

# Markus Fiedler

Docent Dr.-Ing.

Professor of Teletraffic Systems

Blekinge Institute of Technology (BTH)

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## Degrees

2006.12 Docent, Telecommunication Systems

1998.06 Dr.-Ing. (Ph.D.) in Electrical Engineering with focus on information and communication technology (ICT), Saarland University, Saarbrücken, Germany, with “summa cum laude”

1993.12 Dipl.Ing. (M.Sc.E.) in Electrical Engineering with focus on ICT, Saarland University, Saarbrücken, Germany, with highest distinction

## Positions

2020-01– Main responsible for the area “Media Technology” at BTH

2018.01– Deputy Head of Department, Dept. of Technology and Aesthetics (DITE)

2014.01–2015.04 Head of Department, Dept. of Communication Systems (DIKO)

**2011.09– Professor of Teletraffic Systems, BTH**

2000.01–2011.08 Universitetslektor (Senior Lecturer/Associate Professor), BTH

1998.04–1999.12 Visiting Assistant Professor, Höghskolan Karlskrona/Ronneby (now BTH)

1994.01–1998.03 Academic Assistant (2+27 months) / Scholar (22 months), Lehrstuhl für Nachrichten- und Vermittlungstechnik, Saarland University, Saarbrücken, Germany

## Departments

**2017.01– Dept. of Technology and Aesthetics (DITE)**

2014.01–2016.12 Dept. of Communication Systems (DIKO)

2009.04–2013.12 School of Computing (COM), Comm. and Computer Systems Research Lab (CCS)

2004.04–2009.03 School of Engineering (TEK), Dept. of Telecommunication Systems (ATS)

1999.01–2004.03 Dept. of Telecommunications and Signal Processing (ITS)

1998.04–1998.12 Dept. of Telecommunications and Mathematics (ITM)

## First Area of Research: **Quality of Experience (QoE)**

My work in the QoE area is grounded in correlations between network monitoring data and user perception, as well as subsequent work on perceptual Quality of Service (QoS) within the Network of Excellence (NoE) EuroNGI. Due to my teletraffic background, I approached the topic from the networking side, thereby investigating impacts of network-related parameters on user perception. The latter includes modeling and understanding of interdependencies between QoE and QoS as well as interpretation of model parameters. During the years, specific focus was paid on QoE fundamentals; QoE in seamless communications; QoE of mobile video streaming; QoE and energy efficiency; QoE in the healthcare domain; QoE in Virtual/Augmented Reality (VR/AR); and QoE modeling by means of Machine Learning (ML). Due to my move to DITE and the media technology programs attached to this institution, QoE of sound, picture, game, web and immersive experiences got in focus. I see myself as a regular “border-crosser” between user and infrastructure domains, devoted to minimizing the gap between user expectations and deliveries by applications and networks, through informed choices and “QoE by design”.

### Teaching Activities in the QoE domain:

- Course “Quality of Experience” on M.Sc. level (2018.04–)
- Workshops on “Quality of Experience” in Media Technology-related courses (2017.09–)
- Course “Quality of Experience” on B.Sc. level at Gunadarma University, Indonesia (2013.04–05)
- Euro-NF Ph.D. course “Quality of Experience” (2011.06)
- Invited tutorials, workshops and guest lectures (2010–)
- Thesis works (2005–)

### Community Activities in the QoE domain:

- Co-chair of the Special Session “On Behalf of the User – Towards Advanced and Applicable QoE Modeling in Networked Settings” at QoMEX 2019, Berlin, Germany (2019.06)
- Co-organizer of the QoE Management workshop at QoMEX 2018, Sardinia, Italy (2018.05)
- Co-organizer of the Special Session “QoE Vadis?” at QoMEX 2017, Erfurt, Germany (2017.05)
- Co-organizer of the Dagstuhl Perspectives Workshop 16472 “QoE Vadis?” on future directions of QoE research (2016.11)
- Associate editor of the Springer “Journal on Quality and User Experience” (2016–)
- Co-organizer of the Dagstuhl Seminar 15022 “Quality of Experience: From Assessment to Application” (2015.01)
- Co-organizer of the Industrial Panel on “Quality of End User Experience (QoE) for Network Services: Are we really measuring the right things?” at ICC 2013, Budapest, Hungary
- Co-organizer of the Dagstuhl Seminar 12181 “Quality of Experience: From User Perception to Instrumental Metrics” (2012.05)
- Co-organizer of the Dagstuhl Seminar 09192 “From Quality of Service to Quality of Experience” (2009.05)
- Organizer of the “18th International Teletraffic Congress Specialists Seminar on Quality of Experience” (2008.05), of a series of workshops on socio-economic aspects of future networks (NoEs EuroFGI and Euro-NF, 2006–2010) and related special journal issues (2008–2013)

## Second Area of Research: **Teletraffic Modeling and Analysis**

As a student, this area caught my attention in 1992, and was from the very beginning strongly influenced by outcomes from the COST Actions 224 and 242. I started working with fluid models and used them subsequently for admission (M.Sc.E. thesis) and dimensioning (Ph.D. thesis) purposes. The fluid models with variable source activities were complemented by variable capacities during my first directly funded project (by Deutsche Telekom, 1999). While working with network monitoring tools, I saw the potential in linking measurements to fluid models by matching multiplicative Markov-Modulated Rate Processes to traffic traces on multiple time scales, which constitutes a versatile and powerful toolbox. Another methodological contribution is the use of the ML algorithm M5P for deriving performance models. I am particularly interested in building bridges between teletraffic models and QoE models and devoted to applications of teletraffic modeling and analysis for the benefit of users and systems (e.g. for energy- efficient video streaming, and VR/AR).

### Teaching Activities in the teletraffic domain:

- Course “Capacity Analysis” on M.Sc. level (2018)
- Course “Simulation” on M.Sc. level (1998.09–2017.06)
- Thesis works (1995–)

### Community Activities in the teletraffic domain:

- TPC Area Co-Chair for Area 1 “Performance Evaluation, Control and Optimization” at the 30<sup>th</sup> International Teletraffic Congress (ITC-30), Vienna, Austria (2018.09)
- Co-organiser and TPC Co-Chair of ITC-26, Karlskrona, Sweden (2014.09)
- Member and Treasurer of the International Advisory Council (IAC) of the ITC, the first conference in network science and practice (since 1955) (2013.09–)

- Organizer of the 2<sup>nd</sup> European Teletraffic Seminar (ETS), Karlskrona, Sweden (2013.09)
- Invited talk at the 1<sup>st</sup> ETS: “When teletraffic meets the user – building bridges between traffic analysis and Quality of Experience,” Poznan, Poland (2011.02)
- **Member of COST IC1303 “AAPELE: Ambient Assisted Living” (2013–2017)**
- **Member of COST IC1003 “Qualinet” (2010–2014–today)**
- **MC Member of COST Action IC0804 “Energy Efficiency in Large Scale Distributed Systems” (2008–2012)**
- Steering Board Member and workpackage leader of the European Network of Excellence “Euro-NF” (2008–2012)
- Co-organiser of the Dagstuhl Seminar 07042 “Performance Assessment Methods for Next Generation Internet” (2007.01)
- Invited talk at HETNETs 2005 “Measurement and analysis of application-perceived throughput via mobile links,” Ilkley, UK (2005.07)
- Member and workpackage leader of the European Network of Excellence “EuroFGI” (2006–2008)
- Member and workpackage leader of the European Network of Excellence “EuroNGI” (2003–2006)
- **MC Member of COST Action 279 “Analysis and Design of Advanced Multiservice Networks Supporting Mobility, Multimedia, and Internetworking” (2001–2005)**
- **Member of COST Action 257 “Impacts of new services on the architecture and performance of broadband networks” (1998–2000)**

## Further Relevant Activities and Positions

- 2020.02      Keynote “Chasing Milliseconds – on temporal challenges for realtime-rendered virtual reality”, IEEE ICACS, Lahore, Pakistan
- 2016.07      TPC Co-Chair of the IFIP Wireless and Mobile Network Conference (WMNC) 2016, Colmar, France
- 2013–2014    Swedish Domain Committee Member for ICT of the European COST program**
- 2011–2012    Future Internet Cluster Co-Chair of the European Commission, which included organization of a series of Future Internet Cluster Workshops**
- 2008–2012    Member of the Steering Board of the European Network of Excellence “Euro-NF” (Networks of the Future); Organiser of the final conference NGI 2012, Karlskrona, Sweden (2012.06)
- 2008–2015    Executive Editor of the journal “European Transactions on Telecommunications”, now “Transactions on Emerging Telecommunication Technologies” (ETT)

## Completed Ph.D. Students (Principal Supervisor)

1. Dr. Patrik Arlos (2005.10)
2. Dr. Henric Johnson (2005.12)
3. Dr. Lennart Isaksson (2008.03)
4. Dr. Alexandru Popescu (2014.04)
5. Dr. Charlott Lorentzen (2014.04)
6. Dr. Selim Ickin (2015.06)
7. Dr. Junaid Shaikh (2015.09)

## Research Projects

- 2020–2022    National project “PePP”, co-funded by the Ingvar Kamprad Foundation
- 2017–2022    National synergy research project “ViaTech”, co-funded by KKS
- 2014–2020    National research profile “BigData@BTH”, co-funded by KKS
- 2014–2017    European CELTIC project “CONVINCE”, nationally co-funded by VINNOVA
- 2013–2015    European FI-PPP IP “FI-STAR”
- 2011–2012    European CELTIC project “QuEEN”, nationally co-funded by VINNOVA

- 2009–2012 National project “Quality of Experience Based Cross-Layer Optimization of Mobile Streaming On-Demand” (QoEMOS), co-funded by KKS
- 2008–2012 European FP7 Network of Excellence “Euro-NF”
- 2008–2011 European FP7 STREP “PERIMETER”
- 2007–2010 European EUREKA project “Mobicome” (subcontractor through Telenor A/S, Norway)
- 2007–2010 National project “Exploitation and Visualiation of Monitoring Information Used for Realising Always Best Connected” (EViMonA), co-funded by VINNOVA
- 2007–2009 National project “Quality of Experience Based Cross-Layer Design of Mobile Video Systems” (QoEMoVi), co-funded by KKS
- 2006–2009 National project “Smart Mobil Reseguide” (SMR), co-funded by VINNOVA
- 2006–2008 European FP6 Network of Excellence “EuroFGI”
- 2004–2007 National project “Personal Information for Intelligent Transport Systems through Seamless communications and Autonomous decisions” (PIITSA), co-funded by VINNOVA
- 2003–2006 European FP6 Network of Excellence “EuroNGI”
- 1999 Bilateral project funded by Deutsche Telekom, Darmstadt, Germany

## Awards

- 2019.02 Best Paper Award at 2019 IEEE ICACS for the paper “The Effects of Additional Factors on Subjective Quality Assessments”
- 2013.06 IEEE ComSoc Fred W. Ellersick Prize for the article “A generic qualitative relationship between Quality of Experience and Quality of Service”
- 2013.01 Best Paper Award at 2013 IEEE ComManTel for the paper “Quality of Experience Hourglass Model”
- 2010.10 Researcher of the Year at BTH

## Selected Publications

Markus Fiedler's **h-index: 26** (as of June 01, 2020)

- O. Nawaz, M. Fiedler, K. De Moor, and S. Khatibi, "Influence of gender and viewing frequency on Quality of Experience," in Proc. 2020 12<sup>th</sup> Int. Conf. on Quality of Multimedia Experience (QoMEX), Athlone, Ireland/online, June 2020
- M. Fiedler, "Performance analytics of a Virtual Reality streaming model," in Proc. MMB 2020, Saarbrücken, Germany, March 2020
- S. Ickin, K. Vandikas, and M. Fiedler, "Privacy preserving QoE modeling using collaborative learning," in Proc. 4<sup>th</sup> ACM Workshop on QoE-based Analysis and Management of Data Communication Networks (Internet-QoE 2019, with ACM MOBICOM 2019), Los Cabos, Mexico, Oct. 2019
- M. Fiedler, "Performance analytics by means of the M5P Machine Learning algorithm," in Proc. 31<sup>st</sup> International Teletraffic Congress (ITC), Budapest, Hungary, Aug. 2019
- M. Fiedler, U. Chapala, and S. Peteti, "Modeling instantaneous Quality of Experience using Machine Learning of model trees," in Proc. 2019 11<sup>th</sup> Int. Conf. on Quality of Multimedia Experience (QoMEX), Berlin, Germany, June 2019
- M. Fiedler, H.J. Zepernick, and V. Kelkkanen, "Network-induced temporal disturbances in virtual reality applications," in Proc. 2019 11<sup>th</sup> Int. Conf. on Quality of Multimedia Experience (QoMEX), Berlin, Germany, June 2019
- T.N. Minhas, O. Nawaz, M. Fiedler, and S. Khatibi, "The effects of additional factors on subjective quality assessments," in Proc. 2019 2<sup>nd</sup> Int. Conf. on Advancements in Computational Sciences (ICACS), Lahore, Pakistan, Feb. 2019
- V. Kelkkanen and M. Fiedler, "Coefficient of Throughput Variation as indication of playback freezes in streamed omnidirectional videos," in Proc. 2018 28<sup>th</sup> Int. Telecommunication Network and Applications Conf. (ITNAC), Sydney, Australia, Nov. 2018
- V. Kelkkanen and M. Fiedler, "A test-bed for studies of temporal data delivery issues in a TPCAST wireless virtual reality set-up," in Proc. 2018 28<sup>th</sup> Int. Telecommunication Network and Applications Conf. (ITNAC), Sydney, Australia, Nov. 2018
- S. Eivazzadeh, J. S. Berglund, T. Larsson, M. Fiedler, and P. Anderberg, "Most influential qualities in creating satisfaction among the users of health information systems: Study in seven European Union countries," *JMIR Med Inform* 6(4):e11252;3–21, Oct-Dec. 2018
- M. Fiedler, S. Möller, P. Reichl, and M. Xie, "A glance at the Dagstuhl Manifesto 'QoE Vadis?'," in Proc. 2018 10<sup>th</sup> Int. Conf. on Quality of Multimedia Experience (QoMEX), Sardinia, Italy, May 2018
- E. Lagerspetz et al., "Pervasive communities in the Internet of People," in Proc. 2018 IEEE Int. Conf. on Pervasive Computing and Communications (PerCom) Workshops, Athens, Greece, March 2018
- M. Fiedler, K. De Moor, H. Ravuri, P. Tanneedi, and M. Chandiri, "On relationships between QoE ratings, data volumes and intentions to churn," in Proc. 2017 LCN Workshop On User MObility and VEhicular Networks (LCN ON-MOVE), Singapore, Oct. 2017
- Y. Yao, A. Popescu, M. Fiedler, and R. Ljung, "On the performance of mobile video streaming in energy-aware wireless mesh networks," in Proc. 2017 Europ. Conf. on Networks and Communications (EuCNC), Oulu, Finland, June 2017
- F. Fotrousi, S.A. Fricker, and M. Fiedler, "The effects of requests for user feedback on Quality of Experience," *Software Quality Journal*, Springer, May 2017, 31 pp
- T. Hoßfeld, M. Fiedler, and J. Gustafsson, "Betas: Deriving quantiles from MOS-QoE relations of IQX models for QoE management," in Proc. 2017 IFIP/IEEE Int. Symposium on Integrated Network and Service Management (IM 2017), Lisbon, Portugal, May 2017
- O. Nawaz, T.N. Minhas, and M. Fiedler, "QoE based comparison of H.264 and WebM/VP8 in an error-prone wireless network," in Proc. 2017 IFIP/IEEE Int. Symposium on Integrated Network and Service Management (IM 2017), Lisbon, Portugal, May 2017
- M. Fiedler, S. Möller, P. Reichl, and M. Xie, "QoE vadis? (Dagstuhl Perspectives Workshop 16472)," *Dagstuhl Report* 6(11):129–141, 2016; *Dagstuhl Manifesto* 7(1):30–51, 2018

- T.N. Minhas et al., "QoE rating performance evaluation of ITU-T recommended video quality metrics in the context of video freezes," *Australian Journal of Electrical and Electronics Engineering* 13(2):122–131, 2016
- B. Shirmohamadi and M. Fiedler, "Bridging between Quality of Experience and Quality of Service through TCP Flag Ratios," *Proc. 2016 LCN ON-MOVE*, Dubai, UAE, Nov. 2016
- M. Fiedler, A. Popescu, and Y. Yao, "QoE-aware sustainable throughput for energy-efficient video streaming," in *Proc. of 2016 IEEE BDCloud, SocialCom and SustainCom*, Atlanta, GA, Oct. 2016
- D. Ammar, K. De Moor, M. Xie, M. Fiedler, and P. Heegaard, "Video QoE killers and performance statistics in Web-RTC-based video communication," in *Proc. ICCE 2016*, Ha Long, Vietnam, July 2016, pp 429–436
- L. G. M. Ballesteros et al., "Energy Saving Approaches for Video Streaming on Smartphone based on QoE Modeling," in *Proceedings of the 13<sup>th</sup> Annual IEEE Consumer Communications & Networking Conference (CCNC)*, Las Vegas, USA, 2016
- S. Ickin et al., "VLQoE: Video QoE instrumentation on the smartphone," *Multimedia Tools and Applications* 74(2):381–411, Jan. 2015
- K. de Moor, M. Fiedler, P. Reichl, and M. Varela, "Quality of Experience: From Assessment to Application (Dagstuhl Seminar 15022)," *Dagstuhl Report* 5(1):57–93, 2015
- O. Nawaz, T.N. Minhas, and M. Fiedler, "QoE based comparison of H.264 and WebM/VP8 in an error-prone wireless network," in *Proc. 2014 9<sup>th</sup> Int. Conf. for Internet Technology and Secured Transactions (ICITST)*, London, UK, Dec. 2014, pp 396–401
- M. Fiedler, J. Shaikh, and V.J.D. Elepe, "Exponential on-off traffic models for Quality of Experience and Quality of Service assessment," *Praxis der Kommunikationstechnik (PIK)* 37(4):297–304, 2014
- F. Fotrousi, S.A. Fricker, and M. Fiedler, "Quality requirements elicitation based on inquiry of quality-impact relationships," in *Proc. 2014 IEEE 22<sup>nd</sup> Int. Requirements Engineering Conf. (RE)*, Karlskrona, Sweden, Aug. 2014
- M. Fiedler, "On the limited potential of buffers to improve Quality of Experience," in *Proc. 2014 IEEE Int. Conf. on Pervasive Computing and Communications Workshops*, Budapest, Hungary, Mar. 2014
- R. Schatz, M. Fiedler, and L. Skorin-Kapov, "QoE-based network and application management," Chapter 28 of S. Möller and A. Raake, eds: "Quality of Experience," Springer, 2014, pp 411–426
- D. Stezenbach, K. Tutschku, and M. Fiedler, "A Performance Evaluation Metric for NFV Elements on Multiple Timescales," in *Proc. of the IEEE Global Communications Conference (GLOBECOM)*, Atlanta, USA, Dec. 2013
- T.N. Minhas and M. Fiedler, "Quality of Experience Hourglass Model," in *Proc. IEEE ComManTel*, Ho Chi Minh City, Vietnam, Jan. 2013. Best Paper Award
- T. Ciszkowski et al., "Towards quality of experience-based reputation models for future web service provisioning," *Telecommunication Systems*, 51:283–295, Springer, 2012
- J. Shaikh, M. Fiedler, P. Arlos, and D. Collange, "Modeling and analysis of web usage and experience based on link-level measurements," in *Proc. 24th International Teletraffic Congress (ITC 24)*, Cracow, Poland, Sept. 2012
- T. Hossfeld et al., "Initial delays vs. interruptions: Between the devil and the deep blue sea," in *Proc. 2012 Int. Workshop on Quality of Multimedia Experience (QoMEX)*, Yarra Valley, Australia, Jul. 2012
- D. Collange, M. Hajji, J. Shaikh, M. Fiedler, and P. Arlos, "User impatience and network performance," in *Proc. NGI 2012*, Karlskrona, Sweden, June 2012
- S. Ickin et al., "Factors influencing quality of experience of commonly-used mobile applications," *IEEE Communications Magazine*, Special Issue on QoE Management in Emerging Multimedia Services, April 2012
- M. Fiedler, S. Möller, and P. Reichl, "Quality of Experience: From user perception to instrumental metrics (Dagstuhl Seminar 12181)," *Dagstuhl Report* 2(5):1–25, 2012
- C. Lorentzen, M. Fiedler, H. Johnson, and I. Jorstad, "Decisive factors for Quality of Experience of OpenID Authentication using EAP-SIM," in *Proc. ETS 2011*, Poznan, Poland, Feb. 2011
- M. Fiedler, "On resource sharing and careful overbooking for network virtualisation," *Int. Journal of Communication Networks and Distributed Systems (IJCNDS)*, 6(3), 2011
- M. Fiedler and T. Hossfeld, "Quality of Experience-related differential equations and provisioning-delivery hysteresis," in *Proc. 21st ITC Specialists Seminar on Multimedia Applications – Traffic, Performance and QoE*, Miyazaki, Japan, Mar. 2010
- M. Fiedler, T. Hossfeld, and P. Tran-Gia, "A generic quantitative relationship between Quality of Experience and Quality of Service," *IEEE Network*, 24(2):36–41, 2010. Awarded with IEEE ComSoc 2013 Fred W. Ellersick Prize

- J. Shaikh, M. Fiedler, and D. Collange, "Quality of Experience from user and network perspectives," *Annals of Telecommunications*, 65(1-2):47-57, Jan./Feb. 2010
- M. Fiedler, H.-J. Zepernick, L. Lundberg, P. Arlos, and M.I. Pettersson, "QoE-based cross-layer design of mobile video systems: Challenges and concepts," in *Proc. RIVF 2009*, Da Nang, Vietnam, 2009
- T. Ciszkowski et al., "SecMon: End-to-end quality and security monitoring system", *Annales UMCS, Informatica*, 8(1):185-201, 2008
- L. Isaksson and M. Fiedler, "Seamless connectivity in WLAN and cellular networks with Multi Criteria Decision Making," in *Proc. NGI 2007*, Trondheim, Norway, May 2007
- S. Chevul, L. Isaksson, M. Fiedler, J. Karlsson, and P. Lindberg, "Measurement of application-perceived throughput of an E2E VPN connection using a GPRS network," *Springer LNCS 3883: Wireless Systems and Network Architectures in Next Generation Internet*, 2006
- M. Fiedler, S. Chevul, O. Radtke, L. Tutschku, and A. Binzenhöfer, "The Network Utility Function: A practicable concept for assessing network impact on distributed services," in *Proc. 19<sup>th</sup> International Teletraffic Congress (ITC 19)*, Beijing, China, Sept. 2005
- L. Isaksson and M. Fiedler, "On-demand ad-hoc routing with Modified Reverse Path Forwarding for Bluetooth," in *Proc. 2004 Australian Telecommunication Networks and Applications Conference (ATNAC)*, Sydney, Australia, Dec. 2004
- M. Fiedler, K. Tutschku, P. Carlsson, and A.A. Nilsson, "Identification of performance degradation in IP networks using throughput statistics", in *Proc. 18<sup>th</sup> International Teletraffic Congress (ITC 18)*, Berlin, Germany, Sept. 2003
- M. Fiedler and K. Tutschku, "Application of the stochastic fluid flow model for bottleneck identification and classification," in *Proc. 2003 Design, Analysis, and Simulation of Distributed Systems (DASD 2003)*, Orlando, FL, April 2003, pp 35-42
- G. Haßlinger and M. Fiedler, "Why buffers in switching systems do not essentially improve QpE: An analytical case study for aggregated on-off traffic," in *Proc. Internet Performance Control of Networked Systems, SPIE*, Vol. 4895, Boston, MA, July 2002, pp 47-58
- M. Fiedler, P. Carlsson, and A.A. Nilsson, "Voice and multi-fractal data traffic in the Internet," in *Proc. 26<sup>th</sup> Annual IEEE Conf. on Local Computer Networks (LCN 2001)*, Tampa, FL, Nov. 2001, pp 426-431
- M. Fiedler and U.R. Krieger, "The impact of variable channel capacity on the quality of advanced data services in PCS networks," in *Proc. 12<sup>th</sup> ITC Specialists Seminar on Mobile Systems and Mobility*, Lillehammer, Norway, Mar. 2000, pp 51-60
- M. Fiedler and R.G. Addie, "Verification and application of a second-order scale symmetry for queueing systems," in *Proc. 16<sup>th</sup> International Teletraffic Congress (ITC 16)*, Edinburgh, Scotland, June 1999, pp 807-816