AALBORG UNIVERSITET

Den 9. august 2017

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TECH Akademisk Råd, Sommerprocedure 2017

Skriftlig godkendelse af sager vedrørende ph.d.- og videnskabelige stillinger

I henhold til tidligere beslutning i Akademisk Råd om "sommerprocedure" i forbindelse med godkendelse af ovennævnte akademiske sager, fremsedes hermed følgende til godkendelse:

1.	**Tildeling af ph.d.-grad til positivt bedømte ph.d.-afhandlinger fra:** A. Anna Rose Vagn Jensen, Institut for Planlægning. Afhandlingens titel: "Front End Innovation – navigating situated spaces of actors and models". B. Christian Schou Oxvig, Institut for Elektroniske Systemer. Afhandlingens titel: "Algorithms for Reconstruction of Undersampled Atomic Force Microscopy Images". C. Erik Sikström, Institut for Arkitektur og Medieteknologi. Afhandlingens titel: "The Self and Sound in VR". D. Jakob Zinck Thellufsen, Institut for Planlægning. Afhandlingens titel: "Contextual Aspects of Smart City Energy Systems Analysis. Methodology and Tools". E. Lars Møller Mikkelsen, Institut for Elektroniske Systemer. Afhandlingens titel: "Enhancing IoT Systems by Exploiting Opportunistically Collected Information from Communication Networks". F. Louise Brønnum, Institut for Planlægning. Afhandlingens titel: "Strategic Enactment of Front End Innovation: A Case Study of Multiple Enabling Opportunities". G. Mojtaba Farmani, Institut for Elektroniske Systemer. Afhandlingens titel: "Informed Sound Source Localization for Hearing Aid Applications". **Bilag S2017-1**
2.	**Indstilling vedr. sammensætning af sagkyndigt udvalg vedr. lektor stillingen i:** A. "Wireless Communication Systems and Networks" ved Institut for Elektroniske Systemer (stilling 42237) **Bilag S2017-2**
3.	**Indstillinger vedr. sammensætning af sagkyndige udvalg vedr. postdoc stillingerne i:** A. "Control Exoskeletons" ved Institut for Elektroniske Systemer (stilling P21725) B. "Problem Based Learning and Media Technology" ved Institut for Arkitektur og Medieteknologi (stilling P21728) **Bilag S2017-3**
4.	**Til orientering** A. Fortegnelse over sager godkendt af dekanen. **Bilag S2017-4**

OBS! Vedr. bedømmelsesudvalg – i de tilfælde hvor ansøgningsfristen ligger efter Akademisk Råds møde/skriftlig høring kontrolleres der efterfølgende for inhabilitet og sammensætning af udvalget (kvindelig bedømmer). Hvis der konstateres uregelmæssigheder, vil dekanen/formanden godkende nyt/nye medlemmer.

Det gælder for såvel bedømmelsesudvalg nedsat via de skriftlige høringer som ved de ordinære møder.

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Vedr.: Ph.D. forsvar - Anna Rose Vagn Jensen, Aalborg Universitet, Danmark

På vegne af Institut for Planlægning fremsendes hermed bedømmelsesudvalgets endelige indstilling i forbindelse med det ovennævnte forsvar.

Venlig hilsen

p. i. v.

Lise Kirk Nordensgaard

AALBORG UNIVERSITY
DENMARK

Assessment of the PhD thesis entitled:

FRONT END INNOVATION – navigating situated spaces of actors and models.

Submitted by Anna Rose Vagn Jensen

The assessment committee consists of the following members as decided by the Dean of the Technical Faculty of IT and Design January the 29´th 2015. The PhD defence took place at the Copenhagen Campus, Aalborg University Wednesday the 28'th of June.

- Professor John Bessant
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Supervisor for the thesis has been Professor Christian Clausen, Department of Planning, Aalborg University and Liv Gish Aalborg university.

Description of the thesis

The Thesis is a paper-based dissertation, where the papers are incorporated in the dissertation. The papers are produced as an integrated part of the PhD project and process and represent key outcomes of the different phases of the project. The thesis consists of a *literature study* forming the basis for Paper 1, a

practitioner study contributing to Paper 2, a *case study* of three industrial companies contributing to Paper 3, and conceptualisation of a new model as the main basis for Paper 4.

The papers use the same set of *analytical perspectives and sensitising concepts*. This structure has been chosen to support an exploration of new understandings and ways of describing the managing of Front end innovation, and further to propose a new model for Front end innovation.

The Thesis primarily applies literature of innovation management, innovation in organisations, product development, and science and technology studies. The dissertation combines scientific knowledge across different scientific approaches to innovation. The theories and concepts are integrated in the different papers and only the actor network theory Is described explicitly in the methodological chapter.

The *methodological approach* is based on interactive research and qualitative methods and analysis inspired and qualified by Situational analysis and Actor network theory.

The empirical data and analysis are constructed through workshops with practitioners, a survey in an industrial company, and interviews in three industrial companies. Collection and analysis of data has been an iterative learning process whereby the current understanding and approach to Front end innovation and its reflection in practices has been investigated. The empirical framework creates an opportunity to identify and analyse the tensions between employees and managers who are working with product development, business development, and technology applications in an organisational structure. The overall question has been how employees and managers are navigating the space of heterogeneous actors and models in Front end innovation.

In the *literature study,* a key finding has been the identification of primarily two approaches to Front end innovation. Approaches that either lean towards a structure-oriented focus or a social-oriented focus.

The practitioner study uses different understandings and models in the work with Front end innovation and how practitioners navigate in the complex spaces of interaction. The interactive design of knowledge creation and knowledge sharing through use of workshop methodology confirmed the complexity of Front end innovation in practice and at the same time identified the practioners ability to navigate this complexity by using a wide range of different perspectives from both structural- and social-oriented approaches.

The case study of three industry companies provides detailed descriptions in the three companies about how companies use innovation concepts and models in their innovation processes, as well as how these models instead of supporting innovation practitioners seem to increase the complexity of innovation and make the work of innovation more difficult

In addition, the case studies showed how practitioners navigated in this complex innovation room and how they handled comparable challenges in different ways depending on the context they were in. The

industrial case studies form the basis for identifying a third perspective beyond the two identified by literature that the author names “translation”. In this perspective, innovation is understood as a network of ideas, actors and activities and is more sensitive to the complexity of innovation processes and the interaction between actors and innovation models.

The three approaches provide the opportunity to develop a description of the complex processes in front end innovation. Particular emphasis is placed on developing the third perspective, the actor network perspective, and showing *how this perspective opens up to describe and understand how employees and managers can navigate between models and actors.*

Based on the literature-, practitioner-, and case study, the study has provided input to the development of a new model of Front end innovation. The Front end innovation model raises new questions yet to be fully investigated. As such, the thesis contributes to the research of Front end innovation and add value to understand Front End innovation as a co-creating process with practitioners to further develop the model.

Critical evaluation.

Overall, the thesis deals with an important issue in Front end innovation and we will subsequently evaluate these contributions by the following themes

- Research questions
- Methodology
- Literature review –sate of art
- Practitioner analysis
- Case studies
- Conceptualising a new model for Front end innovation

Research Questions.

The thesis focuses on a relevant issue in Front end innovations (FEI) about *the interaction between innovation actors and innovation models and tools* in order to understand *how employees and leaders in innovation processes can navigate*. The problem is well founded in the previous interaction with industry and insights from the literature, which is supported by the subsequent literature analysis.

The problem is investigated and developed on the basis of an explorative research questions

- *How are Front end innovation viewed and understood in literature and which perspectives and models frame the approach to Front end innovation?*
- *How are Front end innovation organised and managed in practice in product innovation companies*

and which perspectives and models frame the approach to Front end innovation?

- *How could a new conceptual model reframe the understanding of Front end innovation to support the practices of Front end innovation?*

The problem formulation supports an exploratory study design, which is in line with the processual approach to innovation and the actor network perspective.

The report provides a significant and independent contribution to understanding the issues that relate to how product development practitioners use and understand innovation models in practice and how to navigate in a complex space of actors and models.

Methodology.

The dissertation is based on an interesting and creative research design that combines literature study, practitioner study and case study. Especially the way the practitioner study is designed is interesting and provide an important information and knowledge about the dynamics of the front end innovation in conjunction with the literature study and the case study. The development of the innovation model provides a competent and solid foundation for problematizing existing practices, concepts and models and gives a solid foundation for building a new concept for Front end Innovation

The design of the practitioner study is a *new and interesting approach to research innovation* that allows for new insights and understanding of dynamics in innovation processes, such as the linking and two workshops, where the first workshop uses *design games* to develop insights and understanding with practitioners about innovation challenges, while the other workshop develops understanding with practitioners through presentations and dialogues. The approach derives inspiration from research traditions such as design thinking (Brandt, E) and participatory innovation (Buur, J), both of which are methodologies that have a constructivist approach to the *development of data, information and knowledge together with the involved actors*.

The above-mentioned traditions could have been further developed and integrated in the dissertation and the methodological choices could have been made clearer explained. For example, in the form of a reflection of the methodological challenges of gaining insight and knowledge from how the product development processes are practiced? What are the challenges in the interaction between different actors and between actors and models? What are the challenges in navigating in these complex and interactive product development processes?

The exploratory focus of the dissertation is expressed in the priority given in the description of research approaches, with the emphasis on actor network theory (ANT) as a study method, combined with the inspiration from Clarkes situational analysis. Description of ANT as a method provides a good background for understanding ANT's potentials as analytical framework and the potentials contained in concept of translation. However, there seems to be an unclear duality in the way ANT is used as both a method of investigating innovation in making and the use of ANT for modelling an innovation model. This duality

becomes particularly evident in the way ANT is used to construct a new innovation model and where ANT is used to model and visualize relationships in combination with Clarkes situation analysis and mapping tools. It is a central challenge not only in this thesis but in the actor's network perspective, and both approaches can find evidence in the literature.

However, it is an important discussion that could have been be expanded more in the dissertation as it opens up some significant discussions about how ANTs understanding of innovation differs from other understandings and what it means for the type of models and instructions that ANT offers.

The analysis and unfolding of social processes and interactions could have gained in clarity by drawing more on the concepts from the literature on innovation as social processes such as networks, communities of practice, boundary objects, complexity, political process and power. Such concepts could have helped to unlock some of the blind spots in the way actor network theory is used in the study and added some sensitivity to the politics and power in innovation.

Literature review – state of art.

The dissertation starts with an analysis of state of the art within innovation literature based on a thorough literature study based on a well-structured literature search. The design is based on an open approach to the field so that the author is able to identify and capture knowledge of innovation issues from literature that goes across existing disciplinary and professional divisions, which allows for capturing literature based on different traditions and published in different journals.

The thesis gives a good review of state of the field. The literature review is based on a structure oriented and a socially oriented approach which allows to examine and weigh the importance of how management systems are integrated in the way in which organizations practice ideas processes and the meaning of this interaction.

Paper One: A literature review of idea management.

The aim of paper 1 is primarily to conduct a state-of-the-art literature review of Idea Management and, secondarily, to point out unanswered questions which are left behind in the reviewed literature. The author shows that literature has begun to investigate how idea management systems are integrated in the practices of idea processes in organisations and to identify certain managerial implications. There is an emphasis on both human behaviour and the systems structure in managing ideas but also the interplay between the two, and which managerial implications become relevant is still an area to be uncovered in depth.

The literature analysis identifies key issues and challenges in product development, and the challenges in the application of ide management systems and the interaction between actors and management systems, concepts, etc.

The text invites to a more elaborate discussion of some of the tensions embedded in product development dynamics seen in relation to interaction between the various employees and managers within and between departments (Carlile, Dougherty), as well as the complex interactions between actors and artefacts, which would require a more in-depth review of some of the key texts.

Study of innovation from a Practitioner perspective.

Practitioner analysis is designed to *construct* data, information and knowledge of how product development practitioners use and understand innovation models in practice and how to navigate in a complex interactive space of actors and models. Inspired by Design thinking and participatory innovation, data are not seen together empirical facts are waiting to be collected out there, but as facts that are embedded in social processes and relationships. The purpose of practitioner analysis is therefore to provide contexts where information and knowledge about the complex innovation processes can be provided and created.

The first step is to generate empirical data through two workshops where interactive methods are used to create a dialogue and insight into the challenges that practitioners have in developing and navigating in the complex context. The first workshop uses *design games* as tools to get the involved actors to create and explain the challenges they face in innovation processes. I the other workshop, they are working with the participating actor experiences in *dialogue processes*.

The author has chosen to supplement workshops with a questionnaire survey in an industrial organization to investigate how the complexity of product development is experienced through the eyes of many different actors. The study uses an exploratory questionnaire that allows the author to gain insight into how product development complexity is experienced by the different social groups in the company and the importance of relations between the different actors.

Paper 2: ´Towards a new perspective of managing ideas in front end innovation as actor networks.

In paper 2 the author presents interactions with practitioners and understanding of empirical data at a very early stage in the research process. The main argument is that the dominating innovation process model approach did not reflect the real practices of idea management nor FEI. The main aim of the paper presents the actor network perspective and argue that this perspective could be useful in the context of managing ideas in Front end innovation. The paper uses Michel Callon's framework of innovation as a process of problematisation (idea need), interessement (idea generation), enrolment (idea evaluation and mobilization (idea selection). Based on this frame work the paper introduced the first model of idea management with focus on the concepts of space (inclusion and exclusion), content (produced or adapted ideas) and processes (as real movement between actors or between actors and things).

The socio-technical perspective of ANT is used to create a new understanding of idea development, and empirical practice from the practitioner study illustrates this perspective. This opens up a new understanding of idea management aimed at capturing identified challenges in process processes in FEI by developing a more sensitizing management of idea development in innovative organizations that can make room for more qualified innovation ideas while acknowledging the complexity of different Stakeholders who can either prevent or promote Ideological themes – in the processes of interaction prevent or promote ideological themes.

The paper is primarily a conceptual development at an early stage, and the empirical material from the practitioner study is primarily used for illustrative purposes and paper can only be viewed as sensitive to practitioner study to a limited extent.

Case study of front end innovation in industrial companies.

The last step in the empirical coverage of innovation practices consists of case studies of three companies. The selected case companies are all companies that have participated in the workshops, which was intended by the author when organising the workshop activities.

The author therefore has a great insight into these companies and their innovation processes, which can explain the relatively limited empirical collection in the case section, in which there is only conducted two interviews in two of the three companies.

It could have been interesting if the author had used the insight to more explicitly describe and analyse the innovation processes and the challenges in these, either by using the information from the workshops or from more interviews. There appears to be an untapped potential in the present empirical, which "waits for" to be described and conceptualized.

The author has chosen to analyse the complex and heterogeneous processes in the front of the innovation processes, based on socio-technical approaches to innovation. These approaches are good at mapping and analysing the dynamics and the complex interaction between the various entities in the processes. The use of Clarke's Situational Analysis and Actor Network Theory, contribute a well placed openness and sensitivity needed to capture the complex processes.

In relation to Actor Network Theory, a more extensive discussion of the translation concepts, as well as a clear emphasis on the difference between ANT as method and theory could have contributed with clarity. The situational approach of Clarke plays a key role in framing a new conceptual approach, so it would have been appropriate for an expression of these concepts. An unfoldment that would have supported the subsequent construction of the new concept and the readers' understanding of it.

Paper three: ´Three perspectives on managing Front end innovation: Process, knowledge and translation.

The paper is an analysis of the case companies through the three different perspectives derived from literature and discusses implications of using the perspectives and related models to manage FEI. The analysis reveals a dominant use of process models in approaching FEI but also finds a knowledge perspective that can extend the limitations of process models. Furthermore, the investigations reveal an emerging perspective of translation that is able to integrate the different managerial approaches to become strategic elements in navigating situated spaces of actors and models in FEI.

Paper four: ´Conceptualising a model for Front End innovation: Navigating and translating processes in innovative spaces.

In this paper, the author collects the knowledge gained through the three analytical steps and develops, based on case analyses, a synthesising discussion of how Front end innovation is presented in the literature. The different innovation frameworks and models are presented and discussed which is useful for understanding the limitations in the dominating frameworks and how the influence innovation in making. The author analyses the use of Front end models in the case companies. Against this background, a conceptualization of Front end innovation is developed from a translation perspective. The article shows how the complex and heterogeneous processes can be understood through the actor network perspective as a translation of networks, as a network perspective that breaks with the structural understanding of network as fixed and predetermined and instead explains networks as interactive processes.

The model takes processual perspective that affects the perception of agency and how innovations progress, where innovation is seen as both a result and a process of experimentation. Innovation is seen as an enactment of relations with human and non-human relations. This understanding forms the basis for developing a concept of innovative spaces, strongly inspired by (Clausen et al), which provides the basis for developing a model for Front end innovation that describes the innovation process and the interaction between human and non-human actors as translation of the network over time through the processes of creative destabilisation and constructive stabilisation.

The conceptual model, based on an actor's network perspective, distinguishes itself through the use of sensitive concepts capable of understanding the complex and heterogeneous process that characterizes innovation processes, interaction between actors and things, as well as the ability to navigate in these processes. By doing so, it represents an important step in our understanding and modelling of Front End innovations and idea management.

However, there are a number of critical issues related to translation of innovation as a translation into an innovation model, which is still unclear. The modelling of innovation proposed has some inherent challenges that makes a simple translation of the translation perspective into an action perspective problematic. Consequently, there is a need for a critical reflection of the translation perspective and how it can be transformed into innovation practices.

Quality of The Thesis Language and presentation.

The candidate has proven to have developed good academic writing skills as demonstrated in the chapters and the papers. Overall the quality of the language is good and the thesis is well presented. The quality of writing is good and overall the dissertation goes fluently, keeping high attention of the reader and communicating well the methodology, the various steps of research and conclusions.

Summery

Overall, the thesis deals with an important issue in Front end innovation. The dissertation has a good structure that provides a good understanding of the research logic underlying the PhD work, as well as a good presentation of how understanding and knowledge develop through the research process. The dissertation gives a well-informed insight into the research process of and the learning and development process that is part of research journey of the PhD process. The traditional structural perspective on innovation is enriched by seeing innovation as social processes and trough the research journey the researcher develops a third perspective on innovation as translation processes.
The dissertation is based on an interesting and creative research design that combines a state of art analysis of innovation literature with a study of innovation practitioners and case studies of innovation in industrial companies. Especially the practitioner study is methodically interesting due to its foundation in interactive research tradition, but also the combination of the study with state of art analysis and company studies opens up interesting aspects of innovation work and identification of a third innovation perspective that by the author is named “Translation perspective”.

The research design creates new insight and knowledge, but there seems to be untapped potential in both the theoretical framing and the empirical material that could have been better achieved. Material that it would be obvious to use in further work.

At the outset the committee had a positive approach towards the written thesis, but had questions about the following themes

1. Design and participatory innovation theory and methodology form an important part of the explorative study methodology. What is the strength of these methods seen in terms of creating knowledge about innovation processes?

2. Understanding innovation as complex and heterogeneous processes plays a key role in the development of research methodology. How are these processes expressed in empirical ways and how could these be incorporated into the analysis possibly through the use of complementary concepts and methods?

3. What are challenges in the three chosen companies seen from a case study perspective?

4. The development of a new conceptualization of Front end innovation is based on actor network theory. What is the basis for the chosen way of incorporating actor networks into the innovation model and what are the challenges of modelling and setting up innovation models using ANT?

Conclusion.

At the defence Anna Rose Vagn Jensen dealt very well with the questions from the committee and demonstrated a mature reflection of her work. Based on the thesis as well as on the oral presentation and following discussion, the assessment Committee recommends the Academic Council at Aalborg University to reward Anna Rose Vagn Jensen with the PhD Degree.

John Bessant

Henry Larsen

Søren Kerndrup

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Dato: 23. juni 2017

Til Forskerskolen
Att.: Lisbeth Diinhoff
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Vedrørende tildeling af ph.d.-grad til Christian Schou Oxvig

Institut for Elektroniske Systemer indstiller at bedømmelsesudvalgets indstilling følges således at Christian Schou Oxvig tildeles ph.d.-graden for sin ph.d.-afhandling "Algorithms for Reconstruction of Undersampled Atomic Force Microscopy Images". Forsvaret fandt sted d. 12.06.2017.

Professor Torben Larsen har været hovedvejleder for Christian Schou Oxvig.

Med venlig hilsen

Børge Lindberg

Institutleder

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Final assessment of the PhD thesis entitled:

Algorithms for Reconstruction of Undersampled Atomic Force Microscopy Images

Submitted by Christian Schou Oxvig, M.Sc. in Signal Processing and Computing

The assessment committee consists of the following members as decided by the Dean of the Faculty of Engineering and Science on 19-04-2017:

- Senior Principal Research Scientist Petros T. Boufounos, Mitsubishi Electric Research Laboratories, USA, E-mail: petros@boufounos.com
- Professor Lars Kai Hansen, Department of Applied Mathematics and Computer Science Technical University of Denmark, E-mail: lkai@dtu.dk
- Associate Professor Zheng-Hua Tan (chairman), Department of Electronic Systems, Aalborg University, E-mail: zt@es.aau.dk

Supervisor for the thesis has been Professor Torben Larsen, Department of Electronic Systems, Aalborg University.

Co-supervisor for the thesis has been Associate Professor Thomas Arildsen, Department of Electronic Systems, Aalborg University.

Description of the thesis
The thesis is written in English and is structured as a collection of scientific papers and a technical report, which are preceded by an extended summary. The extended summary presents the background, overview, and perspectives on exploring the main hypothesis and the aims laid down for the thesis work as well as summarizes the contributions and conclusion of the thesis. The main body of the thesis consists of 222 pages.

The thesis is based on a collection of papers and a technical report, whose details are listed as follows:

A. T. Arildsen, C. S. Oxvig, P. S. Pedersen, J. Østergaard, and T. Larsen, "Reconstruc- tion Algorithms in Undersampled AFM Imaging", *IEEE Journal of Selected Topics in Signal Processing*, vol. 10, no. 1, pp. 31–46, Feb. 2016. doi:10.1109/JSTSP.2015.2500363
B. C. S. Oxvig, T. Arildsen, and T. Larsen, "Structure Assisted Compressed Sensing Reconstruction of Undersampled AFM Images", *Ultramicroscopy*, vol. 172, pp. 1–9, Jan. 2017. doi:10.1016/j.ultramic.2016.09.011
C. C. S. Oxvig, T Arildsen, and T. Larsen, "Entrywise Squared Transforms for High Dimensional Signal Reconstruction via Generalized Approximate Message Passing", submitted to *IEEE Transactions on Computational Imaging*.
D. C. S. Oxvig, P. S. Pedersen, T. Arildsen, J. Østergaard, and T. Larsen, "Magni: A Python Package for Compressive Sampling and Reconstruction of Atomic Force Microscopy Images", *Journal of Open Research Software*, vol. 2, no. 1, p. e29, Oct. 2014. doi:10.5334/jors.bk
E. P. S. Pedersen, C. S. Oxvig, J. Østergaard, and T. Larsen, "Validating Function Arguments in Python Signal Processing Applications," in *Proceedings of the 15th Python in Science Conference*, Austin, Texas, USA, Jul. 11 – 17, 2016, pp. 106–113. http: //conference.scipy.org/proceedings/scipy2016/patrick_pedersen.html
F. C. S. Oxvig, T. Arildsen, and T. Larsen, "Storing Reproducible Results from Com- putational Experiments using Scientific Python Packages", in *Proceedings of the 15th Python in Science*

Conference, Austin, Texas, USA, Jul. 11 – 17, 2016, pp. 45–50. http://conference.scipy.org/proceedings/scipy2016/christian_oxvig.html

G. C. S. Oxvig, T. Arildsen, and T. Larsen, "Generalized Approximate Message Passing: Relations and Derivations", Department of Electronic Systems, Aalborg University, Tech. Rep., Apr. 2017. doi:10.5278/VBN.GAMPTechReport.

Assessment of the thesis

The thesis aims to establish models of AFM images and design structure exploiting reconstruction algorithms that are specifically tailored for the undersampled AFM image reconstruction problem and have sufficiently low computational- and memory requirements to make it feasible to implement them on standard computation platforms. It is based on the following hypothesis: For a fixed number of measurements, undersampled AFM images may be reconstructed to superior quality using algorithms that exploit statistical information in a structured sparse model of the AFM images compared to algorithms that only rely on a sparse model. The thesis achieves this by weighting the sparse reconstruction algorithms. The thesis further studies alternative reconstruction algorithms, such as total variation and simple interpolation. These algorithms are studied in the context of realizable sampling patterns for AFM systems. The main contributions of the thesis include 1) practically applicable reconstruction methods that exploit structured signal sparsity and 2) methods and guidelines for implementing best practices to ensuring correctness and reproducibility of computational results in a scientific Python workflow. The thesis work confirms the main hypothesis namely it is possible to use statistical information in a structured sparse model of AFM images to obtain superior reconstructions of undersampled AFM images as compared to CS sparsity only exploiting reconstruction methods. The thesis is well written and thoroughly describes the scientific contributions of the thesis and at the same time presents its strengths and weaknesses.

The thesis is based on a collection of six papers and one technical report, preceded by an extended summary. The extended summary provides a comprehensive introduction of the problem, presents the state-of-the-art for the research work, summarizes the background of all the methods investigated, and places the results in context. The summary thoroughly discusses the six individual scientific papers and the technical report and nicely ties them together. It is very coherent and well written. The extended summary, with a bibliography of 147 entries, provides extensive references on all aspects of the problems addressed. Furthemore, it provides solid conclusions with guidelines for implementing the results in practice. In that context, it has an honest discussion of the surprising result that, often, simple linear reconstruction exhibits the same performance as more sophisticated methods, at a fraction of the computational cost.

The first six papers, which are also the academically most significant papers, are selected for mini-reviews as detailed as follows.

Paper A:

This paper forms a big part of the core algorithmic and theoretical development in the thesis. Overall it is a very nice and extensive work, studying the scanning patterns as well as the reconstruction algorithms for undersampled atomic force microscopy (AFM).

The paper explores two sampling patterns, spiral and raster, and demonstrates the performance of different reconstruction methods. The patterns chosen are suboptimal from a theoretical compressed sensing (CS) perspective. However, practical AFM systems cannot easily realize the theoretically desired patterns or measurement systems. Thus, the patterns used are reasonable choices given the constraints. Unfrotunately, such patterns exhibit high coherence with some sparse transforms that are known to describe images well, such as the discrete wavelet transform (DWT). The coherence creates a problem in the reconstruction and, as expected in hindsight, DWT-based methods do not perform as well as total-variation (TV) minimization ones.

Simulation results, based on AFM cell images, show that the combination of a simple raster scanning pattern and conventional image interpolation enables a reduction by a factor 10 of the scanning time while retaining an average reconstruction quality around 36 dB PSNR on the tested images.

A surprising but very interesting result is that more classical interpolation methods perform as well as state of the art sparse methods in this problem. The paper suggests that the coherence issues in the sampling patterns are the probable cause for the inability of the sparse methods to perform better.

The results indicate that future work should be focusing on the sampling pattern, as well as on the reconstruction models. The note, R. Willett. "Errata: Sampling Trajectories for Sparse Image Recovery." 2011, http://willett.ece.wisc.edu/wp-uploads/2016/01/TrajectoryErrata.pdf, which discusses a similar problem in the context of MRI, demonstrates the difficulty of this endeavor—by demonstrating errors in earlier development by the same author—and proposes some possible promising paths.

Paper B:

This paper expands on Paper A, by examining the structure of the AFM images in the discrete cosine transform (DCT) coefficients and demonstrating the effectiveness of proper weighting of the reconstruction algorithm. As evident in the results, incorporation of a weighting factor in the algorithms improves reconstruction performance.

While the paper provides extended discussion on how the weights are selected, it does not provide a discussion on what are the guiding principles on selecting the weights. In general, the weights should reflect the change of magnitude in the coefficients in higher frequencies, as the authors discuss, but also the change of the sparsity level, as discusse, e.g., in [Mansour, H.; Yilmaz, O., "Support driven reweighted l1 minimization", *Proc. of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, March 2012.]. A more exhaustive discussion can be found in [Mansour, H.; Saab, R., "Recovery Analysis for Weighted l1 Minimization Using the Null Space Property", *Applied and Computational Harmonic Analysis*, Vol. 43, No. 1, pp. 23-28, March 2016.] and references within.

Paper B nicely demonstrates the effectiveness of weighted minimization in improving the results using a heuristic approach. Future work could investigate the optimal way to set those weights, maybe using some of the results from the references above. As with Paper A, the experimental work in this paper is extensive and provides very useful intuition and results.

Paper C:

This paper is abstracted from the AFM problem, even though the motivation for the development originates in measurement matrices that also occur in the context of AFM. The paper examines Generalized Approximate Message Passing (GAMP) as a reconstruction algorithm in systems for which fast matrix-vector multiplications can be implemented using fast transforms, such as the DCT.

GAMP requires the computation of certain factors involving element-wise manipulation of the coefficients of the measurement operator—not available in fast transforms. The paper theoretically demonstrates that through a certain factorization these factors can be efficiently computed and used in the algorithm. Prior work in the field attempts to bound or approximate those factors, often resulting in suboptimal performance under certain conditions.

The work has broader impact, beyond AFM, and significant applicability in a range of problems. As with the previous two papers, there are extensive experimental results demonstrating the effectiveness of the approach, as well as the range of parameters in which simpler approximations perform as well.

Paper D:

This is one of the two papers focusing in the reproducibility and the replicability of the results. It is a commendable effort to provide code and software to the broader community, ensuring that the output of this project can be used in practice. Unfortunately, such efforts are rare in the wider community and should be promoted and rewarded. It is evident that the effort that went into this development is significant and notable. This effort increases the likelihood that the project and its deliverables will have a broad impact.

Paper E:

This paper proposes an application-driven input validation scheme for languages with dynamic typing, such as Python. This schemes enable more informative run-time errors when assertions and assumptions are violated. The advantage of the proposed method is that the validation is not based on type alone, but also on constraints on the expected input, such as its range, its shape, etc. This allows for more refined assertions, compared to compile-time errors resulting in statically-typed languages. It further allows for greater type flexibility, e.g., allowing both integer and floating point inputs, as necessary, without causing errors. This behavior is consistent with the philosophy of dynamically-typed languages and, also, very useful in signal processing applications.

Paper F:

This paper is the second focusing on the reproducibility of the results. As with paper D, this is a commendable effort increasing the likelihood that the project will have wider impact in the community. This paper focuses on data and metadata management, realizing that the computational environment plays a significant role in the reproducibility of the results. The paper provides a solution to store metadata about the computational environment together with the experimental data and the experiment output. Thus, the data storage carries information on how the data has been generated, such that the experiment can be easily reproduced.

Oral presentation and discussion
Date and place of the oral defence: June 22, 2017, Fredrik Bajers Vej 7B/3-104, 9220 Aalborg, Denmark

The presentation appropriately covered the thesis contents. Slides were well prepared, timing was perfect, and his general presentation skills were excellent. The candidate was very comfortable and well paced. At the questioning session Christian Schou Oxvig answered the questions clearly and precisely, and demonstrated solid knowledge of his field. Overall, the committee found that both general and specific questions were handled very well.

Conclusions
Overall this is an excellent thesis and oral defense. The committee finds the contributions are original and scientifically significant. Furthermore, the efforts on reproducibility are exemplary. The committee unanimously recommends that Christian Schou Oxvig is awarded the PhD degree.

Senior Principal Research Scientist Petros T. Boufounos	Professor Lars Kai Hansen	Associate Professor Zheng-Hua Tan
Boufounos Petros		Zhua Tan
22-06-2017	22-06-2017	22-06-2017

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København, den 15. juni 2017

Vedrørende tildeling af Ph-d grad til Erik Sikström

Det bekræftes hermed, at Institut for Arkitektur & Medieteknologi tilslutter sig bedømmelsesudvalgets indstilling om tildeling af Ph-d graden til Erik Sikström.

Med venlig hilsen

Hans Jørgen Andersen

Institutleder
Institut for Arkitektur & Medieteknologi

AALBORG UNIVERSITY
DENMARK

Assessment of the PhD thesis entitled:

The Self and Sound in VR

A collection of studies investigating the experience and influence of interactive audio in relation to the user, in immersive virtual environments

Submitted by Erik Sikström, M.Sc. in MSc in Audio Engineering

The assessment committee consists of the following members as decided by the Dean of the Technical Faculty of IT and Design on 19 Oct 2016:

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Dept. of Architecture, Design and Media Technology
Medialogy Section, Lighting Design
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Supervisor for the thesis has been Prof. Stefania Serafin, Aalborg University.

Co-supervisor for the thesis has been Assoc. Prof. Amalia de Götzen, Aalborg University.

Description of the thesis

The main body of this thesis consist of the following papers.

[A] Sikström, Erik and Laursen, Morten Havemøller and Pedersen, Kasper Søndergaard and De Götzen, Amalia and Serafin, Stefania, "Participatory amplitude level adjustment of gesture controlled upper body garment sound in immersive virtual reality", Audio Engineering Society Convention 136, 2014.

[B] Sikström, Erik and De Götzen, Amalia and Serafin, Stefania, "The role of sound in the sensation of ownership of a pair of virtual wings in immersive VR", Proceedings of the 9th Audio Mostly: A Conference on Interaction With Sound, pp. 24, 2014.

[C] Sikström, Erik and De Götzen, Amalia and Serafin, Stefania, "Self-characterstics and sound in immersive virtual reality—Estimating avatar weight from footstep sounds", Virtual Reality (VR), IEEE, pp. 283–284, 2015.

[D] Sikström, Erik and De Götzen, Amalia and Serafin, Stefania, "Wings and flying in immersive VR—Controller type, sound effects and experienced ownership and agency", Virtual Reality (VR), IEEE, pp. 281–282, 2015.

[E] Sikström, Erik and De Götzen, Amalia and Serafin, Stefania, "Avatar weight estimates based on footstep sounds in three presentation formats", Sonic Interactions for Virtual Environments (SIVE), 2015 IEEE 2nd VR Workshop on, pp. 1–6, 2015.

[F] Sikström, Erik and Nilsson, Niels Christian and De Götzen, Amalia and Serafin, Stefania, "Is this bridge safe? Evaluation of Audiovisual Cues for a Walk on a Small Bridge Over a Canyon", Virtual Reality (VR), 2016 IEEE, pp. 285–286, 2016.

[G] Sikström, Erik and Høeg, Emil Rosenlund and Mangano, Luca and Nilsson, Niels Christian and De Götzen, Amalia and Serafin, Stefania, "Shop'til you hear it drop: influence of interactive auditory feedback in a virtual reality supermarket", Proceedings of the 22nd ACM Conference on Virtual Reality Software and Technology, pp. 355–356, 2016.

[H] Sikström, Erik and Geronazzo, Michele, and De Götzen, Amalia and Serafin, Stefania, "Evaluation of individually selected HRTFs for an immersive virtual reality experience, and comparison with a generic HRTF and stereo", (Submitted to the) Audio Engineering Society Convention 143, 2017.

This thesis focuses on the role and experience of audio in immersive VR, and in particular in VR simulations where a user has some form of body representation in the virtual world. The research conducted for this thesis amounted in eight publications that investigate different issues related to the experience of audio in relation to the user. There is also a list of nine other publications not included in the thesis.

The 114 page thesis falls in two parts. The first part provides an introduction to the topics of the research and an overview of the background work. The main body of the research work is presented in the form of eight scientific papers (8 conference papers). All publications have Mr Sikström as the first author. There are signed

co-author statements for all published papers generally accrediting Mr Sikström as the main contributor to the work.

Part I

In the first part Mr Sikström introduces the topic of his thesis, discusses background information and research questions, as well as his research findings, future work and conclusions in 5 chapters. More specifically, it contains an introduction chapter which starts off with a short description of Mr Sikström's personal motivation for studying this topic. After that, follows an extended literature review that covers the background and related theory that covers the topic of sound in virtual reality, and particularly sounds that are produced with movements and actions. The second chapter discusses the implementation and evaluation of virtual self-sounds, in order to provide a technical description of how these have been developed for the studies included in the thesis. The third chapter describes the research questions addressed in the thesis, and the fourth chapter provides a summary of all the included publications. The fifth chapter lays out a further discussion of the results, future research and the conclusions.

Part II

The assessment committee has selected five which are the academically most significant papers of Mr Sikström and includes a mini-review of these in the current assessment:

Paper A: This paper approached the question of how the sound amplitude level mixing of self-produced sounds could be possible in an immersive virtual reality context. An experiment was conducted where users of an immersive virtual reality were asked to set the highest and lowest acceptable amplitude levels of the sounds generated by a virtual upper body garment controlled by the participants' own upper body movements. These movements were tracked by a motion capture system. The results provided a possible dynamic range for the possible values of the clothes sound. This range was set at a higher level when the participants started the level adjustment task with the sounds played from the highest possible level, than when the sound level was initially set to the lowest possible.

Paper B: This paper describes an evaluation of the role of self-produced sounds in participants' sensation of ownership and control of virtual wings in an immersive virtual reality scenario. The participants were asked to complete an obstacle course flight while exposed to four different sound conditions. The experiment resulted in very small differences between the experimental conditions, except for the case in which the sonification of the wings is included.

Paper D: An experiment investigated the perception of ownership and agency of a pair of virtual wings attached to the participant's avatar. The avatar is controlled by the participant's movements in an immersive virtual reality scenario. Two groups of participants controlled the wing movements with two different modalities: (i) a hand-held video game controller, and (ii) a rigid body tracking shoulders movement. The participants evaluated their experienced embodiment of the wings on a body ownership and agency questionnaire. The results show significant differences between the two control modalities.

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Assessment of defence

Presentation was concise, clearly giving a good overview of the work and the approaches taken. The presentation was well structured and illustrated with media content. During the discussion phase of the defence, the candidate performed well and was able to participate in the discussion in a comprehensive and reflective way, demonstrating a good knowledge of the important aspects of the field of research covered in the thesis.

Conclusions

Considering the above assessment, the PhD committee unanimously recommends that Mr Erik Sikström is awarded the PhD degree.

Copenhagen, 15 June 2017

Professor Tapio Takala

Professor Roberto Bresin

Associate Professor Georgios Triantafyllidis

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Dato: 30-06-2017

The Technical Doctoral School of It and Design
Niels Jernes Vej 10
9220 Aalborg Øst

Vedr.: Indstilling til ph.d. grad "Contextual Aspects of Smart City Energy Systems Analysis. Mothodology and Tools", Jakob Zinck thellufsen, Institut for Planlægning

Hermed fremsendes bedømmelsesudvalgets Final Assessment vedr. ovennævnte ph.d. afhandling.

Instituttet anbefaler, at bedømmelsesudvalgets indstilling følges, og at Jakob Zinck Thellufsen tildeles ph.d. graden.

Med venlig hilsen

Marianne Sørensen

AALBORG UNIVERSITY
DENMARK

Final assessment of a PhD thesis

14 June 2017

Final assessment of the PhD thesis entitled:

"Contextual Aspects of Smart City Energy Systems Analysis. Methodology and Tools."

Submitted by Jakob Zinck Thellufsen, M.Sc. in Sustainable Energy Planning and Management

The assessment committee consists of the following members as decided by the Dean of the Technical Faculty of IT and Design by 7 April 2017:

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Supervisor for the thesis has been Professor Henrik Lund, Aalborg University.

Description of the thesis

The thesis consists of three parts: 1) a 82-page extended summary; 2) an appendix with a collection of 4 research papers; and 3) an appendix with 2 reports outlining the design and documentation of the MULTINODE software tool for EnergyPLAN. Part 2 consists of the following research papers:

Paper 1: Energy saving synergies in national energy systems, Jakob Zinck Thellufsen and Henrik Lund, *Energy Conversion and Management* 103 (2015) 259–265, printed.

Paper 2: Roles of local and national energy systems in the integration of renewable energy, Jakob Zinck Thellufsen and Henrik Lund, *Applied Energy* 183 (2016) 419–429, printed.

Paper 3: Cross-border versus cross-sector interconnectivity in Renewable Energy Systems, Jakob Zinck Thellufsen and Henrik Lund, *Energy* 124 (2017) 492–501, printed.

Paper 4: Multi-model approach to analysing heating systems in low carbon energy systems: The case o Ireland , Jakob Zinck Thellufsen, David Connolly, James Glynn, John Paul Deane, Henrik Lund, Brian Ó Gallachóir, 2017, raw manuscript.

Jakob Zinck Thellufsen is the first author of all papers and reports submitted together with the thesis. According to the co-author statements, Jakob Zinck Thellufsen has done the bulk of the analyses and draft writing in all research papers. The co-authors have mainly contributed to the framing of the research problems in the papers as well as with providing comments and feedback during the writing process. Additionally, paper 4 builds on previous modeling results provided by some of the co-authors.

Based on the concepts of smart cities and smart energy systems, the thesis defines the concept of smart city energy systems (SCES). The thesis defines SCES as urban energy systems where the integration of electric, thermal, and gas grids is essential to achieving the most efficient energy systems for the city. SCES focus on improving the individual energy sectors, but also on increasing the flexibility of the urban energy system through the integration of the energy sectors. The thesis proposes that SCES do not necessarily require energy production, but must provide the energy required by the inhabitants efficiently based on the concepts of system integration. In addition, the thesis raises the issue of resource and fuel limitations in sustainable energy systems, and suggests that a sustainable city must consider its resource use in order not to limit the opportunities of other cities to become more sustainable. Thus, it is postulated that a vital part of SCES is the acknowledgement of the importance of two contextual aspects: the system integration context of smart cities and the geographical context of smart cities.

For the investigation of the system integration context of SCES and the design of SCES in general, the thesis suggests and demonstrates an approach by which system integration is measured against traditional energy systems. The impact on the energy system design, and the implementation of a single technology, are assessed through energy systems analysis of a systematic implementation of the given technology. It is shown how with a continuous measure of the performance of the energy system, the consequences of the implementation of the given technology in a smart city energy system can be identified. Using the examples of heating technology, electricity and heat savings, the thesis shows that system integration is more efficient than systems not including system integration. Another major result is that system integration influences the performance of these and potential other technologies in a smart energy system. Due to system integration, the optimum capacity and performance of single technologies can be identified. The contextual aspect of system integration is therefore crucial for the energy planner in terms of understanding the performance of the system and for the implementation of the right amount of a certain technology, as the integrated energy systems are more sensitive to changes.

Methodologically, the thesis identifies the need for an analytical tool that can be able to model the city's energy system, can be able to focus on system integration and should be able to analytically link energy systems with each other. One of the main outcomes of the thesis is the development of a new tool that can fulfil these requirements to investigate the geographical context of SCES. The MultiNODE tool is developed as an add-on to EnergyPLAN and uses the EnergyPLAN framework to identify hours in which an energy system produces electricity it cannot utilise itself, as well as other hours where the energy system has insufficient capacity or uses inefficient power plants. The surrounding energy systems are subjected to the same analysis and through a network, the tool matches these periods to find situations in which excess electricity can be transferred from one system to another. The concept allows for the investigation of interconnection, based on the principles of smart energy systems, applying a technical energy system performance point of view.

Regarding the geographical context of SCES the thesis emphasises that the performance of the local energy system must be seen in relation to how it affects the performance of the surrounding energy system. Therefore, it is stressed that the geographical context of SCES should be assessed at least from two perspectives: i) from the perspective of overall resource use and ii) from the perspective of system integration and system interaction. The two perspectives are investigated through a case study of the municipalities of Copenhagen and Sønderborg and the performance of their energy and climate strategies within the context of a renewable

Danish energy system. Based on hourly simulations in EnergyPLAN and MultiNODE, the study shows that an uncoordinated plan that does not take the geographical context into account can result in sub-optimisation in terms of resource use and integration between the local and national energy system.

To combine and discuss the two contextual aspects, the thesis investigates the benefit of system integration in relation to system interconnection – a two-dimensional approach – in the case of two archetypical energy systems, a northern and a southern system. From this, the study shows that when investigating smart energy systems, this approach helps identify how variable renewable energy is best utilised, since it can either be used through system integration or exported to the surrounding energy system. It is shown, that the two-dimensional approach can potentially reveal that it is better to go for system integration than system interconnection in several cases. On the level of SCES, the thesis underlines that combining a system integration with a system interconnection perspective can potentially lead to positive synergies, as for instance, a better system integration can lead to a better and more flexible system integration of SCES.

Assessment of the thesis

The 4 research papers, 2 reports and the extended summary demonstrate high quality as well as appropriate quantity for a PhD thesis. They form a logical and coherent path to address a sequence of meaningful and important research questions.

The content and conclusions of the thesis concern the theoretical definition of, methodological development for as well as presentation of exemplary cases for Smart City Energy Systems Analysis. Specifically, the thesis can be divided into three main research themes:

- Methodology and tools suitable for smart city energy systems analysis
- The system integration context of smart city energy systems (SCES)
- The geographical context of SCES

Chapters 1 and 2 introduce the main research problems, concept definitions and structure of the thesis. The three main research themes are also outlined in the chapters. The thesis takes point of departure in an interesting and important research problem: the growing body of various and differing definitions of smart and/or sustainable cities, which lead to the question of what actually makes a city "smart" in general, and in particular, what makes a city's energy system "smart". Based on a broad and relevant review of the existing literature, the need to understand and analyse smart cities and their energy systems as dependent on at least two contextual conditions is identified in Chapter 1. A clear and coherent problem statement is presented that provides a strong basis for the subsequent analyses: *"What methodologies and tools are suitable to analyse smart city energy systems? And how should they be able to assess the smart city energy system and its contextual aspects?"*. The problem statement's focus on three main research themes provides for a clear analytical structure in the thesis, according to which the research themes form the basis for the chapters in the extended summary. The four research papers and the appendix are logically linked to the chapters, which results in an overall clear link between extended summary and the appendices.

The key concept of "Smart City Energy Systems" is defined in Chapter 2. To this end, the concepts of *smart energy systems* and *smart cities* are investigated and combined to offer a definition for SCES and their context as an analytical basis for the thesis. In terms of smart energy systems, the thesis builds on definitions presented in the existing literature, and emphasizes the necessary flexibility in these energy systems that integrate renewable energy into, both, smart electricity, thermal and gas grids. In terms of the smart city concept, it is interestingly stated that: "there exists no clear and consistent understanding of the concept". Energy systems are in any case identified as critical infrastructural parts of smart cities, and the lack of clear guidelines for how to design energy systems for smart cities is presented as an important challenge. Even though the general difficulty of making such design guidelines is acknowledged, the thesis offers a broad definition of SCES, according to which the identification of smart ICT solutions, stemming from the smart cities concept, should help 100% renewable energy systems for cities. It is an important research contribution that

the thesis suggests a first, analytical definition of SCES and offers a number of initial analytical parameters in this regard. Most importantly, it is suggested that SCES should consider cities' entire energy systems, thus focusing on the *system integration context* in order be flexible enough to integrate more renewable energy. Secondly, the *geographical context* of SCES is emphasized as an important analytical parameter, as cities typically only host and design parts the energy system necessary to achieve a completely 100% renewable energy supply. Therefore, the smart city energy system will often expand beyond the geographical boundary of the city, but should be included in the SCES concept.

Chapter 3 of the thesis contains a review of tools which allow for an analysis of smart city energy systems as well as an analysis of connections of systems and the contextual aspects. After a good discussion on the requirements of such a tool, a detailed description of TIMES, Sifre and EnergyPLAN is provided. In Chapter 4, the contextual aspects of smart city energy systems are analysed. This includes a description of the geographical context. The analysis using EnergyPLAN for Sønderborg, Aalborg and Copenhagen is discussed in some detail, and the differences between the studies for various cities are outlined. This chapter also contains a description of the shortcomings of existing studies.

Details of MultiMODE are described and discussed in Appendix A. The MultiMODE tool is designed in a way that enables a coupling between different EnergyPLAN models for cities, and basically it is based on the same technical principles as EnergyPLAN. The tool provides a possibility to put the planning of SCES into a geographical context. In order to set up a framework that works using the same technical principles as EnergyPLAN it is important to understand the options the user has in tweaking the technical simulation strategy in EnergyPLAN. The goal of the MultiMODE tool is to utilize the excess electricity from each EnergyPLAN area to express the electricity that can be offered to the grid. EnergyPLAN seeks to limit the use of boilers and power plants with the goal of utilizing more efficient energy sources, such as CHP or renewable energy. MultiMODE is seeking the same goals for the overall system. Hence, in situations where a system relies on power plant production, but excess electricity from other areas is available, MultiMODE seeks to turn off or reduce the power plant production and instead use the excess electricity from the other system. A possibility of ramping up the combined heat and power production in one area to replace power plant production in another area is also discussed, since this would give an overall better degree of system efficiency.

Given the way the MultiMODE is set up provides a simple framework in the case of two systems, since it basically is building on an hourly simulation of both systems, and for each hour it is checked to see if the systems produce excess electricity. However, for the case of more than two connected systems the setup gets more complicated. The linking of several systems is dependent on a determination of a merit order, and the definition of a network structure for the connection of the individual systems. In order to study the electrical grids both meshed networks and star networks are considered. However, the current MultiMODE implementation contains only the star network. Regarding the merit order of delivering electricity the thesis contains a description of three different approaches, and a discussion about the pros and cons is provided. For the moment only the case where the user defines the merit order is implemented in MultiMODE.

Finally, it is mentioned that the storage option is not yet implemented in MultiMODE, but the possibilities are discussed in the thesis. In general, the thesis very well describes the perspectives relevant for an analysis of connected smart cities and energy systems of different scales in what is called a smart city energy system. The concepts of demand side response have not yet been addressed in this discussion, and could have been another relevant analytical perspective. In the further work with MultiNODE, it can be considered how this perspective can be included. Appendix B in the thesis contains a well written and nicely illustrated documentation for the MultiMODE system. Also, some of the key equations for the current implementation are found here.

Chapter 5 describes a multi-model approach for the investigation of heating scenarios in Ireland and how energy saving methods may interact with each other in a smart energy system. The goal of the first part of the chapter is the analysis of the heating sector in Ireland, comparing individual heating with district heating from an energy and economic point of view. To overcome the limit of the Irish TIMES software, concerning the simulation of the district heating, a multi-model approach is chosen, linking Irish TIMES and EnergyPLAN. In Annex F, an accurate description and comparison of the two software has been provided. TIMES is based on a

linear optimization. The tool is based on a user defined database of technologies and it chooses the least cost pathway to the given political target within user-defined number of years. EnergyPLAN, instead, is a deterministic model and the user should then manually carry out any kind of optimization. It is used in this sense to provide insight into the district heating option. Moreover, it can perform an hourly simulation, illustrating the dispatch behavior of the energy system.

In Paper 4, the different approaches for the Irish energy system simulation (considering the Irish TIMES model with 80% reduction in CO2 emissions compared to 1990 and the EnergyPLANmodel for Ireland based on 100% renewable smart energy system) are presented: different solutions due to different targets, different models and different inputs of the tools under investigation are shown. The important contribution of the work is the development of a methodology to link EnergyPLAN with TIMES for the investigation of the heating sector, taking into account the advantages of both approaches. The procedure adopted shows that it is possible to replicate the Irish TIMES results in EnergyPLAN. In particular, for a reference scenario the comparison of the outputs in terms of fuel consumption, CO2 emissions and electricity import has shown good agreement. The possibility to include district heating in the reference scenario has been considered and a comparison with the individual heating solution has been performed. The results provide important insights: for the Irish case, the district heating leads to a more efficient energy system with lower annual costs compared to the solution with individual heating.

In the second part of chapter 5, based on Paper 1, the implementation of energy savings in a smart energy systems is discussed. The innovative contribution of the work is to consider energy savings as being system dependent. The energy system's effect on savings and the possible synergies between various type of savings across different sector are investigated. Two scenarios with the same number of energy systems are compared. The reference one considers a separate energy system for each type of savings (electricity and heat). The second scenario considers the savings in the same system, analyzing how the savings interact with each other. In order to perform the analysis and the comparison between the two scenarios EnergyPLAN is used. The methodology is applied to the case of Denmark in order to identify the benefits of combining heat and electricity savings in a current Danish system comparing it to two Danish systems that perform heat or electricity savings separately (combined heat and power plants versus power plant and boilers). The comparison has been performed also varying the heat and electricity demands, measuring the effects in terms of primary energy supply for both the systems. In particular, from the comparison between heat savings and electricity savings (the systems contained in the first scenario) it turned out that electricity savings are more efficient from a primary energy saving point of view. Moreover, the reduction of primary energy consumption is an increasing function of demand reduction. Apart from that, for the Danish energy system, the comparison between scenario 1 and 2 underlines how the synergy effect can improve the reduction of primary energy supply as a function of the energy saving percentage, except in one case. The methodology applied in the paper leads to an important step in the analysis of energy savings, highlighting that the energy system performance can be affected by the integration of (various types of) energy savings, and vice versa. It is important to notice that the same methodologies applied to a different energy system can lead to a different result, highlighting the importance to extend the methodology to other case studies.

Paper 2 presents an analysis of the geographical context of SCES, and forms the basis for Chapter 6 in the extended summary. In the paper, building on the problem of a lack of coordination between national and local energy planning, identified in previous research, the question of *how national energy plans should specify local actions, and how local energy plans should take surrounding, national energy system development into account* is investigated. A methodological approach is developed in which the new MultiNODE tool is used within EnergyPLAN to link two local Danish energy plans with a national smart energy system development, as outlined in the CEESA study. Apart from linking the two municipalities' existing plans for CO_2 neutrality to the national energy system, local reference systems for the two municipalities in line with the CESSA study are included as well in the analysis. As explained in Chapter 6, these two local reference systems can be considered resembling smart city energy systems, in comparison with the existing local plans. The geographical context is then analysed in terms of resource use and the ability of the local energy systems to integrate into the national system. This ability to integrate is measured in terms of *integrable* and *non-integrable* excess electricity, where a low amount of total excess electricity and/or a high share of integrable excess electricity in the linked systems

indicate a better ability to integrate and thus a better coordination between the local and national energy plan. Therefore, as an important academic contribution the paper offers a first approach to how local and national energy planning efforts can be coordinated on an analytical level. Based on the results the paper concludes that the offered methodology is applicable for "evaluating how well local and national energy systems integrate". It is, for instance, shown that the existing Copenhagen plan may lead to an overconsumption of national biomass resources and a higher amount of non-integrable electricity export, as compared to the SCES scenario for Copenhagen. In the case of Sønderborg, the existing plan performs roughly equal in terms of biomass use, but better in terms of non-integrable electricity export than the SCES counterpart for Sønderborg. As noted in the paper, in further studies it will be interesting to investigate possibilities for lowering excess production in these local energy systems to increase their ability to integrate with the surrounding energy system. On the way towards fully renewable energy systems it may also be relevant to consider how the introduction of local new peak demands, for instance through electric vehicles, can change the local systems' integration characteristics. Furthermore, it may be relevant to analyse how groups of municipalities, for instance on a regional level, integrate into the national system, as some imbalances could be handled already on the regional level, making this level of analysis perhaps also more convenient in terms of energy planning. For instance, "resource strong" municipalities may be adjacent to "urban centers" within the same region etc. Finally, as also indicated in the paper, it is very relevant to further consider if and how the presented methodological approach can feed into the concrete decision-making processes connected to local and national energy planning.

Paper 3 together with Chapter 7 elaborates on the combined significance of the system integration context and geographical context with a focus on two national energy systems. Both contextual aspects are defined as different forms of interconnectivity: the system integration context as improved internal interconnection between energy sectors in a smart energy system; and the geographical context as improved interconnection between (national) energy systems through transmission cables. The two types of interconnectivity can provide the necessary flexibility needed to ensure security of supply in energy systems that are going to be based on large amounts of weather-dependent renewable energy sources. However, the two approaches are often implemented without mutual coordination, and it is thus unclear to what extent they can limit or support one another technically. The starting point of paper 3 is thus, to perform a necessary comparative analysis of the energy system benefits of both types of interconnectivity separately and in conjunction, as this has not been documented before. To this end, existing, archetypical Northern and Southern energy systems and the effects of increasing their internal and mutual interconnectivity are analysed in a novel methodological approach applying the new MultiNODE tool within an EnergyPLAN environment. While, for instance, Blarke and Jenkins (2013)[1] have done a related analysis on a smaller scale and with a focus on current electricity market paradigms, the main novelty in the chosen approach in paper 3 is the comparison of entire energy systems and their potential interaction from a technical perspective, pointing to the fundamental technical potentials of cross-sector and cross-border interconnectivity. Specifically, the two types of interconnectivity are compared in terms of primary energy consumption and utilization share of installed renewable energy capacity. The findings indicate that while both types of interconnectivity improve the efficiency of the archetypical energy systems, by itself cross-sector integration leads to a better fuel efficiency than cross-sector interconnection. As a very important point for further ansalysis, the results thus indicate that "highly system integrated energy systems may have very limited benefits from cable transmission." Analyses of the type documented in paper 3 are necessary and important, informing the ongoing debate and research regarding the (re-)design of electricity and energy markets in general. In further research, it will be interesting to expand this new approach to, both, analyse different types of archetypes, as well as to include "real" countries energy systems and their (combined) future plans (on a e.g. the EU level). In Chapter 7, the findings from paper 3 are integrated with the findings from paper 1 and paper 2 (chapters 5 and 6) to stress that system integration at the city level is the preferable approach towards SCES, since it contributes to the overall flexibility and of countries' energy transitions. In that sense, the choice between cross-sector interconnectivity or cross-border interconnectivity

[1] Blarke MB, Jenkins BM. SuperGrid or SmartGrid: Competing strategies for large-scale integration of intermittent renewables? Energy Policy. 2013;58.

starts at the city level, since smart city strategies limit or expand the flexibility of the surrounding national energy system.

Chapter 8 is a concluding chapter, which presents the main results of the analyses conducted in relation to the thesis. In general, the conclusions are sufficiently supported by the results in the different analyses, thus leading to the conclusion that the main research themes outlined in the problem statement have been met. Additionally, in methodological and analytical terms, a few suggestions for further work are discussed. It is, for instance suggested to further refine MultiNODE to be able to take characteristics of specific energy systems and technologies and their impact on excess electricity exchange into account. Regarding the two-dimensional approach to energy systems analysis, the thesis suggests to apply the approach to analyse the benefits of system integration and system interconnection on a country-to-country and continent level, which is at least relevant given the trends in the EU.

Oral presentation and discussion
Date and place of the oral defence: 14 June 2017

The Ph.D. candidate delivered a good and clear presentation elaborating and refining the findings in the thesis.

In the scientific discussion, the following issues were addressed:

- The concept of "efficiency" in the thesis
- Cities as an analytical unit
- The two-dimensional concept of system integration and geographical context
- Discussion of various modeling tools including TIMES, EnergyPLAN and Balmorel
- The results and sensitivity of scenario modeling
- The potential role demand response and demand side management in modeling
- The spatial resolution concerning buildings vs. districts was discussed
- Modeling cross-sector and cross-country interconnectivity
- Recommendations for decision-makers

Jakob Zinck Thellufsen answered the questions asked by the assessment committee demonstrating broad and detailed background knowledge. All in all, the committee was impressed with the candidate's good ability to participate in a scientific discussion.

Conclusions
Jakob Zinck Thellufsen has written a coherent thesis, which documents relevant and well-structured research, combining different analyses to explore a number of interlinked and important research problems using and developing partially new methodological approaches. The committee therefore concludes that the Ph.D. Candidate fulfils all the requirements for the Ph.D. degree.

The committee unanimously recommends to Academic Council that Jakob Zinck Thellufsen is awarded the Ph.D. degree.

Dated and signed by all members of the committee

14 June 2017

Laura Vanoli | Henrik Madsen | Karl Sperling

AALBORG UNIVERSITET
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Dato: 23. juni 2017

Til Forskerskolen
Att.: Lisbeth Diinhoff
N.J. 10

Vedrørende tildeling af ph.d.-grad til Lars Møller Mikkelsen

Institut for Elektroniske Systemer indstiller at bedømmelsesudvalgets indstilling følges således at Lars Møller Mikkelsen tildeles ph.d.-graden for sin ph.d.-afhandling " Enhancing IoT Systems by Exploiting Opportunistically Collected Information from Communication Networks". Forsvaret fandt sted d. 22.06.2017.

Lektor Tatiana K. Madsen har været hovedvejleder for Lars Møller Mikkelsen.

Med venlig hilsen

Børge Lindberg

Børge Lindberg

Institutleder

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AALBORG UNIVERSITY
DENMARK

Final Assessment Report

Assessment of the PhD thesis entitled:

Enhancing IoT Systems by Exploiting Opportunistically Collected Information from Communication Networks

Submitted by Lars Møller Mikkelsen, M.Sc. in Electronics Engineering.

The assessment committee consists of the following members as decided by the Dean of The Technical Faculty of IT and Design on 15 March 2017:

- Professor Noel Crespi, Institut Mines-Telecom, Telecom SudParis, Paris Area, France, E-mail: noel.crespi@institut-telecom.fr
- Professor Laurent Schumacher, Faculty of Computer Science University of Namur, Belgium, E-mail: laurent.schumacher@unamur.be
- Associate Professor Troels Bundgaard Sørensen (chairman), Department of Electronic Systems, Aalborg University, E-mail: tbs@es.aau.dk

The main supervisor for this thesis has been Associate Professor Associate Professor Tatiana K. Madsen, Department of Electronic Systems, Aalborg University.

The co-supervisors for this thesis has been Professor Hans-Peter Schwefel and Associate Professor Rasmus L. Olsen, both Aalborg University.

Description of the thesis

The thesis focusses on the enhancement of internet of things (IoT) systems, by collecting information, which can make them truly smart and adaptable to the context they operate in, and not just operate based on a predefined set of rules or threshold values. The challenge pursued in the thesis is mainly how to measure and collect the information.

The thesis proposes how to obtain information about network performance and context, cost effectively, by opportunistically collecting it using automated approaches. Specifically, network performance information is collected using crowd sourcing measurements, and contextual information (people count) is obtained as estimations based on passively collected WiFi probes.

For the collection of network performance information, the thesis introduces a measurement system – NetMap - based on crowd sourcing. The system is used for characterizing transport layer end-to-end

performance in terms of roundtrip time and achievable throughput between end user devices and a back end system. A method for estimation of achievable throughput, featuring reduced data consumption in the estimation, is evaluated against a reference estimation based on bulk transfer. Besides transport layer measurements, the system also collects received power measurements from the physical layer. It is shown that there is a clear benefit from spatially interpolating round-trip times and received power measurements to provide network performance estimations also in areas with sparse measurement representation.

A specific application is used to evaluate the collection of contextual information. The thesis considers the problem of estimating the number of passengers on a bus, using passive sensing of WiFi probes transmitted by user equipment. Based on the collected probes, the number of devices is estimated based on probabilistic modelling, and finally, the number of passengers from maximum likelihood estimation based on prior distributions for the probability of a person carrying a certain number of devices. A quality indicator is designed to evaluate the quality of the estimate.

Finally, in the frame of the MOBINET platform, and a smart parking system use-case implemented on that platform, the thesis discusses how the network performance and contextual information can be included and exploited to enhance the smart parking system.

The thesis is a collection of papers, based on six papers, and a summary consisting of six chapters. Chapter 1 gives motivation for the work, and sets the thesis objectives. Chapter 2 gives some further background information and definition of concepts relevant for the topics investigated in the thesis work, and provides a survey of the relevant state-of-the-art. Chapter 3 to 5 deals with the respective contributions discussed above, and Chapter 6 gives a short conclusion regarding the whole thesis.

The six papers include two submitted journal papers (one still under review), as well as four conference papers:

[A] L. M.Mikkelsen, S. R Thomsen, M.S. Pedersen, and T. K. Madsen, "NetMap - Creating a Map of Application Layer QoS Metrics of Mobile Networks Using Crowd Sourcing." Cham: Springer International Publishing,2014, pp. 544-555. [Online]. Available: http: //dx.doi.org/10. 1007/978-3-319-10353-2_50

[B] L. M. Mikkelsen, N. B. Højholt, and T. K. Madsen, "Performance Evaluation of Methods for Estimating Achievable Throughput on Cellular Connections." Cham: Springer International Publishing, 2015, pp. 422-435. [Online]. Available: http://dx.doi.org/10 .1007/978-3-319-23126-6_37

[C] M. Lauridsen,I. Rodriguez, L. M. Mikkelsen,L. C. Gimenez, and P. Mogensen,"Verification of 3g and 4g received power measurements in a crowdsourcing android app," in 2016 IEEE Wireless Communications and Networking Conference, April 2016, pp. 1-6.

[D] L. Mikkelsen,T. Madsen,and H.P. Schwefel,"On the Benefits and Challenges of Crowd-Sourced Network Performance Measurements for IoT Scenarios." **accepted for publication** in International

Journal on Wireless Personal Communications as a special issue of the selected papers of GWS 2016, Dec 2016.

[E] L. Mikkelsen, T. Madsen, and H.P. Schwefel, "Accurate and Quality-Aware Bus Occupancy Estimation Utilizing Probabilistic Models for WLAN Probing." Originally submitted for Journal IEEE Transactions on Vehicular Technology, March 2017, but recently resubmitted to Journal of Computer Communications.

[F] L. Mikkelsen, R. Toledo, and N. Agerholm, "Intelligent parking assistant - a showcase of the mobinet platform functionalities," in 2015 22"d ITS World Congress, Bordeaux, France, Oct 2015.

The papers investigates three use cases, namely the survey of cellular network coverage (papers A-0), people counting in public transportation (paper E), and the availability of parking spots (paper F). The papers have been published in/submitted to renowned venues, such as WCNC and Elsevier Journal of Computer Communications. In addition to the main papers on which the thesis is based, the thesis lists five additional workshop/conference publications, which supplement the work presented in the thesis.

Assessment of the thesis

Strong points:

The thesis addresses two areas of much current interest, namely Internet of Things (IoT) and network performance estimation. There is still a lot of hype surrounding IoT, and confusion as to what change it makes to already existing capability. To this end, this thesis sets out to show how IoT can bring a difference by exploiting information and create smarter services, and how the information can be provided. Network performance estimation is by itself of much interest, as access to bandwidth is becoming almost as important as access to mains power and tap water. Hence the need to document the availability and performance. Although not unique, the presented opportunistic approach to collect information about network performance is very complete.

In this respect, the dissertation reflects a tremendous engineering work, for designing, setting up, performing and post-processing crowd-sensing experiments. NetMap, a complete experimental chain, with measurement, data collection and data presentation sections, has been built up. NetMap is on par with competing applications like OpenSignal developed and maintained by much larger R&D groups.

Another strength of the dissertation is the search for Ground Truth references when performing the analysis of collected samples. This is very true in the first use case, addressed in Paper C, where a radio scanner and two dedicated devices are used to establish that Ground Truth.

The thesis background, motivation, problem statement and contributions are presented in a good manner, and in general,the quality of the included papers/the thesis work fulfils the international standard. Especially papers C and D, and partly E, are of good quality.

Weak points:

It appears that papers on different topics from different projects are brought together in a single dissertation, under a combined theme. It appears to present some difficulty in the presentation and formulation of thesis objective. The committee recognizes that the format of presentation somehow encourages this. Alternatively, one could accept that there are different distinct contributions, not necessarily having tight interrelation. The main contribution is related to information collection and measurement, the use of which is demonstrated to enhance IoT systems as secondary objective. With the composition as it is, and from the problem statement, one would have expected more integration and results of IoT systems and network performance information, e.g. in connection with the smart parking system. In the absence of this, the contributions of the thesis look independent.

From the substance point of view, the dissertation duly acknowledges that the collected samples can be widely spread due to a variety of influencing factors, e.g. changing radio conditions, CPU load at the device and cross traffic in the wired part of the network. The dissertation does not discuss the sensitivity to these factors, nor hints to means (if any) for cancelling their influence when analysing Key Performance Indicators (KPIs).

A more consistent approach to statistical significance of the drawn conclusions would have improved the thesis. In Papers D and E, the dissertation successfully discusses potential biases due to the limited size of sample sets, and introduces Quality Indicators to enable "smart" decisions based on the computed averages. On the other hand, statistical significance is sometimes disregarded. The most salient example is Paper B, where a single device has been used for assessing the merits of TOPP vs. BTC bandwidth measurement schemes. As an example, a discussion on the potential bias induced by this sole sensing device on the experimental results would have improved the assessment methodology.

From the editing point of view, the quality of the text can be improved. This holds for the specific formulations of the text, but also in the accurateness and coherence of the text. Discussing the detailed contributions, and making their novelty clear in relation to the state-of-the-art, would have improved the thesis.

Review of the papers:

Paper A:

This paper describes the network performance mapping system, NetMap. It describes the measurement approach with the general system architecture, the application and physical layer metrics and measurement methods, and finally the results of some controlled measurements to confirm the functionality of the tool.

The paper is generally well organised, and mainly serves to describe NetMap.

Paper B:

This paper addresses the estimation of achievable throughput by comparing an established reference method (BTC) to an already proposed method (TOPP) with reduced resource consumption. The comparison is based on real-life measurements.

The paper first discusses several metrics to define the data transfer capability of a link, and the challenges related to this. It then continues to describe the two methods and the related controlled measurement setup, before characterising them individually through a controlled experiment. Following this, the TOPP method is compared to the reference method, to find the best trade-off for the parameters of TOPP in achieving both accurate results and low resource usage. The evaluation is performed under different load conditions. The main conclusion from the paper is that the TOPP method represents a good alternative to the reference method.

The overall structure of the paper is good, with a progression in evaluation complexity throughout the paper. In this sense, the methodology of the paper is generally well-designed, first characterising the reference and alternative (reduced consumption) methods individually and then rating the alternative against the reference. However, there are details that should have been included, e.g. on the actual procedure for comparing the BTC and TOPP results. Most importantly, the fact that a single device has been used for assessing the merits of TOPP vs. BTC bandwidth measurement schemes, deserves a discussion; for instance, what is the potential bias induced by this sole sensing device on the experimental results?

Overall, the quality of Paper B is medium.

Paper C:

The paper compares reports on the verification of the 3G and 4G received power measurements from the NetMap system. The verification is made against professional grade measurement equipment by comparing real-life measurements in a number of scenarios and comparisons.

The paper describes the NetMap measurement sequence and gives detail of the application programmers interface (API) that is used to retrieve the signal strength measurements on the NetMap client application. It further gives details of the measurement methodology and procedure, before outlining the results. The paper concludes that NetMap received power measurements correlates well with what is obtained from professional grade equipment, and in particular for LTE measurements. Further, there is a constant and persistent power offset.

The paper is well organised, and with details on both the measurement and post-processing, intermediate and final results. Based on the observations it provides guidance on what crowd-sourcing measurements can be used for, and which pitfalls to look out for.

In general,the quality of Paper C is good. The candidate is 3rd author on the paper.

Paper D:

This paper focuses on the problem of sparse measurement representation in crowd-sourced network performance measurements. Starting from a short description of the crowd-sourced concept, the paper moves on to describe the measurement scenarios and evaluation procedures applied in the analysis. The paper is experimentally based, using measurements obtained in two different scenario settings.

The explanation of the evaluation procedure is clear and detailed, with good illustration of the measurement sets, processing procedure, intermediate steps/results and final results. The paper addresses a very relevant problem in the crowd sourced measurement concept and gives some useful insight. It is generally well structured.

The relation between the IoT applications and the network performance map is not perfectly clear from the motivation given in the paper.

In general, the quality of Paper D is good.

Paper E:

In this paper, the author proposes a system for collecting WiFi probes and based on these WiFi probes, estimate the number of devices in a bus, and subsequently the number of people on the bus. Specifically, the paper describes an improved estimator and quality indicator for that purpose. The probe collection system, which is the basis for the estimation, is described in its functional detail. The paper then introduces the baseline, state-of-the-art, estimation algorithm and evaluates performance based on a dedicated experimental trial in which probes are measured and number of passengers are counted. In this evaluation, the impact of two algorithmic parameters is assessed, and conclusions are drawn on the baseline algorithm. In the continuation, enhancements of the baseline algorithm are explored, based on stochastic modelling. Two estimators are considered, and ways to obtain their parametrisation are discussed and

outlined. The estimators are finally combined with a ML estimator based on statistics for the number of devices per persons. The resulting algorithm for estimating the number of passengers based on probing is evaluated in a set of real-life experiments in which different scenario types are covered. The results are stated in terms of the mean estimation error for different combinations of time and signal strength threshold values in the base algorithm. The results show that the stochastic modelling leads to lower estimation error in comparison with the baseline algorithm.

The paper is generally well written, and is extensive in its description. It has an extensive state-of-the-art section that clearly describes the novelty contributed by the paper. The methodology is generally clear, with intermediate results to motivate the modelling. The structure of the paper, however, is somewhat confusing, e.g. in the use of the different estimators being introduced, by introducing the quality estimator after the results section, and by having conclusions which are not too clear and specific.

In general,the quality of Paper E is solid.

Paper F:

The paper describes the development of an intelligent parking system, based on the European-wide platform MOBINET. It contains a description of the MOBINET platform, the parking system (in overview, and more functional detail), use cases, as well as the outline of a small field test.

The paper is generally well organised. The only weak point is that the abstract gives the impression that evaluation results are included in the paper, whereas, in fact, only the outline of the evaluation is included. The paper mainly serves to describe the parking application.

Oral presentation and discussion

Date and place of the oral defence: Thursday June 22, 2017 at Fredrik Bajers Vej 7, A4-106, Aalborg University.

The candidate gave a 45 minutes clear and logical overview of his thesis work. The presentation illustrated his contributions compared to the state of the art, specially emphasizing two of the three main research lines.

In the following discussion, Lars demonstrated thorough understanding of his topic, responding in a technically correct and convincing manner. The answers to the questions were clear and precise, and duly addressed the strengths and weaknesses of the delivered work.

Conclusions

The thesis is clearly application oriented, but with such complete and practically relevant contributions that they can be exploited in different business scenarios. Especially the presentation and evaluation of complete solutions, and not just fragments, is a main strength of the thesis. As part of this, there are also clear contributions to the scientific community, e.g. in the evaluation of throughput estimation methods, the validity of spatial performance map interpolation and context estimation methods. Furthermore, the thesis work has resulted in multiple published papers, including journal submissions currently under review.

Overall, it is clear that the candidate did solid scientific work within a limited time, with scientific contributions and a tremendous engineering work effort.

The committee unanimously recommends that Lars Mikkelsen is awarded the PhD degree.

Dated and signed by all members of the committee.

June 22, 2017

Prof. Noel *Crespi*

Prof. *Laurent Schumacher*

Assoc. Prof. Troels B. Sørensen

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Det Teknisk-Naturvidenskabelige Fakultet
Forskerskolen
Niels Jernes Vej 10

Dato: 27-06-2017

Vedr. "Strategic Enactment of Front End Innovation: A Case Study of Multiple Enabling Opportunities", by Louise Brønnum, Institut for Planlægning

Hermed fremsendes bedømmelsesudvalgets Final Assessment vedr. ovennævnte ph.d. afhandling.

Instituttet anbefaler, at bedømmelsesudvalgets indstilling følges, og at Louise Brønnum tildeles ph.d. graden.

Med venlig hilsen

Marianne Sørensen

AALBORG UNIVERSITY
DENMARK

Copenhagen, June, 26, 2017

Final Assessment of the PhD thesis entitled: *Strategic Enactment of Front End Innovation: A Case Study of Multiple Enabling Opportunities* submitted by **Louise Brønnum**, M.Sc. Civil Engineering, Danish Technical University (2009), within Design and Innovation.

The assessment committee consists of the following members as decided by the Dean of the Faculty of IT and Design, Aalborg University by April 27th, 2017:

Professor Peter Karnøe (Chairman)
Aalborg University Department of Planning, A.C. Meyers Vænge 15 DK-2450 Copenhagen SV
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Professor Raghu Garud
The Pennsylvania State University, Farrell Center for Corporate Innovation and Entrepreneurship (FCFE) Smeal College of Business 431 Business Building, University Park PA USA-Pennsylvania 16802-2603
E-mail: rgarud@psu.edu

Professor Jérémy Legardeur
ESTIA Institute, Technopole Izarbel, FR-64210 Bidart
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Supervisor for the thesis has been **Professor Christian Clausen**, Aalborg University Copenhagen

Description of the thesis

The thesis is a 206-pages monograph comprising seven chapters.

Chapter 1 – Scoping
Chapter 2 – Approaching
Chapter 3 – Theorizing
Chapter 4 – Discovering
Chapter 5 – Understanding
Chapter 6 – Enabling
Chapter 7 – Concluding

Assessment of the thesis

In this assessment, we provide comments and suggestions that could be relevant for her to carry out to generate a concise manuscript to be sent for review to a journal.

Overall, the structure of the thesis is such that it breaks from the standard practice that articulates a research problem, research questions, methodology, literature review and then adding the novel aspects before the empirical analysis. Although we accept this format, it is difficult to follow the argument, as theory is introduced before and after the empirical study. Since insights from the

analysis and theory emerged and were known at the point of writing, the dissertation could have been written within a tradition structure.

Chapter 1 – Scoping

Chapter 1 starts with a section "My Story" (p. 9) with personal reflections concerning the author's evolution regarding her thesis. This introduction could have been more interesting (especially for ethnographic work) if it had gone deeper into self-reflection as a "Reflective Practitioner" (Schön, 1983).

The problematic puzzle of the study of the phenomena "front end innovation in a R&D intensive company" is presented through a reflection over a series of research questions such as "Why was early front end innovation still difficult to carry out" and "What influences the possibilities for concept development"? (p. 10). Through the metaphor of cooking, the idea emerges that even with a cookbook, the ingredients (either from theory or the company's Development Constitution) may not be mobilized by involved actors in the way prescribed (p. 13). Unfortunately, the author does not return to the cooking metaphor in the conclusion and discussion sections, but we think that it could have helped her to reinforce the discussion in Chapter 6, as it fits in with figure 23 (p. 167).

There is an early introduction to and use of Actor-Network Theory (ANT) epistemology and ontology in order to position the thesis in relation to existing front-end literature (p. 14-15). ANT overcomes strong normative factor-based perspectives on front-end innovation. However, here and in Chapter 2 on ANT-theory, the thesis does not fully embrace ANT's ontology, which deals with processes of sociomaterial intra-actions. Theseconstitute the particular spacing and staging of situated actions through enactment that make multiple versions of the front end possible.

The distinction between exploitation and exploration is offered to embed the discussion and review of the literature on the fuzzy front-end of innovation. Relevant literature (p. 17-26) on the front-end from 'innovation management', 'organization management', and 'engineering design' is offered. The stage-gate model is unpacked to argue for the sequencing of activities in particular ways (p. 21). The overall conclusion is that there is an emphasis on normative sequencing of actions of people, organizational functions or ideas. This is not seen as being "sufficient in understanding the experienced difficulties in maneuvering a concept development forth" (p.26-27). Moreover, the review points out a lack of focus on the action of involved actors. However, this review could have been improved by introducing and analyzing others' contributions, taking into account social interactions among the stakeholders, as for example "the diffusion of innovation model" proposed by Rogers.

The chapter ends a bit abruptly; the limitations pointed out in the review are not immediately addressed. Instead there is a shift to Chapter 2 (Approaching) that is a 'methods' chapter. As mentioned above, we think that a traditional structure could have been more productive for generate a cumulative understanding of the thesis. Contributions of the new ANT perspective in Chapter 3, and early Chapter 4 (p. 57) could have been presented and built up to offer the new sensitizing concepts. The sensitizing concepts are based on various works by Clausen et al (also including a joint paper with thesis author), and the concepts are based upon ANT thinking. This could also have included the new theories in Chapters 5 and 6 on ambiguity, uncertainty, and enactment. This would

have generated an appreciation of how actors constituting the front end of innovation strategically and differentially mobilize elements and resources from the Development model. This would have sharpened the readers' expectations as to what was going to be the focus in the empirical analysis.

Chapter 2 – Approaching

The chapter opens with the research question that was not formulated before: "What characterizes the enactment(s) that enables front end?" This focus on actors and enactment might as well have been introduced in Chapter 1 in order to steer the argumentation.

Regarding the research process, there is relevant presentation of and reflection on data gathering. The use of methods such as interviews and participant observations is well documented. The number of interviews, participation in meetings, and in general the access to the field is well done.

However, the author does not reflect on how the use of the Serious Play epistemology (p. 39) shifts her own role from an observer to intervener. For example, the author claims that she was an "active observer, inspired by the concept of a participatory observer as described by Spradley" (p. 33). However, there is not much self-reflection and discussion of the methodology, which is rooted in the concepts of action research (offered by pioneers such as Kurt Lewin).

Further reflection could be relevant. Indeed, we would have preferred that the relevant personal biography and reflections on how her involvement matters for the research work is presented in the methodology chapter. It would have been best to keep the rest of the thesis in a more strict scientific style.

There is a good presentation of sensitizing concepts (as opposed to analytical concepts) (p. 28-30) and an honest account of how they emerged from interaction with the case-company, the data, PhD-courses and the theory reading.

Also the reflection about becoming 'allied' (p. 41) with the informants seems to suggest a mode of inquiry of the phenomena that is abductive (what can it) as opposed to modernist modes where the 'researcher knows best what it is'. Abductive mode is not introduced before p. 47 in following chapter. It is not further reflected.

Indeed there are further important methodological reflections following the ANT epistemology in Chapter 3 – i.e. when Stenger's ideas of how new descriptions can be used to raise awareness, of slowing down or provoking the thought process of the "problems and situations mobilizing us" (Stenger, p. 49). The author continues, "I slow down and begin to wonder, and in this wonder I will study what enables front end, not from a predefined perspective on front where I, for instance, think that the front end need to be processed, but rather by studying the actors involved and their actions and capabilities."(p. 49). We find that in this methodological commitment lies a very strong contribution to front end innovation research, that unfortunately disappears a little in the text.

Chapter 3 – Theorizing

The thesis evokes ANT in three moments – traditional translation model, ANT as ethnographic

epistemology to study 'what actors say and do', and multiplicity. This is relatively well done, although the use of secondary literature (Fuglsang and Birkler) is a bit surprising. The choice of ANT is pertinent to analyze sociotechnical processes embedded in front end of innovation context, but the author could have integrated and discussed others' approaches like the Soft System Methodology (proposed by Peter Chekland in the 1980s').

There is over focus on the agency without further use later. However, there is a very good use of ANT epistemology and the research objective is now (finally) better specified with statements like "I am interested in understanding the actions taking place in the translation process and the relations that exist between entities being studied" (p. 52), and "This epistemology allows me to study the processual dynamics of how actors are constructed and why they act"(p. 53).

There is also a return to the role of sensitizing concepts in relation to ANT, that is important, as it is important not to betray the accounts from the field actors while also being able to conceptualize in some way what is happening. However, as mentioned below, it is not really clear how the process of translation and sensitizing concepts are used in the empirical analysis (Chapter 4), as the conceptual dimensions used to order the presentation of the two cases.

We note that ANT does not work with traditional ends or beginnings, as everything is an ongoing configuration of sociomaterial interactions and entanglements characterized by continuity and transformation. Thus, ANT offers a critical view on the front end of innovation, which the author does not take on. For instance, there could have been more reflections that an ANT focus on ongoing action does not acknowledge 'front' or 'back' end. There is some reflection on page 19 where the problem of 'in front of something else' is surfaced. It would be useful to clarify if it is because it is in front of something else, or is it related to the process of creating something that is entirely unknown when shifting attention that makes something the front end?

The new ANT-based performativity approach could have been used to understand and study the stage-gate model 'in action' so to speak. The performativity of 'tools' is different from the traditional normative rationalization of the 'tools'. The performativity view could have contributed greatly to understanding how so-called rational tools are performed. Performativity is evoked, but the concept is not clearly presented. It is not clear if it is a Goffmanian or Callonian approach that is taken. The concept of translation could also have been used in a stronger fashion to show the multiplicity in ways that the stage-gate model is translated in practice. The study of translation of organizational concepts is well established in organization theory (Czarniawska and Sevon, 1996).

Chapter 4 – Discovering

This is the main empirical chapter offering the two empirical cases of front-end innovation in the same company. The empirical study is very interesting. The rich empirical data reveal very different instances of how situated actors translate and mobilize the development constitution. However, maybe due to the confidentiality aspects, the author is sometimes limited to explain in detail the organization and processes of the company and some "raw material" of the fieldwork is not presented. For example, a simplified modeling of the company's organization and processes would be interesting for a better understanding of the simplified and poor vision of the formal processes as compared to the rich and complex socio-technical dynamics described in the case study.

The sensitizing concepts are based on various works by Clausen et al (also including a joint paper with thesis author), and the concepts are based upon ANT thinking. However, it is not really clear how the process of translation and sensitizing concepts are used in the empirical analysis, as the conceptual dimensions used to order the presentation of the two cases (i.e. Development Model, Development Mindset, Development culture etc.) have no relation to the sensitizing concepts. It becomes confusing to follow the argument and what is the role of sensitizing concept as for example culture is theorized (p. 99) without being part of the theoretical framework.

Further, there is no deep discussion and comparison between the proposition of some sensitizing concepts ("development spaces" p. 88, "staging" p. 70, "configuration" p.71) and the link with the concepts of problematization, interessement, enrolment and mobilization of the ANT. The author should be more precise if these sensitizing concepts allow a further analysis in the description of sociotechnical processes or if they describe others phases of innovation not covered by the ANT concepts.

In the empirical study, the ANT approach becomes less visible, as there is a constant reference to human actors, mindset, perception but the role of different materials that is expected to be part of networks or distributed action remains empirically invisible. Here a stricter use of the translation model (and enactment) could have been explicated to demonstrate how actors constituting the front end make a differential strategic translation of elements and resources from the Development model. This would have sharpened the readers' expectation to what was going to be the focus in the empirical analysis.

Chapter 5 – Understanding

This chapter extends the reflections on the empirical observations by adding ambiguity and uncertainty as conceptual resources to get further into the process of working with fuzziness inherent in front end innovation. There is a new literature review building on Weick's point that ambiguity stems from a state of confusion and a lack of knowledge. There is a discussion about whether ambiguity and uncertainty are to be embraced or reduced (p. 138-39). This is related to the empirical project Leap. Even if Leap is said to embrace ambiguity, the continued discussion of 'Opportunities for front end' (p. 140) does not clarify if at some point ambiguity is reduced in the front-end. There are important reflections on how the different personalities of people allow them to embrace and navigate fuzziness. The points made about the role of the organizational resources and rules, and how they are performed is relevant. However, it is not made clear how the translation or performativity view put this in a special light, and therefore the significance in relation to the differential mobilization is less clear.

The importance to understand the navigation of front-end ideas in a political context of legitimacy and resources are well-addressed. The examples of organizational 'tricks' like Tuesday breakfast illustrates also the need for spaces for gathering and informal conversations about 'stuff' (p. 147).

As mentioned, we think these highly relevant concepts could have been introduced in a holistic theoretical chapter up front. The introductions of new concepts and reflections on the cases becomes a bit difficult to follow, and it seems that the two last points about 'Challenging the agency

of established actors' (p.148) and 'Empower key actors' are seen as general implications for building up a new approach to front end innovation.

Chapter 6 – Enabling

The empirical findings are used to develop and present a novel approach to the problems that front-end innovation confronts. The author argues (based on ANT ontology) for "development constitution" as a conception that embraces the opportunity for multiple understandings of the front end, and thus the embedded complexities of front end.

There is an introduction to new theoretical perspectives of path dependency and path creation. While the author has put in considerable effort in presenting and explaining the use of these ontologies in relation to front end innovation, we do not see it as being productive, especially to introduce this as such a late stage in chapter 6. The critical insights from path creation could have been mobilized in an integrated theory Chapter 3, but without evoking the whole debate about path dependence and path creation.

Instead, the chapter could have been restricted to the presentation and discussion of the Development Constitution (p. 165). There is deep insight in the statement that there is no ONE single Development Constitution, but instead several possible enactment strategies dependent upon the identities of involved actors. This allows for creativity and discipline at the same time, because the stage gate model is translated to perform in particular ways.

Consequently, the thesis offers this analytically important conclusion: It is important to accept a differential mobilization of the elements of the Development Constitution in ways that paradoxically both legitimize the actions in relation to formal rules and power relations, but also allow for the ambiguities and uncertainties in an emergent, experimenting idea generating process. This double life of formal rules have been also addressed in institutional theory on organizations such as when (Meyer and Rowan, 1977) showed different de-coupling strategies and legitimization in relation to strong formal doctrines in fields.

Chapter 7 – Concluding

This chapter is a mix of summary and conclusion. It is a little difficult to identify the few lines that nail the contribution of the thesis. We have no doubt that it is there, and that it can be formulated in a concise manner; but yet it has to be done. For instance, the author concludes her thesis by saying:

> Front end is enabled by the construction of actors and actor collectives holding agency as a result of strategically enacting the development constitution. There is a prevalent enactment of the development constitution that is performed in most projects, and constantly adding to and maintaining the strong perception of a specific best practice for front end. Every front-end development opportunity is enacted, and by enacting the development constitution differently, thus challenging the prevalent understanding of front-end possibilities; alternative front-end development spaces can be staged. It is important for the success of any front-end initiative that it enacts and thereby relates to the development constitution, either by enacting the dominant

> prevalent understanding or enacting an alternative understanding. The actors contribute to the perception of the development constitution by enacting it. The development constitution is dynamic and changes over time as new elements are introduced and enacted.

One of the author's main contributions seems to demonstrate that the formalization and the progressive elicitation of a "development constitution" as a common reference shared by the stakeholders both on the formal and the informal perspectives, informs the development possibilities throughout the organization, and thereby how front end is and can be enabled in a company. Consequently, the contributions could incorporate the following somewhere:

> By studying the real-time and intimate processes performed by the stakeholders on a specific fieldwork within a company, I have shown how enabling front end innovation does not lie in the normative and singular understandings of models, processes and structures of the company, but rather in a fuzzy phenomenon where the construction of possibilities is the result of multiple enactment strategies.

Overall, the author does not completely synthesize her insights to address her earlier objective: "I am interested in understanding the actions taking place in the translation process and the relations that exist between entities being studied" (p. 52), and "This epistemology allows me to study the processual dynamics of how actors are constructed and why they act" (p. 53). In our view, she does not fully hold on to the critical facets of ANT's ontology that deals with processes of sociotechnical action-in-interaction that constitute the particular spacing and staging through (enactment) situated actions that make multiple versions of Front end possible. Therefore, the thesis becomes a little fuzzy in the back end.

Conclusion

We conclude that the thesis on "Strategic Enactment of Front End Innovation" builds around a timely empirical and theoretically interesting research question, and that it brings about a very interesting and relevant contribution that can inform front-end innovation academically as well as in practice.

We find this thesis is ambitious and interesting. It is not easy to mobilize the processual conceptions from different fields of literature and make work in empirical study. Yet the thesis makes a strong and convincing empirical case in the comparison of the two cases of front-end innovation in the same company with the 'same' Development Constitution, but with so dramatic different results. We acknowledge the quality of work that has gone into the relations with the persons and the empirical work, without which we would not know about the two different modes of Front End innovation in the same company. The relevance of the chosen methodology based on participatory observations is well articulated and adapted in order to elicit scientific contribution from the company fieldwork.

The thesis reads fluently (which we commend), and the LEGO-based figures catch the attention of the reader. However, there is a conversational style that is present throughout the thesis (which we believe detracts from the seriousness of the study).

In terms of how this defined area of academic work might be taken forward by this study, the contributions are important but not so clearly presented. In particular, we suggest that the various parts of the thesis for future publications can be re-integrated to yield a central signature thesis that can have impact in both industry and academia. To accomplish this purpose, a more traditional structure of the text could allow for the analytical shifts to be clearer and their empirical relevance to be stronger.

At the oral defense Louise Brønnum was engaged and responsive to the academic questions raised. She demonstrated a capacity to broaden and deepen the insights and results provided by the thesis.

The assessment committee unanimously unanimously recommend to the Academic Council of Aalborg University that Louise Brønnum will be awarded the PhD degree

Copenhagen, June 26, 2017

Professor Raghu Garud

Professor Jérémy Legardeur

Professor Peter Karnøe (Chairman)

AALBORG UNIVERSITET

Institut for Elektroniske Systemer
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Dato: 14. juni 2017

Til Forskerskolen
Att.: Lisbeth Diinhoff
N.J. 10

Vedrørende tildeling af ph.d.-grad til Mojtaba Farmani

Institut for Elektroniske Systemer indstiller at bedømmelsesudvalgets indstilling følges således at Mojtaba Farmani tildeles ph.d.-graden for sin ph.d.-afhandling "INFORMED SOUND SOURCE LOCALIZATION FOR HEARING AID APPLICATIONS". Forsvaret fandt sted d. 13.06.2017.

Professor Jesper Jensen har været hovedvejleder for Mojtaba Farmani.

Med venlig hilsen

Børge Lindberg

Børge Lindberg

Institutleder

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Institutsekretær Kirsten Jensen, tlf. +45 9940 8650, E-mail kri@es.aau.dk

AALBORG UNIVERSITY
DENMARK

Assessment of the PhD thesis entitled:

INFORMED SOUND SOURCE LOCALIZATION FOR HEARING AID APPLICATIONS

Submitted by Mojtaba Farmani, M.Sc. In Electrical and Computer Engineering, University of Tehran, 2009

The assessment committee consists of the following members as decided by the Dean of the Technical Faculty of IT and Design on January 13, 2017:

- Professor James Kates, University of Colorado, james.kates@colorado.edu
- Dr Patrick Naylor, Imperial College, p.naylor@imperial.ac.uk
- Associate Professor Tobias L. Jensen, Aalborg University, tlj@es.aau.dk

Supervisor for the thesis has been Prof. Jesper Jensen, Aalborg University and Oticon A/S

Co-supervisor for the thesis has been Assoc. Prof. Zhen-Hua Tan, Aalborg University, and Dr. Michael Syskind Pedersen, Oticon A/S

Description of the thesis
The thesis is a collection of papers, in total 234 pages, including a 46 page introduction with 163 references. The paper part contains 8 papers:

- Informed TDoA-based direction of arrival estimation for hearing aid applications, Mojtaba Farmani, Michael Syskind Pedersen, Zheng-Hua Tan, and Jesper Jensen, Proceedings of IEEE Global Conference on Signal and Information Processing, 2015 (published)
- Informed direction of arrival estimation using a spherical-head model for hearing aid applications, Mojtaba Farmani, Michael Syskind Pedersen, Zheng-Hua Tan, and Jesper Jensen, Proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing, 2016, (published)
- Maximum likelihood approach to "informed" sound source localization for hearing aid applications, Mojtaba Farmani, Michael Syskind Pedersen, Zheng-Hua Tan, and Jesper Jensen, Proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing 2015 (published)
- On the influence of microphone array geometry on HRTF-based sound source localization, Mojtaba Farmani, Michael Syskind Pedersen, Zheng-Hua Tan, and Jesper Jensen, Proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing, 2015 (published)
- Informed sound source localization using relative transfer functions for hearing aid applications, Mojtaba Farmani, Michael Syskind Pedersen, Zheng-Hua Tan, and Jesper Jensen, Journal of IEEE/ACM Transactions on Audio, Speech, and Language Processing, 2017 (published)
- Bias-compensated informed sound source localization using relative transfer functions, Mojtaba Farmani, Michael Syskind Pedersen, Zheng-Hua Tan, and Jesper Jensen, Journal of IEEE/ACM Transactions on Audio, Speech, and Language Processing, (submitted)

- TDoA-based self-calibration of dual-microphone arrays, Mojtaba Farmani, Richard Heusdens, Michael Syskind Pedersen, and Jesper Jensen, Proceedings of European Signal Processing Conference, 2016 (published)

- Concurrent localization of sound sources and dual-microphone sub-arrays using ToFs, Mojtaba Farmani, Richard Heusdens, Michael Syskind Pedersen, Zheng-Hua Tan, and Jesper Jensen, Proceedings of International Conference on Information Fusion, 2016 (published)

Assessment of the thesis

The thesis is in general well written and precise by an author with a good understanding of conveying information at a balanced pace. The author shows good command of the problem area and state-of-the-art, although a broader orientation on localization, time-difference-of-arrival and estimation methods outside the audio and hearing aid community could be beneficial for the work (also for putting the contributions in the right perspective). The introduction provides a good framing for the problem area, the contributions and link between each paper. The introduction provides a summary of human auditory perception, but none of this information is used in the algorithm design or evaluation. The methodology is based on various (partly) stochastic acoustic signal models, including e.g. databases on head related transfer functions, and a maximum likelihood approach to estimation. A key feature of the work is the exploitation of an external microphone in the hearing aid setup, giving rise to the so-called informed methods. Assessment is based on numerical simulations of the models and anechoic experimental setups with a head and torso simulator. The thesis provides solid contributions in the intersection of (sound) source localization and hearing aid applications-in particular the development and assessment of signal processing methods suitable for the problem area. The contributions are also valuable in the direction of commercial applications which shows the thesis work to have high potential for on-going impact.

The papers are in general similar in that they all take a model, provide a maximum likelihood motivated estimator for the model and evaluate these using simulations, possibly based on data from an anechoic experimental setup. The different models reflect different levels of personalization for the hearing aid. A selection of the body of work are the papers:

A: Investigates direction for arrival for a hearing aid system. In this setup the receiver knows the transmitted signal giving rise to the so-called informed hearing aid setup. The direction of arrival is computed based on time difference of arrival using both independent and joint maximum likelihood based delay estimators. The assessment is based on simulations in various settings. The proposed algorithm is compared with algorithms from the hearing aids community. Includes a study of the use of noise statistics to improve informed sound source localization performance. The continuous problem is solved via discretization of the two non-linear parameters. The presentation is clear and well-motivated. The simulations are convincing. A broader orientation on localization, time-difference-of-arrival and estimation methods outside the audio and hearing aid community could have been beneficial for the work.

B: Investigates direction for arrival for a hearing aid system. In this setup the receiver knows the transmitted signal giving rise to the so-called informed hearing aid setup as in paper A. The direction of arrival is computed-based on joint time difference of arrival founded in a spherical head model using a maximum likelihood based delay estimators. The continuous direction of arrival problem is solved via discretization of the two non-linear parameters. The assessment is based on simulations in various settings. The proposed algorithm is compared with algorithms from the hearing-aid community. The presentation is clear and well-motivated. Simulations convincing.

C: Investigates sound source localization for a hearing aid system. In this setup the receiver knows the transmitted signal giving rise to the so-called informed hearing aid setup as in papers A+B. The direction of arrival includes a set of head related transfer functions for maximum likelihood based delay estimators. The assessment is based on simulations from anechoic measurements using a head and torso simulator. The

proposed algorithm is compared with algorithms from the hearing aids community. The presentation is clear and well-motivated. Simulations convincing.

D: Investigates direction of arrival for a hearing aid system. The setup is similar as in C but in this paper the influence of similar head related transfer functions is more thoroughly investigated. An algorithm using the array geometry is used to assist differentiating. The assessment is based on simulations from anechoic measurements using a head and torso simulator. No algorithm comparison. The paper is more based on investigating the problem. The presentation is clear and well-motivated.

E: Investigates direction for arrival for a hearing aid system. In this setup the receiver knows the transmitted signal giving rise to the so-called informed hearing aid setup as in the other papers. The direction of arrival is computed based on a maximum likelihood based delay estimators. Compared to the other papers, this paper includes relative transfer functions to model the shadowing effect. This paper contains a broader introduction to sound source localization than in the previous papers. However, an even broader orientation on localization, time-difference-of-arrival and estimation methods could be beneficial for putting the scientific contributions in the right perspective. The assessment is based on simulations in various settings. The proposed algorithm is compared with algorithms from the hearing aids community – which seems better motivated in this paper since the models are much more tuned for a hearing aid setup. The continuous direction of arrival problem is solved via discretization and is in this paper also assessed when the true angle is not on the discretized grid. The presentation is clear and well-motivated. Simulations numerous and convincing, including the more challenging case in estimation of unknown colored noise.

F: Investigates the direction of arrival for a hearing aid system. In this setup the receiver knows the transmitted signal giving rise to the so-called informed hearing aid setup as in the other papers. The direction of arrival is computed based on a maximum likelihood based delay estimators using a number of known relative transfer functions to model the shadowing effect of the head. Compared to previous papers, this paper investigates possibilities to reduce data transfer in the hearing aid system. The paper also contains analysis of estimation bias. The propose estimators are evaluated using simulations in different noise and reverberant situations.

Besides the published work, 4 patent applications have been filed in connection to the thesis work.

Oral presentation and discussion
The candidate gave a clear and well structured presentation that was succinct, well judged in level of technical details, and which showed excellent pacing.

The candidate gave a good discussion in response to the question posed and demonstrated a solid technical understanding of the material of the thesis. This included both the theoretical foundation of the methods and the technical limitations of the specific methods presented. The candidate was less familiar with material relevant to the problem considered but not directly applied in the dissertation. Overall, the committee was very satisfied with the answers to all the questions.

Date and place of the oral defense: June 13 2017, Aalborg University, Denmark

Conclusions: The methodology and scientific contributions in this thesis are very clear in the presented form. Our assessment indicates that the thesis contains a body of research work that more than sufficiently satisfies the requirements of the PhD degree in terms of innovation, scope of study, and scientific depth. The committee would particularly like to commend the candidate on the clearly structured step by step nature of the scientific method adopted in this work, and in addition was impressed by the high level of quality and productivity shown by the papers incorporated into the very good thesis.

The committee unanimously recommends that Mojtaba Farmani be awarded the PhD degree.

AALBORG UNIVERSITY
DENMARK

13 June 2017

James Kates Patrick Naylor Tobias Lindstrøm Jensen

Fortegnelse over bedømmelsesudvalg til
stilling 42237 - Associate Professor in Wireless Communication Systems and Networks ved ES

Navn: Associate Professor Rasmus Løvenstein Olsen
Arbejdssted: Institut for Elektroniske Systemer
E-mail: rlo@es.aau.dk

Navn: Associate Professor Daniel Enrique Lucani Roetter
Arbejdssted: Institut for Ingeniørvidenskab Aarhus Universitet
E-mail: daniel.lucani@eng.au.dk

Navn: Dr.-Ing. habil Gerhard Wunder
Arbejdssted: Department of Mathematics and Computer Science, Freie Universität Berlin
E-mail: g.wunder@fu-berlin.de

Akademisk Råd har taget stilling til, at medlemmer af bedømmelsesudvalget er sagkyndige inden for stillingsområdet på et niveau, der mindst svarer til det, der forudsættes for stillingen, dog ikke under lektorniveau.

Associate Professor in Wireless Communication Systems and Networks (42237)

Position No.
42237

At the Technical Faculty of IT and Design, Department of Electronic Systems, Section for Wireless Communication Networks, a position as Associate Professor in Wireless Communication Systems and Networks is open for appointment from September 15th, 2017 or as soon as possible thereafter. The position is permanent.

The Department of Electronic Systems is one of the largest departments at Aalborg University with a total of more than 250 employees. The department is internationally recognized in particular for its contributions within Information and Communication Technology (ICT). The research and teaching of the Department of Electronic Systems focus on electronic engineering and the activity areas are organized in the sections: Antennas, Propagation and Radio Networking section (APNet), Automation Control section (Control), Signal and Information Processing section (SIP), Wireless Communication Networks section (WCN) and Communication, Media and Information technologies (CMI).

The department focuses on maintaining a close interplay with the university's surroundings - locally, nationally and internationally – as well as producing unique basic research and educating talented and creative engineers. The department collaborates with leading ICT researchers all over the world.

Job description
The necessity of supporting new applications and use cases for the so called Internet-of-Things (IoT), have pushed industry and academia to the design of novel radio access technologies able to deal with the emerging challenges. In particular, physical layer, medium access control and radio resource management are to be redesigned for coping with challenging reliability and latency targets of use cases such as closed loop control in factory automation, or to support a huge number of devices with power constraints. Some of the aforementioned challenges are tackled by the 5th generation radio, currently being standardized, and expected to be further solved by the successive radio technologies.

The research topics of the position include (but are not limited to):

- Novel physical layer procedures for improving latency and reliability of wireless connections
- Novel transceiver architectures for handling interference patterns generated by diverse sources of traffic
- Novel scheduled and contention based access procedures for handling a large set of devices with different requirements competing for the same radio resources
- Novel radio resource management solutions for improved multi-service end-to-end performance
- Experimental validation of promising concepts over a testbed network

The position involves:

- Research in the aforementioned areas
- Supervision of researchers (Research assistants, PhD students, Postdocs) dealing with specific aspects of the aforementioned topics
- Writing successful applications for national and European research funding
- Development and maintenance of collaboration with international partners, from both academia and industry
- Lecturing in master programs and organization of PhD courses in the area of wireless Communications.

The position is mainly focused on research, but will also include teaching. The teaching will be within the BSc/MSc study programs at the School of Information and Communication Technology and the Technical Doctoral School of IT and Design. At Aalborg University, the teaching is based on problem based learning.

The successful candidate should be able to demonstrate past research activities in the wide range of topics covered by the position. In particular, the candidate should have documented experience on physical layer, radio resource management and experimental research, and show motivation to further advance its experience. The successful candidate should also demonstrate significant experience in managing and supervising junior researchers, and to coordinate and prepare research projects.

You may obtain further professional information from Professor Preben E. Mogensen, phone +45 9940 8818, e-mail pm@es.aau.dk

Qualification requirements:

The level of qualification for Associate Professors shall correspond to the level, which can be achieved on the basis of the appointment as Assistant Professor, but may be achievable in other ways. The appointment presupposes that the applicant can demonstrate original scientific production at an international level as well as documented teaching qualifications. Appointment to the position requires that both research and teaching qualifications are at the requested level. The two qualifications will be given equal and principal priority in the overall assessment.

The application must contain the following:

- A motivated text wherein the reasons for applying, qualifications in relation to the position, and intentions and visions for the position are stated.
- A current curriculum vitae.
- Copies of relevant diplomas (Master of Science and PhD). On request you could be asked for an official English translation.
- Scientific qualifications. A complete list of publications must be attached with an indication of the works the applicant wishes to be considered. You may attach up to 10 publications.
- Teaching qualifications described in the teaching portfolio. If this is not enclosed the applicant must include an explanation for its absence.
- Dissemination qualifications, including participation on committees or boards, participation in organisations and the like.
- Additional qualifications in relation to the position.
- References/recommendations.
- Personal data.

The applications are only to be submitted online by using the "Apply online" button below. An assessment committee will assess all candidates.

For further information concerning the application procedure please contact Anne Christoffersen by mail hr-tech@adm.aau.dk or phone (+45) 9940 9680

Information regarding guidelines, ministerial circular in force, teaching portfolio and procedures can be seen here. (TECH).

Workplace
Aalborg

Agreement
Employment is in accordance with the Ministerial Order on the Appointment of Academic Staff at Universities (the Appointment Order) and the Ministry of Finance's current Job Structure for Academic Staff at Universities. Employment and salary are in accordance with the collective agreement for state-employed academics.

Deadline
08/08/2017

Apply online

Aalborg University (AAU) conducts teaching and research to the highest level in the fields of humanities, engineering, and natural, health, and social sciences.

top

CV – Associate Professor Daniel Enrique Lucani Roetter, Ph.D.

PERSONAL DATA

Name:	Daniel Enrique Lucani Roetter, PhD
Position:	Associate Professor
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Private Address:	Hostrupvaegnet 106, 3 Tv., 9500, Hobro, Denmark
Email:	daniel.lucani@eng.au.dk
Phone (mobile):	+45-22628620

EDUCATION

Massachusetts Institute of Technology	Ph.D in Electrical Engineering Degree Date: June 4, 2010	2006- 2010
Universidad Simón Bolívar	Master in Electronics Engineering with Honors Degree Date: October 5, 2006	2005-2006
Universidad Simón Bolívar	Electronics Engineer *Summa-Cum Laude* Degree Date: January 27, 2005	1999-2005

PRESENT AND RECENT POSITIONS (Not complete)

Aarhus University, Denmark Dept. of Engineering	Associate Professor (Top level, Tenure)	Apr 2017 – now
Aalborg University, Denmark Dept. of Electronic Systems	Associate Professor	Aug 2012 – Mar 2017
Chocolate Cloud ApS	CEO and co-founder	June 2014 – now
Universidade do Porto, Portugal	Assistant Professor	Apr. 2010 – Jul. 2012

ACADEMIC AWARDS AND HONORS (Not complete listing)

- **IEEE Communications Society** "**Outstanding Young Researcher Award**" 2015 - EMEA Region
- **Best Paper Awards** of International Symposium on Wireless Communication Systems (ISWCS) 2016 and European Wireless 2017
- **Aalborg University Talent 2016** (1 of 18 young researchers across all faculties, 1 of the 7 in Engineering)
- **IEEE Senior Member** from June 2016

MANAGEMENT EXPERIENCE AS PRINCIPAL INVESTIGATOR (Not complete listing)

- **More than 10,6 Million DKK granted as PI** (5,16 Million DKK at AAU) in **9 projects** since 2011
- **Around 1,5 Million DKK** granted as **Coordinator for Partner** in a H2020 project consortium

PROJECT NAME	BUDGET	PARTNER	YEAR
COHERENT	47,000 € (~350,000 DKK) + Overhead	Instituto de Telecomunicações	2011-2013
SHOWnet	45,700 € (~340,000 DKK) + Overhead	Instituto de Telecomunicações	2011-2013
M2M	20,000 € (~150,000 DKK) + Overhead	Portugal Telecom Inovação	2011-2012
TuneSCode	2,588,872 DKK	Danish Research Council - FTP	2013-2016
Error-Correct Repair	100,217 USD (~700,000 DKK)	Cisco Research Center	2016-2017
AAU Talent Grant	1.873.318 DKK	Aalborg University	2017-2019
Starting Grant	3.500.000 DKK	Aarhus U. – Research Fund	2017-2020

SCIENTIFIC FOCUS AREA

The research focus of Dr. Lucani is on network coding, wireless communications and networks, and Cloud storage. Network coding constitutes a new paradigm in network theory and practice, which encourages the network to algebraically combine (mix) different data packets at intermediate nodes through coding, rather than storing and forwarding copies of packets that are routed through the network. Thus, it enables the design of

disruptive algorithms and protocols for wireless networks with added resiliency, energy, delay, and throughput benefits. Dr. Lucani has made research contributions on highly volatile environments that are challenged by large latency, high packet losses, and/or half-duplex constraints. More specifically, Dr. Lucani has showed the potential of tailoring feedback and coding in order to yield order of magnitude improvements in such environments. Dr. Lucani's style lies between theory and practice, with a focus on bringing theoretical concepts into practical schemes leading to fruitful collaborations and projects with industrial partners, e.g., Portugal Telecom Inovação, Steinwurf ApS, Cisco, and other research institutions, e.g., the European Space Agency.

INTERNATIONAL RELATIONS

Dr. Lucani maintains active collaboration with a variety of international partners, including, Prof. Muriel Médard (MIT), Prof. Milica Stojanovic (Northeastern Unviersity), Prof. Peter Steenkiste (CMU), Prof. Joerg Kliewer (New Jersey Institute of Tech.), Dr. Marie-José Montpetit (MIT), Prof. João Barros (Univ. of Porto), Prof. Frank Fitzek (TU Dresden), Prof. João Sousa (Univ. of Porto), Prof. S. Palazzo (U. Catania), Dr. Nader Alagha (ESA)

SUPERVISION OF STUDENTS AND TEACHING

- Supervised 6 PhD students and supervising 4 PhD students (2 defending in 2017)
- Supervised 6 Master theses at AAU and 3 Master theses at University of Porto
- Supervised 7 master-level projects at AAU and 2 at U. Porto, 4 undergraduate projects at AAU
- Internal evaluator in two doctoral research qualifier committees at U. Porto
- External examiner in five doctoral theses and Committee Chairman in three defenses at AAU
- At U. Porto: taught course on Information and Communication, Probability and Statistics, Security in Systems and Networks. Committee member planning the Masters in Information Engineering
- Active teaching at AAU on Network Coding and Cooperation in Wireless Networks, as well as PhD level courses on network coding and codes for 5G as well as Summer Schools at AAU in those topics
- Experience teaching groups ranging from 10 to 350 students in three languages

PUBLICATIONS

- 30 Journal publications
- 106 peer-reviewed conference papers
- One authored book (coming in 2017) and one edited book
- Seven patent applications (2 granted, 5 under revision)

INVITED TALKS (selected list – not complete)

TITLE	HOST	YEAR
Composite extension fields for (network) coding: designs and opportunities	**Invited Talk** at Network Coding and Designs Conference (COST Action)	2016
Advanced and Tunable Network Coding for the Real World	**Keynote Speech**, IEEE Workshop on Cooperative and Cognitive Mob. Net.	2014
Ask Not (Only) What Network Coding Can Do For You	**Invited Talk**, Oceans: Challenges and Opportunities, Porto, Portugal, May, 2013	2013
Network Coding for Heterogeneous Networks and/or Real-time Traffic	**Invited Talk**, COST IC1105, Cagliari, Italy, September, 2012	2012
Satellite/Terrestrial Communications: Integration and Convergence	**Invited Talk**, ETSI - SCN Working Group, Wessling, Germany	2012

ORGANIZER OF CONFERENCES, WORKSHOPS, AND TUTORIALS (selected list – not complete)

CONFERENCE	TYPE	ROLE	YEAR
5GCodes in Budapest	IEEE Sponsored	General co-chair	2015
NetCod in Aalborg	IEEE Conference	General co-chair	2014
NC-Pro Workshop in Valencia	IFIP workshop	General co-chair	2011
PSATS in Tolouse	ICST Conference	Technical Program Committee chair	2013
European Wireless	IEEE sponsored	Tutorial Organizer and Presenter	2014-2015

Technical Program Committee (TPC) member (not complete list): IEEE ICC (2015-2016), IEEE GLOBECOM (2014-2016) IEEE CCNC (2012-2014), IEEE ICC Workshops (2012-2016), NetCod (2015-2016).
Session Chair (not complete listing): IEEE ICC (2012), European Wireless (2014-2016), Asilomar Conf. (2013)

Curriculum Vitae

Name:	Dr. Gerhard Wunder, habil.
Address:	Freie Universität (FU) Berlin Heisenberg Communications and Information Theory Group Takustraße 9, 14195 Berlin Office: Room 109
Home address:	Niederbarnimstraße 4A, 10247 Berlin
Personal details:	Married with Ms. Stephanie Wunder Children: Jerrit Matthis Wunder (geb. 17.10.2008) Tomma Emilia Wunder (geb. 09.08.2010)
Phone:	[office: +49 (0)30 838 61931] [work mobile: +49 (0)151 61530882] [secretary office: +49 (0)30 838 75212] [private: +49 (0)30 42012493] [private mobile: +49 (0)176 23213587]
Email:	g.wunder@fu-berlin.de
Web:	http://www.mi.fu-berlin.de/en/inf/groups/ag-comm/index.html
IEEE	Member of Executive Editorial Committee Transactions Wireless Communications, http://www.comsoc.org/twc/editorial-board Symposium Co-Chair Signal Processing for Communications IEEE GLOBECOM 2017, http://globecom2017.ieee-globecom.org/ Editor IEEE Transactions Wireless Communications
Google scholar	https://scholar.google.de

Education

12/2006	**Habilitation (venia legendi)** from Technische Universität (TU) Berlin, Germany Area ("Fachgebiet"): Communication Engineering Habilitation thesis: "OFDM Downlink Air Interface for UMTS Long Term Evolution: Fundamental Capacity and Practical Design" Referees: Prof. P. Paulraj (Stanford University, USA/CA) Prof. S. Litsyn (Tel-Aviv University, Israel) Prof. H. Boche (TU München)
09/2003	**Ph.D. in Electrical Engineering** (*Summa Cum Laude*) from TU Berlin Doctoral thesis: "A theoretical framework for the peak-to-average-power control problem in OFDM transmission" Thesis advisors: Prof. H. Boche (TU München) Prof. H. Bölcskei (ETH Zürich, Switzerland)
02/1999	**Electrical Engineering Diploma (***with highest honors)* from TU Berlin Area ("Fachgebiet"): Electronic systems and control engineering
10/1994	**Electrical Engineering Intermediate Diploma** from Universität Hannover, Germany, "Ausgleichsprüfung" (*sehr gut*)
10/1991	Begin of **Electrical Engineering Studies** at Universität Hannover
05/1989	**High school graduation (Abitur)** Ulrichsgymnasium Norden, Germany

Academic and Industrial Work Experience

Since 09/2015	**Head of Heisenberg Communications and Information Theory Group** **FU Berlin (German Excellence University), Heisenberg Fellow, Associate Professor** 5G, Physical Layer Security, Network Information Theory, Compressed Sensing etc.
Since 09/2015	**Vitusconsult GbR: Founder and Leading Manager**
Since 01/2008	**Privatdozent TU / FU Berlin, teaching:** ***** Physical-Layer Security (start SS 2015, from WS 2016 at FU Berlin) * Estimation and Decision Theory for Commun. Systems (TU Berlin, tbc. FU Berlin) * Information Theory with Exercises (TU Berlin, until WS 2013)

Since 09/2003	**Fraunhofer Heinrich Hertz Institut Berlin,** **German-Sino Lab for Mobile Communications MCI** Senior and Research Group Leader Selected EU/National Projects: *Initiator and Coordinator 5GNOW, www.5gnow.eu, EU FP7 5G Waveforms Project* *Initiator and Coordinator PROPHYLAXE, www.ict-prophylaxe.de, 'The' BMBF (German Ministry of Education and Research) Physical Layer Security Project* *Project Management Team FANTASTIC-5G, www.fantastic5g.eu, 'The' European H2020 5GPPP New Air Interface Project), until 2017* Project Manager Industry Projects: *Projects in areas: 5G, LTE-A, Heterogeneous Access, WIMAX* Selected DFG Projects: *Priority Program Cyber-Physical Networking SPP 1914 (joint project with Prof. Stursberg, University Kassel: "Model-Predictive Cyber-Physical-Networking")* *Priority Program CoSIP SPP 1798 (Compressed Sensing in Information Processing, Joint projects with Prof. Caire, TU Berlin, "Massive MIMO", and Prof. Eisert, FU Berlin, "Compressive Security")* *Priority Program COIN SPP 1397 (Network Information Theory)*
01/2011-3/2015	Founder and Honorary Leading Manager, Baugruppe "Our Space" GbR (4.5 Million EUR Project)
08/2009-01/2010	Paternity leave
04/2009-07/2009	Consultant at Alcatel-Lucent Bell Labs *(Dr. Debasis Mitra)*, Murray Hill/Crawford Hill, USA (New Jersey/ New York)
08/2005-10/2005	Visiting Professor at Stanford University (Prof. Paulraj) in Palo Alto/USA (CA)
05/2000-06/2000	Visiting Professor at Georgia Institute of Technology (Prof. Jayant) in Atlanta/USA (GA)
03/1999-08/2003	Research and Teaching Assistant ("Wissenschaftlicher Mitarbeiter") Heinrich-Hertz-Institut, TU Berlin BMBF Project Manager (3 PJ/J) "Efficient Non-Orthogonal Multicarrier Systems"
11/1996-08/1998	"Studentischer Mitarbeiter" in interdisciplinary research project *Digital Filters*, TU Berlin; Work topic: Nonlinear Optimization for the Design of Digital filters
09/1995-10/1996	"Studentischer Mitarbeiter" in interdisciplinary research project *SPLIT* of European Commission; Work topic: Finite Element Method (FEM) for the Animation of Human Faces
06/1989-12/1994	Part-time student worker with Volkswagen AG Emden und Dt. Post AG Berlin to finance studies
11/1989-01/1991	Civilian service in "Behindertenhilfe gGmbH Norden"(home for handicapped people)

Awards and Honors

2017	Nominated for the "**Deutscher Zukunftspreis 2017**", the most prodigious German Research Award issued by the German Federal President, http://www.deutscher-zukunftspreis.de/en
2015	**Heisenberg Fellowship of German Science Foundations (DFG)** The most prestigious German fellowship (established 1977), awarded for the first time ever to an communication engineer
2014	**IEEE Communications Society Award** for distinguished service as Tutorials and Workshop Chair
2011	**National award for outstanding scientific publication in the field of communication engineering by the German communication engineering society (ITG Award 2011):** *J. Bühler and G. Wunder, Traffic-Aware Optimization of Heterogeneous Access Management,* ***IEEE Transactions on Communications****, June 2010, vol. 58, no. 6*
2003	**Ph.D. in Electrical Engineering** with Summa Cum Laude
1999	**Electrical Engineering Diploma** with highest honors from TU Berlin

List of past PhD students

- Dr. Zhen Ren, BMW (Supervisor S. Stanczak), Co-refereed with Prof. Petar Popovski (Aalborg University), 2016
- Dr. Martin Kasparick
  Magna Cum Laude, Ext. Referee: Prof. Rudolf Mathar (RWTH Aachen), December 2015
- Dr. Jan Schreck, Post-doc HHI/TU Berlin
  Summa Cum Laude, Ext. Referees: Prof. Giuseppe Caire (UCLA, TU Berlin), Prof. Dr. David Gesbert (EURECOM France) 2014
- Dr. Jörg Bühler, Tebis Technische Informationssysteme AG
  Summa Cum Laude, Ext. Referee: Prof. Holger Boche (TU München), 2012
- Dr. Zhou Chan, Senior Huawei Technologies Munich
  Summa Cum Laude, Referees: Dr. Gerhard Wunder, Prof. Michel Honig (Northwestern University Illinois), 2011
- Dr. Ingmar Blau, Manager Blau Optoelektronik GmbH
  Magna Cum Laude, Ext. Referee: Prof. Hans Schotten (Universität Kaiserslautern), 2010
- Dr. Thomas Michel, Head of Operations Management and Projects, former Vattenfall Europe
  Magna Cum Laude, Ext. Referee: Prof. Nihar Jindal (University of Minnesota), 2009

Academic Activities

Editor	***IEEE Transactions on Wireless Communications (TWireless)*** *in the area of Wireless Communications Theory and Systems (WCTS), since 2011, http://www.comsoc.org/twc/editorial-board/*
Lead Guest Editor	***Precoding and Transmitter-Side Processing Techniques for Multiuser MIMO OFDM Systems with Special Emphasis on the PAPR Problem****, Additional Guest Editors: Robert F. H. Fischer (Universität Erlangen-Nürnberg, Germany), Jong-Seon No (Seoul National University, Korea), Simon Litsyn (Tel Aviv University, Israel),* ***EURASIP Journal on Advances in Signal Processing, Special Issue*** *(September 2011)* *http://asp.eurasipjournals.com/series/PAPR*
Tutorials	***Non-orthogonal, Asynchronous Waveforms for Future 5G Mobile Communications*** *GLOBECOM, May 6-10 2015, San Diego USA, http://globecom2015.ieee-globecom.org/program/industry-program/tutorials* *NEWCOM# Spring School Lectures, May 21-23 2014, SUPELEC, Campus of Rennes-France, http://www.newcom-project.eu/images/info/flyer_v6.pdf* ***Energy Efficiency and Peak Power Control in Multicarrier Communications*** with *Holger Boche (Technische Universität München, Germany), Simon Litsyn, (Tel Aviv University, Israel), 2011-2012*
Feature Articles	***FANTASTIC-5G: flexible air interface for scalable service delivery within wireless communication networks of the 5th generation,*** *Transactions on Emerging Telecommunications Technologies, July 2016, http://onlinelibrary.wiley.com/doi/10.1002/ett.3050/full* ***FANTASTIC-5G: Novel, flexible air Interface for enabling efficient multi-service coexistence for 5G below 6GHz,*** *ETSI Workshop on Future Network Technologies, Jan. 27-28 2016, Sophia Antipolis at ETSI Premises/France: http://www.etsi.org/news-events/events/1005-workshop-on-future-radio-technologies-air-interfaces* ***Joint PHYLAWS & PROPHYLAXE contribution: Perspectives of Physical Layer Security (Physec) for the improvement of the subscriber privacy and communication confidentiality at the Air Interface,*** *ETSI Workshop on Future Network Technologies, Jan. 27-28 2016, Sophia Antipolis at ETSI Premises/France: http://www.etsi.org/news-events/events/1005-workshop-on-future-radio-technologies-air-interfaces, http://www.ict-prophylaxe.de/?page_id=9* **Sparse Signal Processing Concepts for Efficient 5G System Design**, G. Wunder, H. Boche, T. Strohmer, P. Jung, **IEEE Access**, http://arxiv.org/abs/1411.0435, December 2015

***"5GNOW: Non-Orthogonal, Asynchronous Waveforms for Future Mobile Applications"**, G. Wunder, P. Jung, M. Kasparick, T. Wild, F. Schaich, Y. Chen, S. ten Brink, I. Gaspar, N. Michailow, A. Festag, L. Mendes, N. Cassiau, D. Ktenas, M. Dryjanski, S. Pietrzyk, B. Eged, P. Vago, and F. Wiedmann, **IEEE Communications Magazine, 5G Special Issue**, vol. 52, no. 2, pp. 97–105, 2014*

***"The PAPR Problem in OFDM Transmission: New Directions for a Long-Lasting Problem"**, Gerhard Wunder, Robert F. H. Fischer, Holger Boche, Simon Litsyn, Jong-Seon No, **IEEE Signal Processing Magazine**, November 2013, http://arxiv.org/abs/1212.2865*

***"5GNOW: Challenging the LTE Design Paradigms of Orthogonality and Synchronicity"**, G. Wunder, M. Kasparick, S. ten Brink, F. Schaich, T. Wild, I. Gaspar, E. Ohlmer, S. Krone, N. Michailow, A. Navarro, G. Fettweis, D. Ktenas, V. Berg, M. Dryjanski, S. Pietrzyk, and B. Eged, **Mobile and Wireless Communication Systems for 2020 and beyond (Workshop @ 77th IEEE Vehicular Technology Conference: VTC2013-Spring)**, Dresden, Jun. 2013; http://arxiv.org/abs/1212.4034*

Conference (Co-) Chair

***GLOBECOM 2017** Symposium Co-Chair Signal Processing for Communications, http://globecom2017.ieee-globecom.org/*

***ICC 2017**, Co-chair of the 3rd "International Workshop on 5G RAN Design" 5G-PPP Joint Workshop (FANTASTIC-5G, METIS II, mmMAGIC, 5GxCrosshaul, Flex5Gware), http://www.5g-ran-design.org/*

***EuCNC 2016,** Co-chair of the Joint 5GPPP Workshop on 5G Physical Layer Design and Hardware Aspects Below and Above 6 GHz, Athens (Greece), June 2016, http://www.eucnc.eu/?q=node/72*

***GLOBEBOM 2016**, Co-chair of the 2ed "International Workshop on 5G RAN Design" 5G-PPP Joint Workshop (FANTASTIC-5G, METIS II, mmMAGIC, 5GxCrosshaul, Flex5Gware), http://www.5g-ran-design.org/gc16*

***ICC 2016**, Co-chair of the 1st "International Workshop on 5G RAN Design" 5G-PPP Joint Workshop (FANTASTIC-5G, METIS II, mmMAGIC, 5GNORMA), http://www.5G-ran-design.org*

***IEEE VTC Spring 2016**, Co-Chair of the 2ed Workshop on "5G New Air Interface", Nanjing (China), 2015, http://workshop2016.fantastic5g.com/*

***Asilomar 2015**, Chair of 1st FANTASTIC-5G session on 5G Massive MTC, Pacific Grove, California (USA)*

***IEEE CTW 2015**, Co-Chairing (with Prof. Gerhard Fettweis) the 5G session, Dana Point, California (USA), http://www.ieee-ctw.org/2015/ (upcoming)*

***ISWCS 2015**, Co-chairing (with S. Schwarz, M. Simsek) Special Session on System-level modelling and Abstraction for 5G Wireless Communications, Brussels (Belgium), http://www.iswcs2015.org/index.php/authors/special-sessions*

***IEEE VTC Spring 2015**, Co-Chair of the 1st Workshop on "5G New Air Interface", Glasgow (UK), http://workshop2015.fantastic5g.com/*

***IEEE GLOBEOM 2014**, General Tutorial and Workshop Chair, IFE Track, Austin, Texas (USA), December 2014 (awarded for the distinguished service and audience recognition)*

***IEEE GLOBEOM 2014**, Co-Chair "Workshop 5G New Air Interfaces", Austin, Texas (USA), Dec. 2014, http://5gworkshop.hhi.fraunhofer.de/*

***IEEE GLOBEOM 2014**, Co-Chair "International Workshop on the Internet of Things", Austin, Texas (USA), December 2014, http://www.iots-workshop.com*

***European Commission EuCNC 2014**, Co-Chair "5G Workshop" (together with METIS), June 2014, Bologna (Italy)*

***IEEE ISWCS 2014**, Co-Chair "Workshop Advanced Multi-Carrier Techniques for Next Generation Commercial and Professional Mobile Systems", August 2014, Barcelona (Spain)*

***IEEE Vehicular Technology Conference (VTC) 2013 Spring**, Special Sessions Chair (5G Non-Orthogonal Modulation), June 2013, Dresden, Germany*

***International ITG Workshop on Smart Antennas (WSA)**, Technical Program Co-Chair, March 2009, Berlin (Germany), http://www.mk.tu-berlin.de/wsa2009*

TPC (2012-xx)

2017 only

CROWNCOM 2017, IEEE COMNETSAT 2017, EuCNC2017–RAT, Globecom2017 SPC, ICC2017-WT02, ICC 2017 WCS, ICC 2017 WCT, INFOCOM 2017, INFOCOM17 WKSHPS 2017 5G Beyond, WSA 2017, WiOpt'17

2016 only:

GlobalSIP WS Massive MIMO, IEEE APCC. IEEE COMNETSAT, INFOCOM 2016 5G & Beyond Workshop, GLOBECOM 2016 (FANTASTIC-)5G Workshop, GLOBECOM (CTS) 2016, GLOBECOM (WCS) 2016, EuCNC 2016 (FANTASTIC-)5G Workshop, CROWNCOM 2016, PIMRC 2016, ISWCS 2016 (3 Tracks), ETSI Workshop 'New Air Interfaces', IEEE VTC Multiple Antenna Systems and Cooperative Communications, IEEE VTC TPC Signal Transmission and Reception, IEEE ICC16-Workshops-5G, ICC16-Workshops-MASSAP, IEEE ICC TPC WCS 2016, IEEE ICC TPC CTS 2016, PESARO'16, WSA'16

2015 only:

ICCVE 2015, IEEE PIMRC 2015 Fundamentals and PHY, IEEE Globecom 2015 WC Symposium, IEEE GC'15 - Workshop - 5G & Beyond, EuCNC 2015 TPC Track 1, IEEE ISWCS 2015 TPC Track 1, IEEE VTC Spring 2015 TPV MIMO Track, IEEE VTC Spring 2015 TPC CT Track, IEEE VTC Spring 2015 TPC Workshop MWC2020, PESARO 2015, IEEE ICC TPC

	WC 2015, IEEE ICC WS 5G Enabler 2015, IEEE ICC CTS 2015, ITG/IEEE WSA 2015 ***2012-2014:*** *IEEE ICCVE 2014, IEEE ISWCS 2014, IEEE PIMRC PHY Track 2014, IEEE ICCVE 2014, EuCNC 2014, IEEE Globecom 2014, IEEE VTC CT Track 2014, IEEE VTC MIMO Track 2014, IEEE VTC MWC2020 WS 2014, IEEE ICC WCS 2014, IEEE ICC WS ULE2E 2014, IEEE ICC WS 5G 2014, PESEARO 2014, ITG/IEEE WSA 2014, IEEE ICCVE 2013, IEEE Globecom 2013, IEEE PIMRC 2013, EC Future Network & Mobile Summit 2013, IEEE VTC 2013 Spring, ITG/IEEE WSA 2013, ISWCS 2013, ISSSE 2012, Valuetools 2012, ITG/IEEE WSA 2012*
Referee (Selection)	***Referee for the Deutsche Forschungsgemeinschaft (DFG)**, also IEEE Communication Magazine, IEEE Signal Processing Magazine, IEEE Trans. on Information Theory, IEEE Trans. on Wireless Communications, IEEE Trans. on Signal Processing etc.*
Memberships	*IEEE German Section, **Senior Member*** *VDE Informationstechnische Gesellschaft*
Panels/Talks/Keynotes (2012-xx)	***ESE 2016,** Embedded Software Engineering Kongress: The Internet of Things, Sindelfingen, Dec, 2016 http://www.ese-kongress.de/speaker/view/id/218, key note* ***10th NGMN Industry Conference & Exhibition,** , "Security, Privacy and Identity in 5G: Strategies and Measures", Steigenberger Airport Hotel, Frankfurt, Germany, 12th to 13th October 2016, 10th https://ice2016.ngmn.org/agenda, plenary panel* ***(EuCNC'16),** Special session "Ultra-Reliable and Mission Critical Communication", June 29, 2016, 16:30-18:00, Room Aphrodite C, http://www.eucnc.eu/?q=node/130, key note* ***ISTC'16**, 5G for the Internet of Things, Brest (France), September 5-9 2016, https://conferences.telecom-bretagne.eu/turbocodes/5g-workshop/, key note* ***ITWIST'16**, Sparse Signal Processing Concepts for 5G, Aalborg (Denmark), August 24-26 2016, http://www.itwist16.es.aau.dk, key note* ***ETSI Summit dedicated to the topic of 5G: From Myth to Reality, taking place,** on 21 April 2016 at the ETSI premises in Sophia Antipolis (France), FANTASTIC-5G presentation* ***GLOBECOM'15**, Workshop 5G & Beyond, December 2015, San Diego (USA), http://www.ctr.kcl.ac.uk/5G2015/, invited panel talk* ***DySPAN'15**, Spectrum crunch below 6GHz? 5G research trends in Europe, September 2015, London (UK), http://dyspan2015.ieee-dyspan.org/content/panels, invited panel talk*

***Nokia Bell Labs**, Scalable Random Access Using Waveform Design and Compressed Sensing for Massive MTC, July 2015, Stuttgart (Germany), invited key note*

***ICC'15**, Workshop on Massive Machine-Type Communication, June 2015, London (UK), invited key note, http://www.massap.org/*

***Transport Networks for Mobile Operators RAN & Backhaul Networks 2015 conference** running the 20-21st of May 2015, Hotel Palace Berlin, invited talk on 5G*

****Mobile World Congress**, representing 5GNOW in the European Commission Booth in the presence of the Commissioner Günther Oettinger (DG Connect) and Vice President of the European Commission Andrus Ansip, http://5gnow.eu, March 3rd*

***Jahreskonferenz Next Generation ID**, Schutz der Industrie – IT-Sicherheit im Internet der Dinge jenseits von Kryptografie, , http://www.ng-identity.de/web/guest/links Berlin, 11. November 2014, invited talk*

***Workshop „Sichere Identitäten" organisiert vom SIDBB**, PROPHYLAXE: Providing PHY-Layer Security for the Internet of Things, Berlin 28. Februar 2014, invited talk*

***RAN World 2015, ICT Industry Stakeholder Forum**, being held 20-21th January in Düsseldorf, invited talk and panel discussion in the 5G session, www.ranworldevent.com*

***GLOBECOM 2014**, Workshop 5G New Air Interfaces and Tutorial, December 2014, Austin, USA, IF&E Forum, initiator and key note, http://5gworkshop.hhi.fraunhofer.de/*

***GLOBECOM 2014**, International Workshop on the Internet of Things, December 2014, Austin, USA, IF&E Forum, initiator and key note, http://www.iots-workshop.com*

***7th GMV Forum & Exhibition, International ICT Industry Stakeholder Forum and Industry exposition**, 09.17(Wed) - 19(Fri) in Kintex, Seoul, Korea [GMV Forum on 09.17(Wed) only], invited forum expert & talk for Tactile Internet in the Session of 5G Technologies, http://www.gmv.or.kr/kor/main.asp*

***European Commission EuCNC Workshop**, RAS Workshop in the European Conference on Networks and Communications, June 2014, Bologna (Italy), invited talk*

***European Commission EuCNC Workshop**, 5G Workshop in European Conference on Networks and Communications (together with METIS), June 2014, Bologna (Italy), invited talk*

***CommNet 2014**, 5G Workshop, Royal Academy of Engineering, Carlton House Terrace, March 2014, London (UK) http://www.commnet.ac.uk/node/65, invited talk*

***FIA 2014**, 5G Workshop in Future Internet Assembly, March 2014, Athens (Greece), invited talk*

***COST IC2004 Newsletter**, 5GNOW Virtual Interview with Prof. Alain Sibille, April 2014, virtual interview*

***COST Meeting**, 5GNOW Presentation, Ferrara (Italy), February 2014, invited talk*

***International Conference on Pervasive Computing and Applications**, to be held in Chile between 5th and 7th of December 2013, invited by Bo Hu, Fujitsu Laboratories of Europe Limited (FLE), keynote talk*

***Total Telecom 5G World 2013–The Future of Mobile**, 3rd Dec.,2013, London (UK), keynote guest speaker*

***ASILOMAR Conference 2013**, System-level interfaces and performance evaluation methodology for 5G physical layer based on non-orthogonal waveforms, 3rd-6th Nov. 2013 (**upcoming event**), Pacific Grove, USA (CA) http://asilomarssc.org/, invited paper & talk*

***Fraunhofer-Symposium »Netzwert« 2013**, PROPHYLAXE–Efficient Key Management for Enhanced Security in the Internet of Things, 4th Dec. 2013, Munich, invited talk*

***FuNEMS Workshop: Research Challenges for Communications in 2020**, in EC Future Network and Mobile Summit Workshop (together with METIS), 3rd July 2013, Lissabon (Portugal), http://www.futurenetworksummit.eu/2013/, invited talk & panelist*

***VTC Spring Workshop: Mobile and Wireless Communication Systems for 2020 and beyond**, in Vehicular Technology Conference (VTC) 2013 Spring, 2nd June 2013, Dresden (Germany), http://mwc2020.verkstad.net/?page_id=481, invited talk & panelist*

***WInnComm 5G Panel**, in European Conference on Communication Technologies and Software Defined Radio, Munich, 13th June 2013, http://groups.winnforum.org/Europe_2013_Agenda, invited talk & panelist*

***Wireless World Research Forum (WWRF)**, 30th Meeting, 23th April 2013, Oulu (Finland), http://www.wwrf30.ch, invited talk*

***European Commission 5G Panel**, in EC Concertation RAS cluster meeting, 28th Feb., Brussels (Belgium), https://ec.europa.eu/digital-agenda/en/future-networks-concertation-meetings, invited talk & panelist*

***BITKOM Workshop Smart Radio: Auf dem Weg zu einer drahtlosen Welt**?, in BITKOM Akademie Workshop über die Zukunft der Funktechnologien, 16. April 2013, Cologne, invited talk*

***ICC 2012 Workshop: How to adopt Mobile Data growth in 2020?**, in Workshop on Advances in Mobile Networking, IEEE International Conference on Communications (ICC), June 2012, Ottawa (Canada), organized by DoCoMo EuroLabs Munich, Dr. Hendrik Berndt, invited talk & panelist*

Current PhDs	*Mahdi Barzegar (co-supervised with G. Caire), Massive MIMO and Compressed Sensing, PhD TU Berlin*
	Saeed Afrasiabi Gorgani, Peak Power Control for Ultra-Flat Waveforms, PhD FU Berlin
	M. Sc. Rick Fritschek, Deterministische Multi-zellulare Mobilfunknetze mit Kooperation, PhD FU Berlin
	Khan Reaz, Physical Layer Security, PhD FU Berlin
Master thesis (only 2012-xx)	*Abdelrahman Sabry, Compressive Coded Random Access, Master thesis TU Berlin, 2016 (upcoming)*
	Khan Reaz, Physical Security in 6LowPAN Networks, Master thesis TU Berlin, 2016 (upcoming)
	Mohammed Eshghi, Secret Key Extraction in Sensor Networks Based on Received Signal Strength, April 2015
	Mohammed Ramadan, Compressive 5G Random Access, Master thesis TU Berlin, March 2015 (planned)
	Sofiane Sid Ahmed, Bi-orthogonal Waveforms for Random Access and Short Message Support, Master thesis TU Berlin, March 2015 (planned)
	Finn-Arne Böhner, Compressive System Identification, Master thesis TU Berlin, June 2014
	Dick Maryopi, Design of Random Access Channel using Non-orthogonal Spline-based Waveforms, Master thesis TU Berlin, June 2013
	Chen Wang, Recovery Algorithm for Compressible Multiuser Signals, Master thesis TU Berlin, July 2013
	Kuan Lu, De-Randomization and Compressed Sensing for PAPR Power Control, Master thesis TU Berlin, July 2013
	Sebastian Schiller, Kalibration von Antennen-Arrays für ein breitbandiges Funkkanal-Meßgerät, Master Thesis TU Berlin, 2012
	*Supreeth Raghuprakash, The impact of limited feedback on a multiuser multiantenna system, Master Thesis TU Berlin/Uni Kassel (**together with Prof. Dirk Dahlhaus, Kassel**), 2012*
	Ye Ji, Detektion und Charakterisierung von Pfaden auf Basis von breitbandigen Kanalmessdaten der Fahrzeugkommunikation, Master Thesis TU Berlin, 2012

5 Selected Key Publications

G. Wunder, H. Boche, T. Strohmer, P. Jung, Sparse Signal Processing Concepts for Efficient 5G System Design, **IEEE Access**, http://arxiv.org/abs/1411.0435, December 2015, TOP 10 downloaded papers in April

G. Wunder, P. Jung, M. Kasparick, T. Wild, F. Schaich, Y. Chen, S. ten Brink, I. Gaspar, N. Michailow, A. Festag, L. Mendes, N. Cassiau, D. Ktenas, M. Dryjanski, S. Pietrzyk, B. Eged, P. Vago, and F. Wiedmann, "**5GNOW: Non-Orthogonal, Asynchronous Waveforms for Future Mobile Applications**," **IEEE Communications Magazine, 5G Special Issue**, February 2014, vol. 52, no. 2, pp. 97–105

G. Wunder, Robert F. H. Fischer, H. Boche, S. Litsyn, J.-S. No, **The PAPR Problem in OFDM Transmission: New Directions for a Long-Lasting Problem, IEEE Signal Processing Magazine**, November 2013, vol. 30, no. 6, pp. 130-144

J. Bühler and G. Wunder, Traffic-Aware Optimization of Heterogeneous Access Management, **IEEE Transactions on Communications**, June 2010, vol. 58, no. 6, pp. 1-10 ***(ITG Award 2011)***

S. Litsyn and G. Wunder, Generalized Bounds on the CF Distribution of OFDM Signals with Application to Code Design, **IEEE Trans. on Information Theory**, March 2006, vol. 52, no. 3, pp. 992-1006

Fortegnelse over bedømmelsesudvalg til
stilling P21725 - Postdoc in control exoskeletons ved Department of Electronic Systems

Navn: Associate Professor Christoffer Sloth
Arbejdssted: Department of Electronic Systems, AAU
E-mail: ces@es.aau.dk

Navn: Associate Professor Shaoping Bai
Arbejdssted: Department of Mechanical and Manufacturing Engineering, AAU
E-mail: shb@m-tech.aau.dk

Akademisk Råd har taget stilling til, at medlemmer af bedømmelsesudvalget er sagkyndige inden for stillingsområdet på et niveau, der mindst svarer til det, der forudsættes for stillingen, dog ikke under lektorniveau.

Postdoc in control of exoskeletons (P21725)

Position No.
P21725

At the Technical Faculty of IT and Design, Department of Electronic Systems a position as postdoc in control of exoskeletons is open for appointment from September 1, 2017 or soon hereafter. The position is available for 28 months.

The Department of Electronic Systems is one of the largest departments at Aalborg University with a total of more than 250 employees. The department is internationally recognized in particular for its contributions within Information and Communication Technology (ICT). The research and teaching of the Department of Electronic Systems focus on electronic engineering and the activity areas are organized in the sections: Antennas, Propagation and Radio Networking section (APNet), Automation Control section (Control), Signal and Information Processing section (SIP), Wireless Communication Networks section (WCN) and Communication, Media and Information technologies (CMI).

The department focuses on maintaining a close interplay with the university's surroundings - locally, nationally and internationally – as well as producing unique basic research and educating talented and creative engineers. The department collaborates with leading ICT researchers all over the world.

Job description
A postdoc position on control systems design for exoskeletons is available at the Section for Automation and Control, Aalborg University. The candidate is expected to work on the design of the control system for an upper-body exoskeleton, including processing of sEMG signals, design of microcomputer system, and controller design. The work will be conducted within the Exo-Aider project in collaboration with mechanical engineers at Aalborg University and industrial partners. More information on the project is available at exo-aider.dk.

We are looking for highly motivated applicants with a PhD degree within robotics, electrical engineering or similar, with competences in control systems design, estimation, and signal processing. In addition, programming skills are necessary within MATLAB, C++, LabVIEW etc.

Interested candidates are invited to send CV and their most significant publications through the online application system.

You may obtain further professional information from Associate Professor Christoffer Sloth, Phone +45 99408767 or e-mail ces@es.aau.dk.

Qualification requirements:
Appointment as Postdoc presupposes scientific qualifications at PhD–level or similar scientific qualifications. The research potential of each applicant will be emphasized in the overall assessment. Appointment as a Postdoc cannot exceed a period of four years in total at Aalborg University.

The application must contain the following:

- A motivated text wherein the reasons for applying, qualifications in relation to the position, and intentions and visions for the position are stated.
- A current curriculum vitae.
- Copies of relevant diplomas (Master of Science and PhD). On request you could be asked for an official English translation.
- Scientific qualifications. A complete list of publications must be attached with an indication of the works the applicant wishes to be considered. You may attach up to 5 publications.
- Dissemination qualifications, including participation on committees or boards, participation in organisations and the like.
- Additional qualifications in relation to the position. References/recommendations.
- Personal data.

The applications are only to be submitted online by using the "Apply online" button below.

An assessment committee will assess all candidates.

For further information concerning the application procedure please contact Anne Christoffersen by mail hr-tech@adm.aau.dk or phone (+45) 9940 9680

Information regarding guidelines, ministerial circular in force and procedures can be seen here.

Workplace
Aalborg

Agreement
Employment is in accordance with the Ministerial Order on the Appointment of Academic Staff at Universities (the Appointment Order) and the Ministry of Finance's current Job Structure for Academic Staff at Universities. Employment and salary are in accordance with the collective agreement for state-employed academics.

Deadline
29/07/2017

Apply online

Aalborg University (AAU) conducts teaching and research to the highest level in the fields of humanities, engineering, and natural, health, and social sciences.

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Fortegnelse over bedømmelsesudvalg til
stilling P21728 Postdoc in Problem Based Learning and Media Technology ved Department of Architecture and Media Technology

Navn: Professor emeritus Lise Busk Kofoed
Arbejdssted: Department of Architecture and Media Technology, AAU
E-mail: lk@create.aau.dk

Navn: Associate Professor Lars Birch Andreasen
Arbejdssted: Department of learning and philosophy, AAU
E-mail: lba@learning.aau.dk

Navn: Professor Anette Kolmos
Arbejdssted: Department of Planning, AAU
E-mail: ak@plan.aau.dk

Akademisk Råd har taget stilling til, at medlemmer af bedømmelsesudvalget er sagkyndige inden for stillingsområdet på et niveau, der mindst svarer til det, der forudsættes for stillingen, dog ikke under lektorniveau.

Postdoc in Problem Based Learning and Media Technology

Position No.
P21728

At the Technical Faculty of IT and Design, Department of Architecture, Design and Media Technology, Aalborg University Copenhagen a position as Postdoc in Problem Based Learning and IT is available for appointment for a 3-year period from OCT 1 2017 or soon thereafter.

The Department of Architecture, Design and Media Technology has as its goal the development of an innovative cluster of engineering-based environments for education and research which integrate creativity, engineering and technology within the disciplines of architecture, urban design, industrial design, digital design and interactive media. The department is a leading research and educational environment in Denmark that addresses the challenge of the interplay between creativity and technology, and develops new areas in research and education directed towards the end-user.

Job description
The Postdoc position is part of the larger PBL-Future research project. This cross-faculty research project has as its overall aim to examine, challenge and further develop the problem-based learning, PBL approach to university education as it is practiced at Aalborg University and in a wide international context. The project is managed by senior researchers from PBL research environments across Aalborg University and as a successful candidate you should therefore expect to be part of a small group of PhD students, Postdocs and other staff all connected to this project.

Further, this Postdoc position is part of a sub-project within the larger PBL-future project titled "Towards a flipped semester PBL approach". The aim of this subproject is to identify and conceptualise how new ways of organizing the learning using ICT tools for communication, data construction and collaborative writing, and to get a deeper understanding of how these digitalized learning environments will influence the organization of learning as well students' projects and their PBL skills and competences. The research will be the foundation for designing and implementing new PBL initiatives.

The Postdoc position is a combination of research and teaching. Research areas will be within problem based learning with a focus on IT, change of curriculum and teaching.

Teaching will be primarily in the course "Problem Based Learning in Science, Technology and Society" in the Media Technology bachelor program."

For the full study programs please follow this link:
http://www.sict.aau.dk/Til+Studerende+og+ansatte/Studieordninger/Medieteknologi/

You may obtain further information about the position from **Professor Emeritus Lise Busk Kofoed**, phone +45 9940 2473 or e-mail lk@create.aau.dk

Qualification requirements:
Appointment as Postdoc presupposes scientific qualifications at PhD–level or similar scientific qualifications. The research potential of each applicant will be emphasized in the overall assessment. Appointment as a Postdoc cannot exceed a period of four years in total at Aalborg University.

The application must contain the following:

- A motivated text wherein the reasons for applying, qualifications in relation to the position, and intentions and visions for the position are stated.
- A current curriculum vitae.
- Copies of relevant diplomas (Master of Science and PhD). On request you could be asked for an official English translation.
- Scientific qualifications. A complete list of publications must be attached with an indication of the works the applicant wishes to be considered. You may attach up to 5 publications.
- Dissemination qualifications, including participation on committees or boards, participation in organisations and the like.
- Additional qualifications in relation to the position. References/recommendations.

- Personal data.

The applications are only to be submitted online by using the "Apply online" button below.

An assessment committee will assess all candidates.

For further information concerning the application procedure please contact Anne Christoffersen by mail ach@adm.aau.dk or phone (+45) 9940 9680.

Information regarding guidelines, ministerial circular in force and procedures can be seen here.

Workplace
Copenhagen

Agreement
Employment is in accordance with the Ministerial Order on the Appointment of Academic Staff at Universities (the Appointment Order) and the Ministry of Finance's current Job Structure for Academic Staff at Universities. Employment and salary are in accordance with the collective agreement for state-employed academics.

Deadline
25/08/2017

Apply online

Aalborg University (AAU) conducts teaching and research to the highest level in the fields of humanities, engineering, and natural, health, and social sciences.

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Lise Busk Kofoed

CURRICILUM VITAE

Lise Busk Kofoed, Ph. D. Professor Emeritus/consultant
Department of Architecture, Design & Media Technology, Aalborg University
Copenhagen, A.C. Myers vænge 15. DK 2450 Copenhagen
Phone: + 45 99402473
Mail: lk@create.aau.dk
Home address: Lindealle 19, DK – 4500 Nykøbing Sjælland
Phone: + 45 23312335

Educational background

1994:	Ph.D.; Aalborg University.
1986:	Master in Social Science and B.A in Psychology, Aalborg University.
1984:	Year of specialization in Women's study, Aalborg University.
1962:	Education from the Danish School of Art and Design, Copenhagen.

Employment (University)

2015	Professor Emeritus/ekstern lektor, Department of Architecture, Design & Media Technology, Aalborg University, Copenhagen
2013	Professor Department of Architecture, Design & Media Technology, Aalborg University, Copenhagen.
2010	Section leader, Medialogy, Department of Architecture, Design & Media Technology. Aalborg University, Copenhagen.
2008:	Head of Department, Medialogy, Aalborg, Copenhagen and Esbjerg.
2006:	Section leader, Media Technology, Department of Media Technology and Engineering Science, Aalborg Universoty Copenhagen.
2006:	Professor, Department of Media Technology and Engineering Science, Aalborg Universoty Copenhagen.
2000:	Head of Department, Architecture&Design, Faculty of Engineering and Science, Aalborg University.
1996:	Associate Professor, Department of Development and Planning, Faculty of Engineering and Science, Aalborg University.
1992:	Assistant Professor, Department of Development and Planning, Faculty of Engineering and Science, Aalborg University.
1991:	Project Manager: Evaluation of EU-Programme: Mål 2 in Nordjylland. Aalborg University.
1990	Head of the Centre for Working Environment, Aalborg University.
1988:	Ph.D. student at Department of Development and Planning, Faculty of Engineering and Science, Aalborg University.
1986:	Research Assistant at Department of Development and Planning, Faculty of Engineering and Science, Aalborg University

Research areas

Research within technological and organizational innovation and changes with special focus on:

- Problem Based Learning processes in interdisciplinary educations
- Teaching and Learning in Engineering
- The learning processes connected to innovation and changes.
- Serious game.
- User driven innovation, action research and participation
- Employee participation and development of working environment.
- Development of cooperative skills in product design and –development in companies as well as in educational institutions.
- Pedagogical methods within the project organized and problem based curriculum.

My research is based on action science and action research with interdisciplinary perspectives. During the last 20 years I have been involved in research projects dealing with the integration of technical, organizational as well as the human factors in innovation and change processes. A major focus has been on learning processes in companies and in educational institutions where the PBL approach has been central. This counts for the theoretical development as well as the innovative and practical implementation.
My national network is connected to different departments at Aalborg University, Roskilde University and The Danish Technical University and my international network is connected to research centers in Germany, France, Belgium, Portugal, Poland, USA and Australia.
During the years I have been project leader of several research projects (among them EU-Projects) and been involved in developing national and international Ph.D. courses and supervision as well.

In connection to developing the medialogy research area with special focus on "Technology Enhanced Problem Based Learning" we are establishing a *Mobile Learning Lab*, where the equipment can be used for both developing technological tools e.g. purposeful games, experimenting with games and other supportive teaching and learning features together with users, as well as testing the technological tools in all phases of the design and testing processes. Recently I have been involved in developing and testing 'flipped classroom' experiments..

Selected Publications: 2012 – 2017 (for a total list see vbn.aau.dk)

S**tudent evaluation of the flipped classroom instruction method: is it aligned with PBL?** / Triantafyllou, Evangelia; Timcenko, Olga; Kofoed, Lise. Proceedings of the 6th International Research Symposium on PBL (IRSPBL 2017). 2017.

1.

ACCEPTED/IN PRESS

2017. **Teachers' development and reflection in the flipped classroom.** / Triantafyllou, Evangelia; Timcenko, Olga; Kofoed, Lise. Proceedings of Exploring Teaching for Active Learning in Engineering Education (ETALEE) 2017. 2017.

2016. Applying a learning design methodology in the flipped classroom approach – empowering teachers to reflect/ Triantafyllou, Evangelia; Kofoed, Lise; Purwins, Hendrik; Timcenko, Olga.
In: Læring og Medier (LOM), Vol. 9, No. 15, 2016.

2016. G**ame production - Teachers Challenges in a Danish Public School.** / Reng, Lars; Kofoed, Lise. The 10th European Conference on Games Based Learning. Academic Conferences and Publishing International, 2016. p. 552-558 (Academic Bookshop Proceedings Series).

2015 **Student Behaviors and Perceptions in a Flipped Classroom: A case in undergraduate mathematics.** / Triantafyllou, Evangelia; Timcenko, Olga; Kofoed, Lise B.mProceedings of the Annual Conference of the European Society for Engineering Education 2015 (SEFI 2015). 2015.

2014 **Possibilities of using Problem Based Learning when Teaching IT Specialists at Russian Universities.** / Amelin, Roman; Kofoed, Lise B.; Bessono, Leonid. In proceedings from ICEE/ICIT. iNEER,

2014 **Project Planning and Management for First Year Engineering Students.** / Kofoed, Lise B.; S. Stachowicz, Marian. Conference proceedings: Joint International Conference on Engineering Education & International Conference on Information Technology. iNEER, 2014. p. 384-391.

2014 **Teaching Interdisciplinary Engineering and Science Educations.** / Kofoed, Lise B.; S. Stachowicz, Marian.. ICEER 2014 McMaster Digest. red. / Mohamed Bakr; Ahmed Elsharabasy. iNEER, 2014.

2013 **The behavioural motivation model in open distance learning.** / Zaikin, Oleg; Malinowska, Magdalena; Kofoed, Lise B.; Tadeusiewicz, Ryszard; Żyławski, Andrzej . In proceedings from the Sixt International Conference on advanced cognitive technologies and applications. IARIA, 2014. s. 226-234.

2013 **How academic teachers perceive and facilitate creativity.** / Bjørner, Thomas; Kofoed, Lise B.In: European Journal of Engineering Education, Vol. 38, Nr. 5, 2013, s. 556-566.

2013 Modeling the Competence Acquiring Process in Higher Education Institution. / Malinowska, Magdelena; Kusztina, Emma; Zaikin, Oleg; Reng, Lars; Kofoed, Lise B.; Zylawski, Andrzej. I F A C Workshop Series, Vol. 7, Nr. 1, 2013, s. 1578

2013 The Motivational Power of Game Communities - Engaged through Game Jamming. / Reng, Lars; Schoenau-Fog, Henrik ; Kofoed, Lise B.In: Foundations of Digital Games Conference Proceedings, 2013.

2012 Problem Based Learning Principles in two Pedagogical Models. Busk Kofoed, L. and Stachowicz, M. In proceedings from ICIT conference. Information and Communication Technologies in Education, Manufacturing and Research. Saratov University of Technology, Russia.

2012 Assessment of Students Projects - Numbers, Letters, Words?: Busk Kofoed, L. and Stachowicz M. In proceedings from ICEE Turku, Finland 2012 (ISBN 978-952 – 216 – 3158)

2012 Creatvity in Project Work : Students' Perceptions and Barriers. / Bjørner, Thomas ; Kofoed, Lise B. ; Bruun-Pedersen, Jon Ram.I: International Journal of Engineering Education, Vol. 28, Nr. 3, 2012, s. 545-553.

2012 **Teaching and Learning Media Psychology and Media ethnographic Methods in Technical Educations.** / Petersson, Eva; Kofoed, Lise B. In Proceedings of International Conference on Education and Educational Psychology (ICEEPSY 2012). Elsevier LtD. . Elsevier Science, 2012.

Det Tekniske Fakultet for IT og Design - Fortegnelse over sager godkendt af Dekanen i perioden 13.06.2017-09.08.2017

Kodeforklaring

A1: Ansættelse med opslag
A2: Ansættelse u/ opslag (tidsbegrænset)
1F: 1. forlængelse
2F: 2. forlængelse
3F: Forlængelse pga barsel/orlov/fastansætte
G: Genansættelse
O: oprykning
(i) intern ansættelse (u) ekstern ansættelse

	Periode Fra	Til	Institut	Kode
Ansættelse/genansættelse af videnskabelige assistenter				
Andres Lucero	01.06.2017	15.07.2017	Datalogi	A2
Bianca Clavio Christensen	01.08.2017	30.06.2018	Create	A2
Chris Holmberg Bahnsen	15.07.2017	30.04.2018	Create	A2
Trine Skovgaard Kirkfeldt	01.08.2017	31.01.2018	PLAN	A2
Kemo Usto	15.08.2017	14.08.2019	Create	A1
Malte Pedersen	01.08.2017	30.06.2018	Create	A2
Andrei Ducu Predescu	16.08.2017	15.02.2018	Create	2F
Morten Frølund	01.08.2017	31.01.2018	Create	A2
Mohammad Mehdi Samaditaheri	01.08.2017	31.07.2018	ES	A2
Patrick Stolc	01.09.2017	31.08.2018	Create	2F
Kasper Fromm Pedersen	15.08.2017	14.01.2018	CS	A2
Thomas Frisk Olesen	15.08.2017	14.01.2018	CS	A2
Thomas Lundgaard Hansen	01.09.2017	31.03.2018	ES	A2
Mette Møller Jeppesen	01.08.2017	31.01.2018	PLAN	A1
Stefan Hein Bengtson	01.08.2017	30.06.2018	CREATE	A2
Sumit Sen	01.08.2017	31.01.2018	Create	A2
Bolette Dybkjær Hansen	01.08.2017	30.06.2018	Create	A2
Katrine Marie Schledermann	01.08.2017	31.01.2018	Create	A2
Alexandru-Sabin Bana	15.08.2017	31.08.2017	ES	1F
Kirsten Cornelia Elisabeth van Dam	01.08.2017	31.07.2018	Create	A2
Kristine Askeland	15.08.2017	14.02.2018	PLAN	A2
Emil Rosenlund Høeg	15.08.2017	14.02.2018	Create	A2
Anders Mariegaard	01.09.2017	31.08.2018	CS	A2
Stine Schmieg Lundgaard	01.08.2017	31.07.2018	CS	A2
Joana Brillhante das Neves	01.09.2017	02.28.2018	PLAN	A2
Ansættelse/genansættelse af adjunkter (tidsbegrænset)				
Anja Marie Bundgaard	01.07.2017	30.06.2020	PLAN	A1
Behnam Zakeri	15.08.2017	14.08.2020	PLAN	A1
Rasmus Søgaard Lund	01.08.2017	31.07.2020	PLAN	A1
Gabriela Valentina Montoya	15.09.2017	14.09.2020	CS	A1
Camilla Nørgaard Jensen	01.08.2017	31.07.2020	CS	A1
Lu Chen	01.08.2017	31.07.2020	CS	A1
Giorgio Bacci	01.08.2017	31.07.2020	CS	A1
George Palamas	15.08.2017	14.08.2020	Create	A1

Ansættelse/genansættelse af adjunkter (ikke tidsbegrænset)

Ansættelse af studieadjunkter

Ansættelse/genansættelse af PostDoc

Jonas Dahlbæk	01.09.2017	31.08.2019	PLAN	A1
Lykke Brogaard Bertel	01.08.2017	31.07.2018	PLAN	A2
Anders Kalsgaard Møller	01.07.2017	31.01.2019	CREATE	A1
Virginie F.C. Servant	01.01.2018	31.12.2018	PLAN	A2
Giovanni Bacci	01.08.2017	31.7.2019	CS	A2
Emil Jatib Khatib	01.09.2017	31.08.2018	ES	A2
Tsampikos Kounalakis	01.09.2017	31.08.2019	CREATE	A1
Katja Lund	01.09.2017	31.08.2019	ES	A1

Ansættelse af lektorer (tidsbegrænset)

Søren Frimodt-Møller	15.08.2017	14.08.20	PLAN	A1
Chunfang Zhou	01.08.2017	31.07.2018	PLAN	A2
Mads Lauridsen	15.07.2017	14.07.2020	ES	A1

Ansættelse af lektorer (tidsubegrænset)

Maria Frier Hvejsel	01.07.2017		Create	
Timothy Robert Merritt	01.08.2017		CS	A1
Shuai Zhang	01.08.2017		ES	A1

Ansættelse af studielektorer

Ansættelse/genansættelse af professorer

Sergios Theodoridis	10.06.2017	28.10.2017	ES	A2
Zheng-Hua Tan	01.07.2017		ES	A1

Ansættelse/genansættelse af professorer MSO

Nicola Morelli	01.08.2017	31.07.2020	Create	1F

Ansættelse/genansættelse af adjungerende professorer (tidsbegrænset)

Professor Emeritus

Lektor Emeritus

Orlov

Burak Cakmak	01.08.2017	14.04.2018	ES	100%

Opsigelser

Anja Marie Bundgaard	30.06.2017		PLAN	
Anders Lumbye	31.07.2017		Create	

Bo Thiesson	31.07.2017	CS	
Hans Kiib	30.09.2017	Create	

Opslag af stillinger

Overflyttelser, ændring i timetal

Palle Andersen	01.08.2017	ES	80%