-OFDM systems with 3D channel models”. December 2013. (Now with Magister Solutions, Espoo, Finland)

P. Komulainen (co-supervised by A. Tölli), “Coordinated Multi-Antenna Techniques for Cellular Networks -- Effective CSI Signaling and Decentralized Optimization in TDD Mode”. November 2013. (Now with University of Oulu)

A. Yadav, “Space-Time Constellation and Precoder Design under Channel Estimation Errors”. October 2013. (Now with Université du Québec à Montréal as postdoctoral researcher)

J. Ketonen (co-supervised by J. Cavallaro), “Equalization and Channel Estimation Algorithms and Implementations for Cellular MIMO-OFDM Downlink”, June 2012. (Now with University of Oulu)

J. Janhunen (co-supervised by O. Silven), “Software based reconfigurable MIMO detectors”, December 2011. (Now with University of Oulu)

J. Karjalainen (co-supervised by T. Matsumoto), “Broadband single carrier multi-antenna communications with frequency domain turbo equalization”, September 2011. (Now with Renesas Mobile)

M. Myllylä (co-supervised by J. Cavallaro), “Detection algorithms and architectures for wireless spatial multiplexing communications”, May 2011. (Now with Renesas Mobile)

J. Vartiainen (co-supervised by H. Saarnisaari), “Concentrated signal extraction using consecutive mean excision algorithms”, November 2010. (Now with University of Oulu, Academy of Finland postdoctoral Fellow)

J. Ylioinas, “Reducing complexity through activation optimization and algorithm design in iterative receiver for MIMO-OFDM”, June 2010. (Now with Nokia Solutions and Networks)

J.-P. Haapola ((co-supervised by C. Pomalaza Raez and I. Oppermann), “Evaluating Medium Access Control Protocols for Wireless Sensor Networks”, February 2010. (Now with University of Oulu)

J. Leinonen, “Analysis of OFDMA Resource Allocation with Limited Feedback”, October 2009. (Now with Ericsson)

A. Tölli, “Radio Resource Management in Future Wireless Broadband Systems”, April 2008. (Now with University of Oulu)

H. Miao, “Channel estimation and positioning for multiple antenna systems”, May 2007. (Now with Nokia Research Center)

J. Lehtomäki, “Performance analysis of energy detectors for communication signal intelligence”, December 2005. (Now with University of Oulu and Georgia Tech)

N. Veselinovic (co-supervised by T. Matsumoto), “Iterative receivers for interference cancellation and suppression in wireless communications”, December 2004. (Now with Varian Medical Systems)

Dj. Tujkovic, “Space-time turbo coded modulation for wireless communication systems”. University of Oulu, Department of Electrical and Information Engineering, April 2003. (Now with Broadcom)

Co-supervisor: M. Codreanu (supervised by M. Latva-aho), “Multidimensional adaptive radio links for broadband communications”. University of Oulu, Department of Electrical and Information

Engineering, December 2007 (with distinction). (Now with University of Oulu, Academy of Finland Research Fellow)

Co-supervisor: K. Hooli (supervised by M. Latva-aho), “Equalization in WCDMA terminals”. University of Oulu, Department of Electrical and Information Engineering, December 2003 (with distinction). (Now with Nokia Solutions and Networks)

Postdoctoral Supervisor

Postdoctoral supervisor for Fatih Bayramoglu, Giuseppe Destino, Muhammad Fainan Hanif, Janne Janhunen, Johanna Ketonen, Davide Macagnano, Le-Nam Tran, Antti Tölli, Nenad Veselinovic, Yi Wu. Co-supervisor for Wei Li.

Licentiate and Master Thesis supervision in University of Oulu

Supervisor for nine (9) and examiner for three (3) licentiate degrees and theses.

Supervisor or examiner for 70 master theses.

Teaching Experience and Expertise

Participation and pssing **university pedagogic course** “Excellence in Technology Education [Tekniikan opetuksen asiantuntijuus]” (worth 8 ECTS credits) organized by the Teaching Development Unit and Department of Electrical and Information Engineering, University of Oulu, 2005.

Serving in a professor or associate professor position and teaching typically one or two courses per semester on graduate level. Currently taught courses: *Elements of Information Theory and Coding*, *Communications Signal Processing I and II*.

Teaching and supervision of several doctoral courses with timely topic.

Lecturer of in-service updating training courses on code-division multiple-access (CDMA) technology given to several Finnish telecommunication companies.

Several tutorial presentations in international scientific conferences.

Other Scientific and Academic Merits

External Thesis Reviews ,Opponent and Thesis Committee Service

K. Haghighi, “Cognitive Sensing and Transmission Strategies.” Doctoral thesis, Chalmers University of Technology, Gothenburg, Sweden, 2013. Committee member.

C.-H. Yu, “Radio Resource Management for Cellular Networks Enhanced by Inter-user Communication.” Doctoral dissertation, Aalto University, School of Electrical Engineering, Espoo, Finland, 2012. Opponent.

A. Shahed hagh ghadam, “Contributions to Analysis and DSP-based Mitigation of Nonlinear Distortion in Radio Transceivers.” Doctoral dissertation, Tampere University of Technology, Tampere, Finland, 2011. Opponent.

K. Ruttik, “Secondary Spectrum Usage in TV White Space.” Doctoral dissertation, Aalto University, School of Electrical Engineering, Espoo, Finland, 2011. Reviewer.

T. Ihalainen, “Filter Bank Signal Processing Techniques for Dynamic Spectrum Access Communications.” Doctoral dissertation, Tampere University of Technology, Tampere, Finland, 2010/2011. Reviewer and opponent.

T. Jokela, “Design and Analysis of Forward Error Control Coding and Signaling for Guaranteeing QoS in Wireless Broadcast Systems.” Doctoral dissertation, University of Turku, Turku, Finland, 2010. Reviewer.

Y. Zou, “Analysis and Mitigation of I/Q Imbalances in Multi-Antenna Transmission Systems.” Doctoral dissertation, Tampere University of Technology, Tampere, Finland, 2009. Reviewer and opponent.

M. Zhao, “Iterative Receiver Techniques for Data-Driven Channel Estimation and Interference Mitigation in Wireless Communications.” Doctoral dissertation, Australian National University, Canberra, Australia, 2009. Reviewer.

S. Kumar, “Techniques for Efficient Spectrum Usage for Next Generation Mobile Communication Networks – A LTE and LTE-A Case Study” Doctoral dissertation, Aalborg University, Aalborg, Denmark, 2009. Committee member.

D. Hammarwall, “Resource Allocation in Multi-Antenna Communication Systems with Limited Feedback.” Doctoral dissertation, Royal Institute of Technology, Stockholm, Sweden, 2007. Committee member.

A. A. Abouda, “Characterization of MIMO Channel Capacity in Urban Microcellular Environment.” Doctoral dissertation, Helsinki University of Technology, Espoo, Finland, 2007. Opponent.

O. Vainio, “Digital modulators with crest factor reduction techniques.” Doctoral thesis, Helsinki University of Technology, Espoo, Finland, 2006. Opponent.

E. S. Lohan, “Multipath Delay Estimators Fading Channels with Applications in CDMA Receivers and Mobile Positioning.” Doctoral thesis, Tampere University of Technology, Tampere, Finland, 2003. Reviewer and opponent.

S. Werner, “Reduced complexity adaptive filtering algorithms for communications systems.” Doctoral thesis, Helsinki University of Technology, Espoo, Finland, 2002. Reviewer.

R. Jäntti, “Power control and transmission rate management in cellular radio systems – a snapshot analysis approach.” Doctoral thesis, Helsinki University of Technology, Espoo, Finland, 2001. Reviewer.

K. Haghighi, “Cognitive Sensing and Transmission Strategies.” Licentiate thesis, Chalmers University of Technology, Gothenburg, Sweden, 2011. Discussion Leader.

P. H. Tan, “Multiuser detection in CDMA – combinatorial optimization methods.” Licentiate thesis, Chalmers University of Technology, Gothenburg, Sweden, 2001. Discussion Leader.

W. S. Ying “Adaptive IIR filtering for multiuser detection in asynchronous CDMA systems.” Master thesis, National University of Singapore, Singapore, 2000. Reviewer.

Academic Position Evaluations

Associate Professor and tenure position at Drexel University, Philadelphia, Pennsylvania, USA, 2011.

Professor position at Aalto University, Espoo, Finland, 2011.

Professor position at Aalborg University, Aalborg, Denmark, 2010.

Professor position at King Fahd University of Petroleum & Minerals, Saudi Arabia, 2009.

Docent (adjunct professor) position at University of Vaasa, Vaasa, Finland, 2007.

Docent (adjunct professor) position at Tampere University of Technology, Tampere, Finland, 2005.

Professor position at University of Vaasa, Vaasa, Finland, 2001.

Scientific Project or Grant Evaluations

BelSPO (Belgian Federal Science Policy Office) Interuniversity Attraction Poles (IAP) Program 2012.

European Commission (EC) for Future and Enabling Technologies (FET) program, 2011.

Qatar National Research Fund (QNRF) grant evaluation, 2009.

SINTEF (Stiftelsen for industriell og teknisk forskning) project proposal evaluation, 2009.

Editorial Boards Memberships

Associate Editor of IEEE Transactions on Vehicular Technology 2002–2008.

Editor, IEEE Transactions on Communications, 2009–.

Guest Editor, IEEE Journal on Selected Areas in Communications, Special Issue on “Spectrum and Energy Efficient Design of Wireless Communication Networks”, 2012–2013.

Guest Editor, EURASIP Journal on Advances in Signal Processing, Special Issue on “Advances in Two-Dimensional Angle-of-Arrival Processing for Localization and Communications”, 2010–2011

Scientific Conference Board Memberships

Co-Chair of the 2014 Signal Processing for Communications Symposium at IEEE Global Telecommunications Conference (GLOBECOM 2014).

Track Chair of 2014 International Conference on Cognitive Radio Oriented Wireless Networks and Communication (CROWNCOM 2014).

General Chair of the 2011 IEEE Communication Theory Workshop (CTW 2011).

Co-Chair of the Technical Program Committee (TPC) of the 2006 IEEE International Personal Indoor and Mobile radio Communications (PIMRC 2006).

Track Co-Chair of the Technical Program Committee (TPC) of the 2009 IEEE Vehicular Technology Conference (VTC 2009 Fall).

Secretary of the Technical Program Committee (TPC) of the 2001 IEEE International Conference on Communications (ICC’01).

Co-Chair of the TPC of 2004 Nordic Radio Symposium (NRS 2004).

General Chairman of the 2003 Finnish Wireless Communications Workshop (FWCW’03).

Chair of the TPC of the 2000 Finnish Wireless Communications Workshop (FWCW’00).

Chair of the TPC of the 1999 Finnish Signal Processing Symposium (FINSIG’99).

Session organizer, session chair, TPC member, and reviewer in tens of conferences since late 1990s.

Memberships in Academic Societies

Senior Member of IEEE (The Institute of Electrical and Electronics Engineers, Inc.) since 2004.
Member of IEEE Communication Society, IEEE Information Society, and IEEE Signal Processing Society, IEEE Circuits and Systems Society, IEEE Vehicular Technology Society, and IEEE Circuits and Systems Society.
Active member IEEE Communications Sociecty Communication Theory Technical Committee and Radio Communications Technical Committee. Affiliate Member of IEEE Signal Processing Society Communications Signal Processing Technical Committee as well as Design and Implementation Technical Committee.
Member of European Association of Signal Processing (EURASIP) and its Local Liaison in Finland.

Scientific Positions of Trust

Vice-Dean, University of Oulu Graduate School (UniOGS) 2012–2013.

Chair of the Doctoral Training Committee for Engineering and Natural Sciences, University of Oulu Graduate School (UniOGS) 2011–2013.

Member of the Nokia Foundation Board 2009–2011.

Member of China–Finland Strategic ICT Alliance Advisory Board 2009–.

Member of the Faculty Council, Faculty of Technology, University of Oulu, 2003–2009.

Member of the Research Committee, Faculty of Technology, University of Oulu, 2010–2013.

Member of the Department Council, Department of Electrical and Information Engineering, University of Oulu, 2003–2009.

Chair of the Management Board and Director, Infotech Oulu Doctoral Program, University of Oulu, 2010–2013.

Member of the Management Board, Infotech Oulu Graduate School, University of Oulu. 2000–2009

Associate Scientific Director of Infotech Oulu, University of Oulu, 2010–2013.

Member of the Management Board, Department of Electrical and Information Engineering, University of Oulu, 2003–2007.

Member of the Management Board, Department of Communications Engineering, University of Oulu, 2011–2013.

Member 2000–2002, Vice-Chair 2003–2005 and Chair 2006–2013 of the Doctoral Program Board, Department of Electrical and Information Engineering, University of Oulu.

Member of University of Oulu Graduate School preparation committee 2010.

Member of Internal Management Group of Centre for Wireless Communications, University of Oulu 2000–2004, 2006–.

Chairman (2000–2001) and Secretary (1996–1997) of IEEE Communications Society Finland Chapter.

Paper Awards

Student Paper Award on paper “Linear multiuser detector update in synchronous dynamic CDMA systems” at 1995 IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC'95), Toronto, Ontario, Canada, September 27–29, 1995.

Co-author of the *Student Paper Award* winner of “Zero-forcing spatial interweave with greedy scheduling” at 2011 International Symposium on Wireless Personal Multimedia Communications (WPMC 2011), Brest, France, October 3–6, 2011.

Co-author of the *Best Paper Award* winner of “Novel detector implementations achieving 3G LTE downlink and uplink requirements”. Proceedings of Wireless Innovation Forum Conference on Wireless Communications Technologies and Software Radio (SDR WInnComm), R&D Track, Washington, District of Columbia, USA, January 8–10, 2013.

Research Impact

The number of international peer-reviewed scientific publications: 70 journal articles, four (4) book chapter, and 249 conference articles (out of which six invited). In addition, six (6) patents granted and seven (7) pending.

Citation analysis: H-index in Scopus 21, Web of Science 17 and Google Scholar 32. Scopus finds 250 publications, which gain 1496 citations by 1235 documents. The most cited and scientifically impactful works have related to my doctoral thesis and postdoctoral research on multiuser receiver design. Later my work on positioning algorithms and resource allocation in multiuser MIMO systems have had strong impact as well.

Practical and commercial application of the research results has been significant. This is evidenced by the patents, which are all own by private companies, most by Nokia, and by significant company commitment to many of the research projects. Several results of the highly-cited papers have been commercialized by the leading wireless network and device vendors.