Application

2015-03-31

2015-04841	Fodor, Viktoria	NT-14

Information about applicant

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Administrating organisation: Kungliga Tekniska högskolan

Project site: Avdelningen för Kommunikationsnät

Information about application

Call name: Forskningsbidrag Stora utlysningen 2015 (Naturvetenskap och teknikvetenskap)

Type of grant: Projektbidrag

Focus: Fri

Subject area:

Project title (english): Performance modeling of information processing networks

Project start: 2016-01-01

Project end: 2019-12-31

Review panel applied for: NT-14

Classification code: 20203. Kommunikationssystem

Keywords: network optimization, distributed processing, stochastic systems

Funds applied for

Year:	2016	2017	2018	2019
Amount:	1,060,000	1,070,000	1,090,000	1,150,000

Descriptive data

Project info

Project title (Swedish)*

Prestanda modellering av informationsbehandlings nätverk

Project title (English)*

Performance modeling of information processing networks

Abstract (English)*

Cloud computing, visual sensor networks and multi-processor computer architectures all have something in common: They provide distributed services including storage, transmission and processing of information, where the delays of transmitting and processing the information are comparable and therefore have to be jointly considered for system optimization. To express the importance of both processing and communication, we call these systems as information processing networks.

The objective of this proposal is to provide fundamental results for the design of information processing networks, extending previous works, where processing and communication are addressed separately. We will address distributed information processing in structured and unstructured networks, providing theoretic tools that can give fundamental understanding on the effects of topology selection, request routing and task scheduling, considering deterministic systems where the set of tasks to be scheduled, their communication and processing needs are exactly known, as well as stochastic systems where these parameters are characterized by probability distributions.

Due to the wide range of application areas, the design and modeling of information processing networks expected to be a prominent area of network research in the coming years. We believe that this project will provide new theoretic tools and demonstrate their applicability for system design.

Popular scientific description (Swedish)*

Moln service, visuella sensornätverk och multi-processor datorarkitektur alla har något gemensamt: De ger distribuerade tjänster, inklusive lagring, överföring och bearbetning av information. Med framväxten av billiga sensorer och processorer dessa och liknande system kommer att överföra, lagra och bearbeta stora mängder av information. Därför kallar vi dem informationsbehandlings nätverk.

I dessa system tar både kommunikation och bearbetning tid och har betydande kostnad. Syftet med detta projekt är att definiera nya teoretiska verktyg som hjälper modellering och utvärdering av informationsbehandlings nätverk, både på den lilla skalan av en inbäddad dator och den stora skalan av Internet.

Project period

Number of project years*

4

Calculated project time*

2016-01-01 - 2019-12-31

Classifications

Select a minimum of one and a maximum of three SCB-codes in order of priority.

Select the SCB-code in three levels and then click the lower plus-button to save your selection.

SCB-codes*	2. Teknik > 202. Elektroteknik och elektronik > 20203. Kommunikationssystem

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Enter a minimum of three, and up to five, short keywords that describe your project.

Keyword 1*

network optimization

Keyword 2*

distributed processing

Keyword 3*

stochastic systems

Keyword 4

Keyword 5

Ethical considerations

Specify any ethical issues that the project (or equivalent) raises, and describe how they will be addressed in your research. Also indicate the specific considerations that might be relevant to your application.

Reporting of ethical considerations*

The project does not raise ethical issues.

The project includes handling of personal data

No

The project includes animal experiments

No

Account of experiments on humans

No

Research plan

A Performance modeling of information processing networks

A.1 Purpose and aims

Cloud computing, visual sensor networks and multi-processor computer architectures all have something in common: They provide distributed services including storage, transmission and processing the information, where the delays of transmitting and processing of information are comparable and therefore have to be jointly considered for system optimization. To express the importance of both processing and communication, we call these systems as information processing networks.

Information processing networks may consist of data sources, like sensors or cameras, storage devices and processing nodes. Processing of information may require to collect the information from one or several storage devices, and process it at one or at several processing nodes. The sources of the information, storage and processing nodes may be connected by a well structured network, like in the case of cloud computing services, or by an unstructured network in the case of Internet of Things clusters or distributed computing at the edge of the Internet.

The design of information processing networks therefore includes the dimensioning of storage, processing and communication resources as well as the design of algorithms and protocols that control how requests for storage and processing use the available resources.

The objective of this proposal is to provide fundamental results for the design of information processing networks, extending previous works, where processing and communication are not considered jointly, like task assignment for parallel processing on one side, and classical communication network modeling on the other side. The theoretic results will be illustrated by some characteristic use cases.

We expect the following main results from the project:

$i)$ Modeling and evaluation of information processing networks with structured communication topology, such as centralized or distributed cloud services, small sensor networks or parallel processing computer architectures, as well as networks with unstructured, flexible communication patterns, such as social networks and Internet of Things clusters.

$ii)$ For both structured and unstructured networks, we aim at finding theoretic tools that can provide fundamental understanding on the effects of topology selection, request routing and task scheduling, considering $i)$ deterministic systems where the set of tasks to be scheduled, their communication and processing needs are known a priori, and $ii)$ stochastic systems where these parameters are characterized by probability distributions.

$iii)$ Finally, building on our theoretic results, we will design distributed algorithms to route and schedule processing requests, and we will characterize the control overhead and performance trade offs.

A.2 Survey of the filed

A.2.1 Distributed information processing

Recent developments in networking, processing and storage technologies foster the emergence of data-intensive applications, where large amount of information is stored and processed at various locations of the network.

Networked information processing systems need to provide fast service, that is low task completion times for the users, and need to ensure high utilization and a balanced use of resources for the service providers. Optimal parallel processing in mobile cloud offloading is addressed in [1] and [2] considering the cost of the processing and communication resources, and in [3], for the case where parallelization has limited flexibility, described by a processing graph. On the smaller scale, [4] addresses parallelization of large matrix operations over a multi-processor architecture. [3][4] takes the communication costs into account, however, all these works address only the scheduling of one processing task at a time. Theoretically optimal architectures are derived for big data aggregation in [5], considering again the processing of a single task, but evaluating as well the effect of different time complexities of the aggregation, as a function of the input size. The simultaneous execution of distributed data analytics tasks is addressed in [6], with the objective to balance the quality of service they receive.

Resource assignment and task scheduling of a stream of randomly arriving requests is addressed in [7], considering the case where each of the servers are able to perform a subset of the possible tasks, not considering, however, the cost of routing the request to a given server.

A.2.2 Deterministic modeling and optimization

All but the last paper mentioned in the previous section formulate the system optimization as a deterministic optimization problem, where the utilities and costs of using given resources are known, or if they are random variables, the average values can be considered. The optimization task is then formulated as a large mixed integer problem, and near-optimal solutions are found by heuristics. Interesting approach is presented in [8], where optimal assignment for distributed storage is derived through hyper-graph partitioning. In this project we are more interested in the research direction, where the optimality of a given solution can be theoretically proved, like the results presented in [5], where optimal aggregation architectures are defined based on the task complexity.

Divisible Load Theory (DLT) [9] has been shown to provide a powerful approach to find the rules of optimal distributed processing of a task in simple network topologies, such as bus, star or tree networks. Usually three decisions need to be made: the subset of the processors used, the order they receive their share of workload, and the division of the workload. Theoretic results exist for processor and order selection rules, for the cases when transmission and processing times are linear to the input data size [10][11] and for the case of additive processing overhead but with the constraint of homogeneous transmission capacities [12]. Some more recent results address the processing of multiple loads [13], however for very specific cases. As the processing of requests arriving from many sources is a key issue for information processing networks, we will extend the results of DLT in this direction.

A step forward to apply DLT for scenarios with some randomness has been done in [14], where the processing time is given by a random variable, considering the application of distributed signature search. In our recent works we apply DLT to solve a stochastic optimization problem with the objective of minimizing the mean square error introduced by the randomness in transmission and processing [15][16].

A.2.3 Stochastic modeling and optimization

Queuing Theory is one of the main tools of stochastic optimization applied for evaluating the performance consumers receive in resource sharing systems, among others in communication networks and in computing systems. Queuing theory considers stochastic arrival and service processes and derives relationship among the arrival process and the service requirement of the requests, the system capacity and the resulting performance in terms of delay, loss, and system utilization. While queuing theory provides simple results for basic queuing systems, it is challenging to extend the results for more complex scenarios, like concatenated queues and multi-server multi-class systems, scenarios that are very relevant for information processing networks.

Network Calculus is the branch of Queuing Theory that aims at addressing the performance of dependent concatenated queues, deriving bounds of end-to-end delay and burstiness in a traffic stream [17], also considering varying server capacity [18]. While Network Calculus inherently builds on the flow conservation law - that is, all incoming requests leave the queueing system, scaling of load has been addressed recently for line topologies in [19] and in our work on visual sensor networks [20]. These are very important initial results that may enable the use of Network Calculus to model information processing networks, where, after the processing stage the amount of traffic typically decreases significantly (or may even increase, for example in the case of matric completion based applications).

The existence of parallel, interacting service queues is a key feature of information processing networks. The performance of these multi-class multi-server systems has been addressed in [21] for simple routing decisions. Educated decisions on the routing and scheduling of the requests introduce significant dependence among the queues. The Mean Field Method may provide tractable models for symmetric scenarios, as in [22] or in our earlier work [23]. The general case of services in interacting queues has been addressed recently in [7][24], however these results are asymptotic, and the considered routing and scheduling policies may perform very poorly in systems of limited size.

A.2.4 Complex networks

The topology of the connectivity graph has known, significant effect on the end to end performance of networking applications, multihop from point-to-point transmission to information dissemination and iterative consensus algorithms [25][26]. Graph models like the Erd**H**os-Rényi random graph, small world and scale-free graphs aim at adequately describing the connectivity structures of real systems, as well as at supporting the design of topology formation algorithms. While the above well known models do not consider the physical location of the nodes, graph models for wireless node connectivity are discussed in [27][28].

Algorithms for forming topologies in dense wireless networks that optimize some connectivity graph properties have been proposed in our previous work [29], and for fast, energy efficient consensus in [30]. Social ties based local communication has been recently discussed for mobile device to device communication in [31][32]. These works show that the social graph mapped on the wireless connectivity graph still exhibits small-word phenomena, also demonstrating that the selection of the appropriate graph model is important also in the case of local communication based networked services.

A.3 Project description

The overall objective of the project is to gain fundamental understanding of the performance of information processing networks, considering the sharing of communication, processing and storage resources.

We address the objective in steps. We first consider deterministic systems with simple communication structure. This step is necessary to define what factors affect the complexity of routing and task scheduling problems. Then, using the results of deterministic modeling we extend our studies for stochastic systems. We then consider the additional challenges of information processing networks with unstructured, flexible communication architecture.

The primary methodology used in the project is mathematical modeling, with the specific goal of designing appropriate, tractable theoretic tools to support the design of information processing networks. Theoretic results will be supported with simulations for specific case studies.

A.3.1 Research Tasks

Task 1 - Deterministic modeling of structured information processing networks

Many of the distributed information storage and processing infrastructures exhibit star, tree or multiple parallel tree (that is, directed acyclic graph) topologies. The objective of this task is to find storage and processing offloading rules when requests arrive from many sources and can utilize many storage nodes and processing servers. Specifically we will consider heterogeneous communication, storage and processing capabilities and a communication architecture with limited flexibility. We will characterise the processing tasks considering the cost parallel processing introduces and the task complexity as a function of the input size, and evaluate the effects of the various parameters on the resulting complexity of the task assignment problem.

We will utilize solution approaches derived in DLT for single source processing offloading, combined with graph theoretic results on bipartite and hierarchical graphs. We will consider the case of single scheduling instance and well as the case of stream of requests, where the objective of the offloading design may also be the balancing of the processing and communication costs across the network, for example to extend the lifetime of wireless nodes.

We will demonstrate the theoretic results for case studies on distributed visual analysis and on data analytics based management of mobile networks.

This task is an extension of our recent work on visual analysis task scheduling in sensor networks, where, however we have not derived general scheduling rules. The tasks will be completed well within the first year, and will provide important input for Task 2.

Task 2 - Stochastic modeling of structured information processing networks

Deterministic modeling can be applied when the request arrivals and their service needs are exactly known. It may also be a reasonable direction of system design when some of the parameters are given by random variables, but mean value analysis is of interest.

Realistic use cases are however often highly stochastic, considering the process of the arrival of requests, the service needs of the requests, and also the state of the service infrastructure, that is, the available transmission, processing and storage resources.

In the case of information processing systems traditional teletraffic theory based analysis faces the following problems: $i)$ concatenated service: even for the simplest scenario the service process consists of two steps, transmission and then processing; $ii)$ batch processing: units of transmission and processing are different (packets contra complete tasks), processing can not be started before the entire information is received; $iii)$ distributed processing: processing is finished when all processing at the parallel processing nodes complete service; and finally considering processing at a sequence of processing nodes $iv)$ scaling: traffic flowing in the network does not anymore fulfills the traditional flow conservation law due to the intermediate processing.

As of today there is no consensus on what is the most appropriate tool of stochastic modeling of information processing networks. As we described in Section A.2 most of recent research provides deterministic optimization of the service of single requests. Therefore, our objective is to evaluate three possible directions. $1)$ The formal extension of DLT for stochastic systems may give powerful models for the architectures where deterministic DLT gives theoretically optimal offloading rules. We will evaluate the limits of tractable extension of DLT. $2)$ For general stochastic systems with random request arrivals and services DLT extensions would turn into traditional queuing theory models. Therefore we aim at addressing the general case building directly on queuing theory results, with the objective of adding the phase of communication to the queuing theory models of service in parallel queues [7][22], as well as the phase of waiting for all parallel services to complete. $3)$ As Network Calculus has been designed to tackle end to end performance of consecutive services, or objective will be to extend these models to also address batch and distributed processing.

As a result, we would like to provide a set of tools that can support the design of distributed information processing for a high variety of networking and application scenarios.

Task 3 - Modelling of unstructured information processing networks

Emerging flexible communication architectures, like social networks, private clouds, fog-computing and Internet of Things bring new challenges in the design and modeling of distributed processing. Specifically, here we have the opportunity to design efficient connection patterns among the nodes. While the available connections may be constrained by social preferences and trust or by the transmission distance of the wireless nodes, the connectivity graphs are expected to be rather dense, giving some freedom to select optimal virtual topologies for the information processing network.

In this task we will first consider the case when the service of a request needs one instant of information processing, which may be distributed among the available processing nodes. We will evaluate what graph properties lead to efficient multi-class multi-server systems, and design algorithms that achieve these virtual topologies under given physical connectivity graphs.

Finally, our objective will be to address the design of iterative in-network data processing algorithms, where the local computation instances require significant resources and can not be disregarded at the algorithm design. This is by far the most challenging part of the project, because distributed graph algorithms, giving the theoretic background, as of today, mainly consider only the complexity and cost of communication.

A.3.2 Organization and time plan

The tasks are planned to run in year 1, years 2-3 and years 3-4 respectively, with parallel activities for the involved Ph.D student and postdoctoral researcher. All activities will be lead by the main applicant of this proposal.

A.4 Significance

Distributed information processing is expected to be one of the main application for network systems in the coming years, both on the large scale of the Internet and mobile networks and on the small scale of multi-processor computing in general purpose computers as well as in embedded systems. As processing and communication is now coupled, it is also necessary to merge the theoretic tools used in these two areas, a process that has only started. Our project aims at contributing to this area of research at a very early stage, and therefore we believe that it will provide significant results both in advancing the theory as in demonstrating its applicability for system design.

A.5 Preliminary results

In recent years we worked on distributed visual processing in sensor networks, addressing this way a few specific problems of information processing network design.

Divisible Load Theory: We applied DLT for the design of optimal offloading schemes for individual images as well as for videos, where the offloading can be optimized by utilizing the correlation among the consecutive video frames. We formulated the offloading problem as stochastic optimisation problem, to be able to address the effect of the randomness of the image content and of the wireless channel capacity. For the single camera case we shown that optimization based on expected transmission rates minimizes the expected task completion time, and evaluated how the necessary transmission overhead of distributed processing and the use of multicast transmissions affect the optimal order of utilized processing nodes in heterogeneous scenarios [15][16]. We also started to address the case of processing video streams arriving from multiple cameras, and evaluated how the individual decision of the cameras affect the system performance [33].

Network Calculus: For the same scenario we applied Network Calculus to derive the end-to-end performance bounds of the processing of a stream of images at a remote processing node. This simple scenario already covers two of the challenges of networked information processing: the batched processing at the remote node and the scaling of the information introduced at the processing node, breaking the flow conservation law. Therefore we have introduced a specific service curve for the batch processing unit, and careful scaling of traffic, such that the performance bounds do not become approximate. As encouraging results we see that even under batch processing the delay bound has exponential decay, and the bounds are tight despite the introduced scaling [20].

A.6 Competence and collaboration

Due to the wide range of application areas, the design and modeling of information processing networks expected to be a prominent area of network research in the coming years. While the applicant has little experience in this specific area, she believes to have the right competence to address the challenges.

In addition to the preliminary results presented in Section A.5, several of our previous works contain theoretic approaches that are relevant for this project. Our studies on peer to peer streaming systems and cognitive wireless networks provide theoretic tools for the modelling of correlated servers [23][34]. We studied the topologies emerging in wireless networks, following the complex network theory approach [29] as well as building on stochastic geometry [35], results that will help us to address information processing in unstructured networks.

The project builds on our ongoing collaboration with the Image Processing group at KTH in the area of networked visual processing, sponsored by the ACCESS Linnaeus Centre, and on our previous work with the Computational Biology group in the area of graph topology optimization, also sponsored by ACCESS. We will also build on the results and experience gained in the EU FP7 GreenEyes FET project (2012-2015), specifically through the collaboration with Politecnico di Milano, on the topic of divisible load theory based offloading of visual processing. The theoretic results of the project will be used for the case study of data analytics based mobile network management in the frame of the collaboration we started with Ericsson Research.

References

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Interdisciplinarity

My application is interdisciplinary

☐

An interdisciplinary research project is defined in this call for proposals as a project that can not be completed without knowledge, methods, terminology, data and researchers from more than one of the Swedish Research Councils subject areas; Medicine and health, Natural and engineering sciences, Humanities and social sciences and Educational sciences. If your research project is interdisciplinary according to this definition, you indicate and explain this here.

Click here for more information

Scientific report

Scientific report/Account for scientific activities of previous project

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Budget and research resources

Project staff

Describe the staff that will be working in the project and the salary that is applied for in the project budget. Enter the full amount, not in thousands SEK.

Participating researchers that accept an invitation to participate in the application will be displayed automatically under Dedicated time for this project. Note that it will take a few minutes before the information is updated, and that it might be necessary for the project leader to close and reopen the form.

Dedicated time for this project

	Role in the project	Name	Percent of full time
1	Applicant	Viktoria Fodor	20

Salaries including social fees

	Role in the project	Name	Percent of salary	2016	2017	2018	2019	Total
1	Applicant	Viktoria Fodor	20	180,000	190,000	190,000	200,000	760,000
2	Other personnel without doctoral degree	New student	80	390,000	390,000	400,000	430,000	1,610,000
3	Other personnel with doctoral degree	Post Doctoral Researcher	30	200,000	200,000	200,000	200,000	800,000
	Total			770,000	780,000	790,000	830,000	3,170,000

Other costs

Describe the other project costs for which you apply from the Swedish Research Council. Enter the full amount, not in thousands SEK.

Premises

Type of premises	2016	2017	2018	2019

Running Costs

Running Cost	Description	2016	2017	2018	2019

Depreciation costs

Depreciation cost	Description	2016	2017	2018	2019

Total project cost

Below you can see a summary of the costs in your budget, which are the costs that you apply for from the Swedish Research Council. Indirect costs are entered separately into the table.

Under Other costs you can enter which costs, aside from the ones you apply for from the Swedish Research Council, that the project includes. Add the full amounts, not in thousands of SEK.

The subtotal plus indirect costs are the total per year that you apply for.

Total budget

Specified costs	2016	2017	2018	2019	Total, applied	Other costs	Total cost
Salaries including social fees	770,000	780,000	790,000	830,000	3,170,000		3,170,000
Running costs					0		0
Depreciation costs					0		0
Premises					0		0
Subtotal	770,000	780,000	790,000	830,000	3,170,000	0	3,170,000
Indirect costs	290,000	290,000	300,000	320,000	1,200,000		1,200,000
Total project cost	1,060,000	1,070,000	1,090,000	1,150,000	4,370,000	0	4,370,000

Explanation of the proposed budget

Briefly justify each proposed cost in the stated budget.

Explanation of the proposed budget*

Project members:

Main applicant: Viktoria Fodor, associate professor

Co-workers: Graduate student to be recruited, Post doctoral researcher

Budget for in this project:

The project applies for a grant covering salaries for part time research for one senior researcher, one graduate student and a postdoctoral researcher who is planned to be financed from several resources. Other smaller cost like computer and travels will be covered from basic funding at KTH.

Indirect costs include all indirect costs at KTH according to the SUHF model (40%).

Budget items (in kSEK, rounded):

	2016	2017	2018	2019
Viktoria Fodor				
Yearly salary	580	610	610	630
With 55.5% LKP	900	950	950	980
Research time	20%	20%	20%	20%
Requested grant	**180**	**190**	**190**	**200**
New student				
Yearly salary	310	310	325	350
With 55.5% LKP	480	480	500	540
Research time	80%	80%	80%	80%
Requested grant	**390**	**390**	**400**	**430**
Post-doc				
Yearly salary	420	420	420	420
With 55.5% LKP	650	650	650	650
Research time	30%	30%	30%	30%
Requested grant	**200**	**200**	**200**	**200**
Sum of salaries	**770**	**780**	**790**	**830**
Indirect costs	**290**	**290**	**300**	**320**
Sum	**1060**	**1070**	**1090**	**1150**

Other funding

Describe your other project funding for the project period (applied for or granted) aside from that which you apply for from the Swedish Research Council. Write the whole sum, not thousands of SEK.

Other funding for this project

Funder	Applicant/project leader	Type of grant	Reg no or equiv.	2016	2017	2018	2019

CV and publications

CV

Curriculum Vitae

1. Master degree
- Year: 1993
- University: Budapest University of Technology and Economics (BUTE), Hungary
- Discipline: Electrical engineering, Informatics

2. Doctoral exam
- Title: Doctor of Philosophy
- Year of exam: 1999
- Discipline: telecommunication, teletraffic theory

3. Postdoctoral work
- Department of Teleinformatics, KTH, Royal Institute of Technology, 1998-1999.

4. Docent level: 2011

5. Present position
- Associate professor (lektor), from June 2007
- Laboratory for Communication Networks School of Electrical Engineering, KTH
- Program coordinator for the Network Services and Systems and the EIT ITC Internet Technology and Architecture master programs at KTH
- Member of the Strategic Advisory Council of the School
- Member of the ACCESS Linnaeus Centre Executive Board
- Percentage of research: 70%

6. Previous positions
- Senior research engineer, 1997-1998, Hungarian Telecommunications Company
- Assistant professor, part time, 1998, BUTE, Hungary Postdoctoral work, 1998-1999 Department of Teleinformatics, KTH
- Acting lecturer, 1999-2001, KTH
- Assistant professor (adjunct), 2002-2007, KTH

7. Interruptions in research – parental leave
- from January 2000 to December 2000, in 100%
- from January 2001 to August 2001, in 70%
- from September 2001 to June 2003, in 50%
- from July 2003 to January 2005, in 100%
- from February 2005, in 50%
- from September 2009, in 25%
- from September 2014, in 10%

8. Supervisory work
Co-advisor of graduate students
- György Dán, Ph.D in February 2006, Thesis: Internet Video Transmission

- Ignacio Más Ivars, Ph.D in June 2008, Thesis: On Admission Control for IP Networks Based on Probing
- Ilias Chatzidrossos PhD in February 2012, Thesis: Live Streaming Performance of Peer-to-Peer Systems
- Emil Ericsson, expected graduation 2018.

Main advisor
- Liping Wang, PhD in June 2013, Thesis: Cooperative and Cognitive Communication in Wireless Networks
- Ioannis Glaropolulos, PhD in May 2015, thesis: Coexistence and energy efficiency for wireless networks

8. Other information

Funds received as principal or co-applicant over the past five years.

- Topology optimization for distributed applications, Project grant, 2.25 MSEK, 2010-2014, (Main project leader: V. Fodor)
- Network layer models, TNG, The Next Generation Strategic Research Areas funded project, 2 MSEK, 2010-2013 (PI: V. Fodor)
- Hydrobionets, Autonomous control for large-scale water treatment plants, EU FP7 collaborative project, 1.5 MSEK, 2011-2014. (PI: B. Beferull-Lozano, UVEG)
- GreenEyes, Networked energy-aware visual analysis, EU FP7 FET project, 1.4 MSEK, 2012-2015, (PI: Marco Tagliasacchi, POLIMI)
- EIT ICT Labs Master School, Internet Technology and Architectures, 300 kSEK yearly from 2012 (PI: Viktoria Fodor and Markus Hidell, KTH)
- ACCESS Linnaeus Center NetCV, 1MSEK, 2012-2014, (PI: Viktoria Fodor)

Technical Program Committee Member over the past 5 years.

- IFIP International Teletraffic Congress, 2011, 2012, 2013, 2014
- IEEE Infocom 2013, 2014.

Workshop Organizer over the past 5 years.

- IEEE Swedish Communication Technologies Workshop, TPC Vice-Chair, 2011.
- IEEE Distributed and Cooperative Visual Representation and Analysis, TPC Chair.

Grading committee member / opponent at PhD defences

- David Erman, Blekinge Institute of Technology, grading committee, 2008
- Daniele Croce University of Nice and of Politecnico di Torino, opponent, 2010
- Gabor Enyedi, Budapest University of Technology and Economics, 2010
- Majid Khormujin, KTH, grading committee, 2011
- Fredrik Österlind, Uppsala University, grading committee, 2011
- Pål Gronsund, University of Oslo, adjudication committee, 2013
- Santosh Shah, Universitat de Valencia, external expert, 2014
- John Ardelius, KTH, grading committee, 2014

Expert assignments, such as employment cases and other assignments
- Vetenskapsrådet, Natural and Engineering Sciences, panel member, 2010, 2014
- Karl-Johan Grinnemo, promotion to associate professor, Karlstad University, 2014
- Robert Lagerström, docent committee, teacher representative, KTH, 2014.
- External evaluator of research fellow applicants at University of Agder, 2014
- EU FP7 SUNRISE project open call, independent expert, 2015

Publication list

Pulications list

Citation database: Google Scholar

Publications 2007-2015

1. Peer-reviewed journal articles

[1] Gy. Dán, V. Fodor, and G. Karlsson, “Robust source-Channel coding for Real-time Multimedia,” ACM Multimedia systems Journal, 13(5-6), pp. 363-377, 2008. Number of citations: 2

[2] V. Fodor and I. Chatzidrossos, “Playback delay in mesh-based Peer-to-Peer systems with random packet forwarding and transmission capacity limitations,” International Journal of Internet Protocol Technology 3(4) pp. 257 – 265, 2008. Number of citations: 2.

[3] Gy. Dán and V. Fodor, “Delay Asymptotics and Scalability for Peer-to-peer Live Streaming,” IEEE Trans. on Parallel and Distributed Systems, 20(10), pp1499-1511, 2009, Number of citations: 11.

[4] I. Chatzidrossos, Gy. Dan, V. Fodor, “Dealy and playout probability trade-off in mesh-based peer-to-peer streaming with delayed buffer map updates,” P2P Networking and Applications, 3(1), March 2010. Number of citations: 20. (*)

[5] P. Holme, BJ. Kim and V. Fodor, “Heterogeneous attachment strategies optimiz the topology of dynamic wireless networks,” The European Physical Journal B, 73(4), pp597-604, 2010. Number of citations : 2.

[6] Gy. Dan and V. Fodor, “Stability and performance of overlay multicast systems employing forward error correction,” Performance Evaluation, vol 67, pp. 80-101, 2010. Number of citations : 7.

[7] I. Glaropoulos, V. Fodor, “Discrete stochastic optimization based parameter estimation for modeling partially observed WLAN spectrum activity”, Infocommunications Journal, vol. 4, no. 2, 2012. No citations.

[8] L. Wang, V. Fodor, “On the Gain of Primary Exclusion Region and Vertical Cooperation in Spectrum Sharing Wireless Networks,” IEEE Transactions on Vehicular Technology, vol. 61, no. 8, pp. 3746-3758, 2012. Number of citations: 7.(*)

[9] R. Yanggratoke, G. Kreitz, M. Goldmann, R. Stadler, V. Fodor, “On the performance of the Spotify backend,” Journal of Network and Systems Management, 1-28, 2013. No citations.

[10] I Glaropoulos, A Vizcaino Luna, V Fodor, M Papadopouli, “Closing the gap between traffic workload and channel occupancy models for 802.11 networks,” Elsevier Ad Hoc Networks, vol 21, Oct. 2014. No citations.

[11] L. Wang, V. Fodor, "Dynamic Cooperative Secondary Access in Hierarchical Spectrum Sharing Networks," IEEE Transactions on Wireless Communications, vol.13, no.11, Nov. 2014.

[12] A. Redondi, M. Cesana, M. Tagliasacchi, I. Filippini, Gy. Dan, V. Fodor, “Cooperative Image Analysis in Visual Sensor Networks,” Elsevier Ad Hoc Networks, 2015, to appear.

[13] I. Glaropoulos, M. Lagana, V. Fodor and C. Petrioli, "Energy Efficient COGnitive MAC for Sensor Networks under WLAN Co-existence," IEEE Transactions on Wireless Communications, 2015, to appear.

[14] György Dán, M. Altamash Khan, Viktoria Fodor,"Characterization of SURF and BRISK Interest Point Distribution for Distributed Feature Extraction in Visual Sensor Networks," IEEE Transactions on Multimedia, 2015, to appear.

2. Peer-reviewed conference contributions

[15] Gy. Dán, I. Chatzidrossos, V. Fodor, "On the performance of multiple-tree based peer-to-peer live streaming," in Proc. of IEEE Infocom, May 2007. Number of citations: 40.

[16] Gy. Dán, I. Chatzidrossos, V. Fodor, "Streaming performance in multiple-tree-based overlays," in Proc. of IFIP Networking 2007, May 2007. Number of citations: 7.

[17] Gy. Dán, V. Fodor, "An analytical study of Low Delay Multi-tree-based Overlay Multicast," in Proc. of ACM Sigcomm Peer-to-peer Streaming and IPTV Workshop, Aug. 2007. Number of citations: 6.

[18] I. Chatzidrossos, V. Fodor, "On the effect of free-riders in P2P streaming systems," in Proc. of International Workshop on QoS in Multiservice IP Networks (QoSIP) 2008, February 2008. Number of citations: 9.

[19] Gy. Dán, V. Fodor, "Delay bounds and scalability for overlay multicast," in Proc. of IFIP Networking 2008, May 2008. Best paper award. Number of citations: 4.

[20] V. Fodor, and I. Chatzidrossos**, "**Playback delay in mesh-based peer-to-peer systems with random packet forwarding," In Proc. of IEEE Future Multimedia Networks**,** September 2008, Number of citations: 4.

[21] B. Mercier, et al, "Sensor networks for cognitive radio: Theory and system design," in Proc. ICT Mobile Summit, 2008. Number of citations: 40.

[22] V. Fodor and I. Glaropoulos**, "**On the gains of deterministic placement and coordinated activation in sensor networks with full coverage," In Proc. of IEEE Global Telecommunications Conference**,** December 2008. Number of citations: 3.

[23] V. Fodor, I. Glaropoulos, and L. Pescosolido**, "**Detecting low-power primary signals via distributed sensing to support opportunistic spectrum access," In Proc. of IEEE International Conference on Communications**,** June 2009. Number of citations: 40.

[24] L. Wang, V. Fodor and M Skoglund, "Using cooperative transmission in wireless multihop networks," in Proc. of IEEE International Symposium On Personal, Indoor and Mobile Radio Communications (PIMRC), 2009. Number of citations: 3.

[25] I. Glaropoulos, V. Fodor, "On the efficiency of distributed spectrum sensing in ad-hoc cognitive radio networks," in Proc. of ACM Mobicom CoRoNet 2009. Number of citations: 4.

[26] I. Chatzidrossos, Gy. Dan and N. Fodor, Server guaranteed cap: An incentive mechanism for maximizing streaming quality in heterogeneous overlays," in Proc. of IFIP Networking, 2010. Number of citations: 5.

[27] L. Wang and V. Fodor, "Cooperative geographic routing in wireless mesh networks," IEEE International Workshop on Enabling Technologies and Standards for Wireless Mesh Networking (MeshTech), 2010. Number of citations: 3.

[28] A. Nahvi, V. Fodor and I. Glaropoulos, "Performance of deterministic local sensing aggregation under interference," in Proc. International Conference on Cognitive

Radio Oriented Wireless Networks & Communications (Crowncom), 2010. Number of citations: 3.
[29] D. Zorbas, C. Douligeris and V. Fodor, “Target location based sink positioning in wireless sensor network,” in Proc. International Conference on Telecommunications, 2011. Number of citations:1.
[30] L. Wang, V. Fodor and M. Skoglund, “Cooperative Communication for Spatial Frequency Reuse Multihop Wireless Networks under Slow Rayleigh Fading,” in Proc. IEEE ICC, 2011. No citation.
[31] L. Wang, V. Fodor, “On the Gain of Vertical Cooperation in Cognitive Radio Networks,” in Proc. IEEE ICC, 2011. Number of citations: 2.
[32] I. Glaropoulos, V. Fodor, L. Pescosolido and C. Petrioli, “Cognitive WSN Transmission Control for Energy Efficiency under WLAN Coexistence,” in Proc. International Conference on Cognitive Radio Oriented Wireless Networks & Communications (Crowncom), 2011. Number of citations: 11.
[33] M. Lagana, I. Glaropoulos, V. Fodor and C. Petrioli, “Modeling and Estimation of Partially Observed WLAN Activity for Cognitive WSNs,” in Proc. IEEE Wireless Communications and Networking Conference, 2012. Number of citations: 2.
[34] L. Wang and V. Fodor, "Cooperate or not: the secondary user's dilemma in hierarchical spectrum sharing networks," IEEE International Conference on Communications (ICC), 2013. Number of citations: 1.
[35] M. A. Khan, Gy. Dan, V. Fodor, “Characterization of SURF Interest Point Distribution for Visual Processing in Sensor Networks,” International Conference on Digital Signal Processing, 2013. Number of citations: 2.
[36] Y. Xu, L. Wang, C. Fischione, V. Fodor, “Distributed spectrum leasing via vertical cooperation in spectrum sharing networks,” International Conference on Cognitive Radio Oriented Wireless Networks (CROWNCOM), 2014. Numner of citations:1.
[37] I. Glaropoulos, V. Fodor, “Spectrum sharing with low power primary networks,” IEEE Dynamic Spectrum Access Networks (DySpan), 2014. No citations.
[38] Emil Eriksson, György Dán and Viktoria Fodor, “Real-time Distributed Visual Feature Extraction from Video in Sensor Networks,” IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS), 2014. Number of citations:3. (*)
[39] A. Redondi, L. Baroffio, A. Canclini, M. Cesana, M. Tagliasacchi, Gy. Dán, V. Fodor, E. Eriksson, J. Ascenso, P. Monteiro “Enabling Visual Analysis in Wireless Sensor Networks” IEEE Intl. Conference on Image Processing (ICIP), 2014. No citation.
[40] E. Eriksson, Gy. Dán, V. Fodor, “Prediction-based load control and balancing for feature extraction in visual sensor networks,” International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2014. Numner of citations:3.
[41] L. Ye, V. Fodor, A. Giannetsos, P. Papadimitratos, “Path Metric Authentication for Low-Power and Lossy Networks,” CPS Week International Workshop on Cyber-Physical Systems for Smart Water Networks, 2015, to appear.
[42] Emil Eriksson, György Dán, Viktoria Fodor, ``Algorithms for Distributed Feature Extraction in Multi-camera Visual Sensor Networks," in Proc. of IFIP/TC6 Networking, 2015, to appear. (*)

[43] Hussein Al-Zubaidy, György Dán, Viktoria Fodor, ``Performance of in-network processing for visual analysis in wireless sensor networks," in Proc. of IFIP/TC6 Networking, 2015, to appear. (*)

4. Overview articles

[44] V. Fodor and Gy. Dán, "Resilience in live peer-to-peer streaming," IEEE Communications Magazine, vol. 45, no. 6, June 2007. Number of citations: 44.

Five mest cited publications, regardless year of publication

Peer-reviewed journal articles

[1] I. Chlamtac, V. Elek, A. Fumagalli, and C. Szabo, "Scalable WDM Network Architecture Based on Photonic Slot Routing," IEEE Transaction on Networking, vol. 7, no. 1, Feb. 1999. Number of citations: 96.

Peer-reviewed conference contributions

[2] V. Elek, G. Karlsson, and R. Rönngren, "Admission Control Based on End-to-End Measurements," in Proc. of IEEE Infocom 2000, Tel Aviv, March 2000. Number of citations: 258.

[3] Gy. Dán, I. Chatzidrossos, V. Fodor, "On the performance of multiple-tree based peer-to-peer live streaming," in Proc. of IEEE Infocom, May 2007. Number of citations: 40.

[4] V. Fodor, I. Glaropoulos and L. Pescosolido, "Detecting low-power primary signals via distributed sensing to support opportunistic spectrum access," in Proc. of IEEE ICC, 2009. Number of citations: 40.

Overview articles

[5] V. Fodor and Gy. Dán, "Resilience in live peer-to-peer streaming," IEEE Communications Magazine, vol. 45, no. 6, June 2007. Number of citations: 48.

CV

Name: Viktoria Fodor	**Doctorial degree:** 1999-01-28
Birthdate: 19691108	**Academic title:** Docent
Gender: Female	**Employer:** Kungliga Tekniska högskolan

Research education

Dissertation title (swe)

Dissertation title (en)

Organisation	Unit	Supervisor
Budapest University of Technology and Economics, Hungary Not Sweden - Higher Education institutes	School of Electrical Engineering	
Subject doctors degree	**ISSN/ISBN-number**	**Date doctoral exam**
20203. Kommunikationssystem		1999-01-28

Publications

Name: Viktoria Fodor	**Doctorial degree:** 1999-01-28
Birthdate: 19691108	**Academic title:** Docent
Gender: Female	**Employer:** Kungliga Tekniska högskolan

Fodor, Viktoria has not added any publications to the application.

Register

Terms and conditions

The application must be signed by the applicant as well as the authorised representative of the administrating organisation. The representative is normally the department head of the institution where the research is to be conducted, but may in some instances be e.g. the vice-chancellor. This is specified in the call for proposals.

The signature*from the applicant*confirms that:

- the information in the application is correct and according to the instructions form the Swedish Research Council
- any additional professional activities or commercial ties have been reported to the administrating organisation, and that no conflicts have arisen that would conflict with good research practice
- that the necessary permits and approvals are in place at the start of the project e.g. regarding ethical review.

The signature *from the administrating organisation* confirms that:

- the research, employment and equipment indicated will be accommodated in the institution during the time, and to the extent, described in the application
- the institution approves the cost-estimate in the application
- the research is conducted according to Swedish legislation.

The above-mentioned points must have been discussed between the parties before the representative of the administrating organisation approves and signs the application.

Project out lines are not signed by the administrating organisation. The administrating organisation only sign the application if the project outline is accepted for step two.

Applications with an organisation as applicant is automatically signed when the application is registered.