

**INFOTEHNOLOOGIA TEADUSKOND
RAADIO- JA SIDETEHNIKA INSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2014**

1. Struktuur

Raadio- ja sidetehnika instituut, Department of Radio and Communication Engineering
Instituudi direktor: dots. Toomas Ruuben

- Raadiotehnika õppetool, Chair of Radio Engineering, õppetooli hoidja: dots. Toomas Ruuben
- Signaalitöötluse õppetool, Chair of Signal Processing, õppetooli juhataja: prof. Tõnu Trump
- Telekommunikatsiooni õppetool, Chair of Telecommunications, õppetooli hoidja: dots. Eerik Lossmann

2. Teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

2.1 Struktuuriüksusesse kuuluvad uurimisgrupid

1) Signaalitöötluse uurimisgrupp (Signal Processing Research Group), juht: prof. Tõnu Trump

Research in the Signal Processing Research Group is focused on adaptive signal processing algorithms and robust signal processing.

Three subareas of research are robust detection of signals in the presence of nongaussian disturbances, robust adaptive beamforming and signal processing in spatially distributed networks of sensors.

Uurimisgrupi olulisemad publikatsioonid 2014.aastal:

1. Trump, T. (2014). A Robust Eigenvalue Ratio Detector for Cognitive Radio. 19th International Conference on Digital Signal Processing (DSP 2014), Hong Kong, China, 20-23 Aug. 2014. Hong Kong: IEEE, 2014, 30 - 35.
2. Tart, A.; Trump, T. (2014). Two Dimensional Robust Beamforming for Air-Ground Communication System. Integrated Communications, Navigation and Surveillance Conference (ICNS); Westin Washington Dulles Airport, Herndon, Virginia, USA; April 8-10, 2014. IEEE, 2014, B2-1 - B2-8.
3. Ainomäe, A.; Trump, T.; Bengtsson, M. (2014). Distributed Recursive Energy Detection. In: Proceedings of IEEE Wireless Communications and Networking Conference (WCNC): WCNC 2014 IEEE Wireless Communication and Networking Conference, Istanbul, Turkey, 6-9 April 2014 . IEEE, 2014, 1265 - 1270.
4. S. Ulp, T. Trump, "Distributed Adaptive Network Performance with Static Topology and Unweighed Communication" in Proc. 5th International Conference on Circuits, Systems, Control, Signals (CSCS '14), Salerno, Italy, June 2014, pp. 126–130.

5. E. Astra, T. Trump, "Outage Probability of a Robust Antenna Array" in Proc. 5th International Conference on Circuits, Systems, Control, Signals (CSCS '14), Salerno, Italy, June 2014, pp. 64–69.

2) Fiiberoptilise kommunikatsiooni uurimisgrupp (Fibre Optical Communication Research Group). Projekt: „PSOPA—Phase-sensitive optical parametric amplifiers” VEU645

juht: prof. Peter Avo Andrekson

Optical amplifiers are essential in optical communication systems as they compensate loss induced by the transmission fiber ensuring signal integrity of the information being transmitted, as well as in other applications such as spectroscopy. This research proposal deals with phase-sensitive optical parametric amplifiers (PSA) that have unique and superior properties compared with all other optical amplifiers, most notably the potential of noiseless amplification, very broad optical bandwidth, and being an enabler of a range of ultrafast all-optical functionalities. In communication, there is an urgent need to develop new technologies that can break the 'nonlinear Shannon capacity limit', which is considered a serious barrier for continued capacity increase needed to meet the exponentially growing demand for bandwidth. The use of PSAs is expected to be an essential part of this development. The objective is to unleash the unexplored potential of PSAs by generating knowledge and implementing experimental demonstrations that go substantially beyond current state-of-the-art. This involves a mix of engineering and scientific challenges with telecom and non-telecom applications in mind. We will leverage advances in other areas e.g. low loss photonic crystal fibers and highly nonlinear materials to realize compact PSAs with unprecedented performance. Specifically, we will demonstrate:

- Significant merits (reach, spectral efficiency, capacity) of PSAs in optical transmission systems
- High coherence, low noise lasers by utilizing ultralow noise amplifier as gain element
- Very broad gain bandwidth, low noise PSAs using specially tailored nonlinear gain medium
- Compact (hybrid integration compatible) PSA using new nonlinear materials
- Novel ultrafast all-optical operations/signal processing using PSAs
- Capability of PSAs for detection of very weak optical signals for e.g. and quantum optics

Uurimisgrupi olulisemad publikatsioonid 2014.aastal:

1. Lorences-Riesgo, Abel; Chiarello, Fabrizio; Lundstrom, Carl; Karlsson, Magnus; Andrekson, Peter A. (2014). Experimental analysis of degenerate vector phase-sensitive amplification. *Optics Express*, 22(18), 21889 - 21902.
2. Eriksson, Tobias A.; Johannisson, Pontus; Puttnam, Benjamin J.; Agrell, Erik; Andrekson, Peter A.; Karlsson, Magnus (2014). K-Over-L Multidimensional Position Modulation. *Journal of Lightwave Technology*, 32(12), 2254 – 2262.
3. Corcoran, B.; Malik, R.; Olsson, S. L. I.; Lundstrom, C.; Karlsson, M.; Andrekson, P. A. (2014). Noise beating in hybrid phase-sensitive amplifier systems. *Optics Express*, 22(5), 5762 – 5771.
4. Malik, R.; Kumpera, A.; Olsson, S. L. I.; Andrekson, P. A.; Karlsson, M. (2014). Optical signal to noise ratio improvement through unbalanced noise beating in phase-sensitive parametric amplifiers. *Optics Express*, 22(9), 10477 – 10486.

3). Raadiovõrkude uurimisgrupp (Wireless Network Research Group), juht: dots. Eerik Lossmann

Research activities of the research group are focused on propagation of radio signals and on reliability of wireless communication networks.

The main results of the research in 2014 include radio signal propagation measurements of the ZigBee-based home automation sensor networks (IEEE 802.15.4) and investigation of coexistence problems of ZigBee- and other wireless networks and equipment (WiFi-networks) in the license-free 2.4 GHz frequency band. Recommendations were given regarding the reliability and maximum communications range of ZigBee networks in various environment. Vulnerability of ZigBee communications link to interference from WiFi routers operating in various modes and at different bit rates was estimated.

The research was done in cooperation with and the results were implemented by Estonian telecommunications service provider Elion Ettevõtte Ltd (research contract Lep14051 'Coexistence of Zigbee (IEEE 802.15.4) and other 2.4 GHz wireless devices').

2.2 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

Peter Avo Andrekson - Member of Swedish Royal Academy of Engineering

2.3 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiade või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed.

Prof. Peter Avo Andrekson - Fellow of IEEE, Fellow of OSA

Prof. Tõnu Trump- -IEEE vanemliige (Senior Member)