INFOTEHNOLOOGIA TEADUSKOND
ARVUTITEADUSE INSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2013

1. Struktuur
Arvutiteaduse instituut / Department of Computer Science
Direktor Jüri Vain

- **Õppetoolid**:
  - Üldinformaatika õppetool/ Chair of General Informatics, juhataja Jüri Vain
  - Teoreetilise informaatika õppetool/ Chair of Theoretical Informatics, juhataja Tarmo Uustalu
  - Võrgutarkvara õppetool/ Chair of Network Software, juhataja Tanel Tammet

2. **Teadus- ja arendustegevuse (edaspidi T&A) iseloomustus**
2.1 Struktuuriüksusesse kuuluvad uurimisgrupid

Formaalmeetodite uurimisgrupp/Formal methods research group, juht Jüri Vain
Description of the research. The focus of research is developing and applying formal design and verification techniques in the field of distributed cyber-physical and cognitive system such as smart energy grid control architecture, autonomous robots' software and other. Theoretical research integrates various domains: SMT constraint solving methods, refinement calculus for timed systems, state abstraction techniques and heuristic algorithms of resource and time constrained planning. Specific domain of study is model-based diagnosis and synthesis of online testers for distributed and time constrained systems. Second application target of theoretical research is model driven software development for autonomous robotic and large scale web-based applications.
Main reserach results:
An Agent-based Modelling for Price-Responsive Demand Simulation. Multi-agent system modelling approach has been developed for modelling demand participation in smart energy grids. An agent-based meta-model representing various concepts, relations, and structure of agents has been constructed. The domain model has been instantiated based upon the meta-model and simulation experiments developed for use case demonstration and model validation. The simulation is for the supplier to obtain the profit-maximizing demand curve which has such a shape that it follows the spot price curve in inverse ratio. The result suggests that this multi-agent-based construct could contribute to 1) estimating the impacts of various timevarying tariff options on peak-period energy use through simulation, before any experimental pilots can be carried out; 2) modeling the electricity retail market evolving interactions in a systematic manner; 3) inducing innovative simulation configurations.

Integration of IEC 61850 and OPC UA for Smart Grid Automation. The need for integration of data models following IEC 61850 and OPC UA standards for smart grid control has been studied. New vistas like multi-agent systems, hierarchical control, and diagnosis and monitoring using suitable examples have been proposed. As a result, a model of control architecture that follows proposed principles has been developed.

Aspect-Orientated Model-Based Testing using UPPAAL Timed Automata. An aspect-oriented method for model based testing using UPPAAL timed automata (UPTA) has been developed with the focus on providing a rigorous constructive approach supported by modelling and test automation tool support. In both cases, we define precise semantics for the composition and, respectively, for the test generation process.

An in-depth analysis of the application of model-based diagnosis system Livingstone 2 to an autonomous underwater vehicle Autosub 6000. The paper gives an overview how a model-based diagnosis system can be built for an autonomous underwater vehicle. We built a diagnosis system and tested it on hundreds of hours of recorded mission logs. We showed that the system could have discovered a number of faults that occurred during the actual missions and could have prevented a collision with the sea bed. Juhan Ernits participated in the research while being a research fellow at the School of Computer Science of the University of Birmingham. He has continued the research at Tallinn University of Technology. The fault diagnosis and robot autonomy line of work continues at the Department of Computer Science and will be applied to the recently acquired Iver 2 autonomous underwater vehicle.

Main publications:

- Dearden, R.; Ernits, J. (2013). Automated Fault Diagnosis for an Autonomous Underwater Vehicle. IEEE Journal of Oceanic Engineering, 38(3), 484 - 499.
- Srinivasan, Seshadhri; Kumar, Ravish; Vain, Juri. Integration of IEC 61850 and OPC UA for Smart Grid Automation. *In: ISGT 2013 : Innovative Smart Grid Technologies Conference, November 10-13, 2013, Bangalore, India:* Piscataway, N.J.: IEEE, 2014, [1 - 6].
- Siavashi, Faezeh; Waldén, Marina; Tsiopoulos, Leonidas; Vain, Jüri (2013). Modelling critical systems with timing constraints in Event-B. *In: 25th Nordic Workshop on Programming Theory, NWPT 2013 : Tallinn, Estonia, 20-22 November 2013, Abstracts: (Eds.) Uustalu, Tarmo; Vain, Jüri.* Tallinn: Institute of Cybernetics at Tallinn University of Technology, 2013, 70 - 72.
- Liu, Hongyan; Vain, Jüri. An agent-based modeling for price-responsive demand simulation. *In: ICEIS 2013 : Proceedings of the 15th International Conference on Enterprise Information Systems, Volume 1, Angers, France, 4 - 6 July, 2013: (Eds.) Hammoudi, Slimane; Maciaszek, Leszek; Cordeiro, José; Dietz, Jan.* SciTePress, 2013, 405 - 412.

Võrgutarkvara uurimisgrupp/Network software group, juht Tanel Tammet

Description of the research. The group is focusing on the following areas of applied research in the field of *semantic web, big data and cyber security.* All these research areas are investigated by combining theoretical investigations with practical experimentation with the implementations.

- Semantic analysis, classification and deduplication of tourism objects worldwide.
- In-memory databases with an integrated reasoner and applications in impact analysis for database systems.
- Security issues of cyber space and modelling of cyber threats.

Some research has been also done in optimizing robot movement strategies for large multi-robot systems and robot swarms.

Main research results:

Semantic analysis of tourism objects. We have performed semantic analyses and used these for creating popular visualization tools (see http://sightsmap.com) for large crowd-sourced, geotagged world-wide datasets created by a large number of individuals: Panoramio photoset

(used for photos on Google maps), Foursquare (recording visits to places) and a geotagged subset of Wikipedia.

Databases for big data. The research here is relatively new (first publications have been submitted) and focuses on two interconnected areas: first, developing algorithms for rule-based analysis of large datasets, with experimental work focusing on building an efficient in-memory database with an integrated reasoning engine: see http://whitedb.org. Second, developing algorithms for analysing data lineage and impact in large real-life database systems: see http://dlineage.org.

Security issues of cyber space. The focus of the research has been on practical and organizational issues of preparing for cyber threats in the context of military operations of different kinds.

Main publications:

- Schoefegger, K.; Tammet, T.; Granitzer, M. (2013). A survey on socio-semantic information retrieval. Computer Science Review, 8, 25 - 46.
- Tammet, T.; Luberg, A.; Järv, P. (2013). Sightsmap: crowd-sourced popularity of the world places. *In: Information and Communication Technologies in Tourism 2013: ENTER 2013, Innsbruck, Austria, January 22-25, 2013. (Toim.) Cantoni, L.; Xiang, Z.*. Springer, 2013.
- Gunneriusson, H.; Ottis, R. (2013). Cyberspace from the Hybrid Threat Perspective. Kuusisto, R.; Kurkkinen, E. (Toim.). Proceedings of the 12th European Conference on Information Warfare and Security (98 - 105). Reading: Academic Conferences and Publishing International Limited
- Cardash, S.; Cilluffo, F.; Ottis, R. (2013). Estonia's Cyber Defence League: A Model for the United States? Studies in Conflict & Terrorism, 36(9), 777 - 787.

2.2 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

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

2.4 Soovi korral esitatakse aruandeaastal saadud T&A-ga seotud tunnustused (va punktis 2.3 toodud tunnustused), ülevaade teaduskorralduslikust tegevusest, teadlasmobiilsusest ning hinnang oma teadustulemustele.

Valmistati ette ja esitati 3 FP7 taotlus:

1. Joint EC FP7 STREP proposal (TTÜ koordinaator)

Call: FP7-ICT-2013-11, Small or medium-scale focused research project INFSO (STREP),Proposal number: 619452, Proposal acronym: G-RADIANT, Proposal title: Smart Energy Grid Agents in Cloud, Activity: 11- 6.1 EnergyGrids STREP

Partners: Eixo Atlântico Do Noroeste Peninsular (PT), Fundacio Privada Ascamm (ES), Kungliga Tekniska Hoegskolan (SE) , Agenzia Fiorentina Per L'energia (IT), Ts Energia (EE), ABB Ab (SE), Universita Degli Studi Di Firenze (IT), As EMT (EE).

2. FP7 EU - India Science programme " **New INDIGO Partnership Programme**"

Project Name: Multi-Agent Systems for Smart Grid Control and Optimization

Patners: Abo Akademi University (Finland), Kalasalingam University (India) INSA de Rouen (The National Institute of Applied Sciences) (France), ABB India Ltd (India), TUT (EE). Koordinaator INSA de Rouen.

Taotlus sai positiivse rahastusotuse, kuid Prantsuse partneri (koordinaatori) tegemata jätmise tõttu ei käivitunud.

3. Economic impacts of Cybercrime (E-CRIME). A Capability Project A small or medium-scale focused research project. SEC-2013.2.5-2 . Understanding the economic impacts of cyber-crime in non-ICT sectors across jurisdictions

Projekt sai rahastuse ja toimib.