2012 IEEE International Symposium on Dynamic Spectrum Access Networks

(DYSPAN 2012)

Bellevue, Washington, USA
16-19 October 2012
Program

**P1: Regulatory Frameworks**

*Allocating Spectrum: Towards a Commons Future*
Mohamed El-Moghazi (University of Strathclyde, United Kingdom); Jason Whalley (University of Strathclyde, United Kingdom); James Irvine (University of Strathclyde, United Kingdom)
pp. 1-9

*Regulating for Carrier Aggregation & Getting Spectrum Management Right for the Longer Term*
Linda Doyle (Trinity College Dublin, Ireland); Jasmina McMenamy (CTVR, Trinity College, Ireland); Timothy K. Forde (University of Dublin, Trinity College, Ireland)
pp. 10-20

*Seeing the bigger picture: context-aware regulations*
Kate Harrison (UC Berkeley, USA); Anant Sahai (UC Berkeley, USA)
pp. 21-32

*Pluralistic Licensing*
Oliver D Holland (King's College London, United Kingdom); Luca De Nardis (University of Rome La Sapienza, Italy); Keith Nolan (Trinity College Dublin, Ireland); Arturas Medeisis (Vilnius Gediminas Technical University, Lithuania); Peter Anker (Ministry of Economic Affairs, Agriculture and Innovation, USA); Leo Minervini (University of Macerata, Italy); Fernando J. Velez (University of Beira Interior & Instituto de Telecomunicações, Portugal); Marja Matinmikko (VTT Technical Research Centre of Finland, Finland); John Sydor (Communications Research Centre, Canada)
pp. 33-41

**T1: Demonstrators, hardware and efficiency**

*A MultiTaper Hardware Core for Spectrum Sensing*
Spyros Kyperountas (Motorola Solutions, USA); Qicai Shi (Motorola Solutions, USA); Neiyer Correal (Motorola Solutions, USA); Alex Vallejo (Motorola Solutions, USA)
pp. 42-46

*Enable Flexible Spectrum Access with Spectrum Virtualization*
Kun Tan (Microsoft Research Asia, P.R. China); Haichen Shen (Microsoft Research Asia, P.R. China); Jiansong Zhang (Microsoft Research Asia, P.R. China); Yongguang Zhang (Microsoft Research Asia, P.R. China)
pp. 47-58

*CSERE (Cognitive System Enabling Radio Evolution): A Modular and User-Friendly Cognitive Engine*
Alexander Young (Virginia Polytechnic Institute and State University, USA); Nicholas Kaminski (Center for Wireless Telecommunications & Virginia Tech, USA); Almohanad Fazez (Virginia Tech, USA); Charles Bostian (Virginia Tech, USA)
pp. 59-67

*Spectrum Utilization Efficiency of Cognitive Radio Systems with Limited Sampling Capability: The Impact of Spectrum Non-contiguity*
Husheng Li (University of Tennessee, USA); Sintayehu Dehnie (Booz Allen Hamilton, USA); Vasu Devan Chakravarthy (Air Force Research Laboratory, USA); Zhiqiang Wu (Wright State University, USA); Yao Ma (Air Force Research Lab, USA); Deborah J Walter (Rose-Hulman Institute of Technology, USA)
pp. 68-76

**P2: Market Mechanisms and Auctions**

*Value System Evolution Towards a Cognitive Radio Era: Implications of Underlying Market Dynamics*
Thomas R. Casey (Aalto University, Finland); Timo Ali-Vehmas (Nokia Corporation, Finland)
Analysis of Policy Instruments for Enhanced Competition in Spectrum Auction
Junwhan Kim (Virginia Tech, USA); Achla Marathe (Virginia Tech, USA); Guanhong Pei (Virginia Tech, USA); Sudip Saha (Virginia Tech, USA); Balaaji Subbiah (Virginia Tech, USA); Anil Kumar S Vullikanti (Virginia Tech, USA)
pp. 89-96

Spectrum access models and auction mechanisms
Kimmo Berg (Aalto University School of Science, Finland); Mikko A Uusitalo (Nokia Research Center, Finland); Carl S. Wijting (Nokia & Nokia Research Center, Finland)
pp. 97-104

T2: Measurements of white space

Statistical Characterization of TVWS Noise: An Experimental Study
Jie Cao (University of Science and Technology of China, P.R. China); Delian Wang (University of Science and Technology of China, P.R. China); Wenyi Zhang (University of Science and Technology of China, P.R. China)
pp. 105-113

An RF Spectrum Observatory Database based on a Hybrid Storage System
George Noorts (Illinois Institute of Technology, USA); Jeffrey Engel (Illinois Institute of Technology, USA); Roger B Bacchus (Illinois Institute of Technology, USA); Tanim M Taher (Illinois Institute of Technology, USA); Jesse Taylor (Illinois Institute of Technology, USA); Dennis A. Roberson (Illinois Institute of Technology & Roberson and Associates, LLC, USA); Kenneth J Zdunek (Illinois Institute of Technology & Roberson and Associates, USA)
pp. 114-120

Digital Dividend Capacity in China: A Developing Country’s Case Study
Liang Yin (Beijing University of Posts and Telecommunications, P.R. China); Kaishun Wu (HKUST & Sun Yat-sen University, Hong Kong); Sixing Yin (Beijing University of Posts and Telecommunications, P.R. China); Jiayue Li (Beijing University of Posts and Telecommunications, P.R. China); Shufang Li (Beijing University of Posts and Telecommunications, P.R. China); Lionel Ni (Hong Kong University of Science and Technology, Hong Kong)
pp. 121-130

Plen1: Plenary 1 Session

Using TV Receiver Information to Increase Cognitive White Space Spectrum
Brage Ellingsæter (University of Oslo, Norway); Hemdan Bezabih (University of Oslo, Norway); Josef Noli (UNIK, Norway); Torleiv Maseng (FFI, Norway)
pp. 131-141

Towards a Market Mechanism for Heterogeneous Secondary Spectrum Usage: An Evolutionary Approach
Ankit Taparia (Aalto University School of Electrical Engineering, Finland); Thomas R. Casey (Aalto University, Finland); Heikki Hämmäinen (Aalto University, Finland)
pp. 142-153

Measurements of Spectrum Use in London: Exploratory Data Analysis and Study of Temporal, Spatial and Frequency-Domain Dynamics
Alexandros Palaios (RWTH Aachen University, Germany); Janne Riihijärvi (RWTH Aachen University, Germany); Oliver D Holland (King's College London, United Kingdom); Andreas Achtzehn (RWTH Aachen University, Germany); Petri Mähönen (RWTH Aachen University, Germany)
pp. 154-165
**P3: DSA Frameworks and Architectures**

**Taxonomy of Cognitive Radio Applications**  
Arturas Medeisis (Vilnius Gediminas Technical University, Lithuania); Oliver D Holland (King's College London, United Kingdom); Luca De Nardis (University of Rome La Sapienza, Italy)  
pp. 166-170

**The Hinges of Destiny: A Decision Analysis of Spectrum Users' Choices**  
Martin B. H. Weiss (University of Pittsburgh, USA); Liu Cui (University of Pittsburgh, USA)  
pp. 171-179

**MobilityFirst, LTE and the Evolution of Mobile Networks**  
Roy Yates (Rutgers University, USA); William Lehr (Massachusetts Institute of Technology, USA)  
pp. 180-188

**To subscribe, or not to subscribe: Modeling and analysis of service paradigms in cellular markets**  
Georgios Fortetsanakis (University of Crete, Greece); Maria Papadopouli (University of Crete, Greece); Gunnar Karlsson (KTH Royal Institute of Technology, Sweden); Manos Dramitinos (Athens University of Economics and Business, Greece); Emre A. Yavuz (Royal Institute of Technology (KTH), Sweden)  
pp. 189-200

**T3: Interference and co-existence**

**Optimizing power limits for white space devices under a probability constraint on aggregated interference**  
Yngve Selén (Ericsson AB, Sweden); Jonas Kronander (Ericsson AB, Sweden)  
pp. 201-211

**A Closed-Form Solution to the Power Minimization Problem over Two Orthogonal Frequency Bands under QoS and Cognitive Radio Interference Constraints**  
Raouia Masmoudi (ETIS / ENSEA - University of Cergy-Pontoise - CNRS & LETI / ENIS-University of Sfax, France); Elena Veronica Belmega (ENSEA/UCP/CNRS, France); Inbar Fijalkow (ETIS, CNRS, ENSEA, UniversityCergy-Pontoise, France); Noura Sellami (Ecole Nationale d'Ingénieurs de Sfax, Tunisia)  
pp. 212-222

**On Time-domain Coexistence of Unlicensed and Licensed Spectrum Users**  
Ashwini Kumar (University of Michigan, USA); Kang G. Shin (University of Michigan, USA); YoungJune Choi (Ajou University, Korea); Dragos S Niculescu (Universitatea Politehnica Bucuresti, Romania)  
pp. 223-234

**Delay Analysis of a Point-to-Multipoint Spectrum Sharing Network With CSI Based Power Allocation**  
Fahd Ahmed Khan (King Abdullah University of Science and Technology, Saudi Arabia); Kamel Tourki (Texas A&M University at Qatar, Qatar); Mohamed-Slim Alouini (King Abdullah University of Science and Technology (KAUST), Saudi Arabia); Khalid A. Qaraqe (Texas A&M University at Qatar, USA)  
pp. 235-241

**Plen2: Plenary Session 2**

**A Dual Technology Femto Cell Architecture for Robust Communication using Whitespaces**  
Sayandeep Sen (University of Wisconsin Madison, USA); Tan Zhang (University of Wisconsin-Madison, USA); Milind Madhav Buddhikot (Bell Labs, Alcatel-Lucent, USA); Suman Banerjee (University of Wisconsin, USA); Dragan Samardzija (Bell Labs, Alcatel-Lucent, USA); Susan Walker (Bell Labs, Alcatel-Lucent, USA)  
pp. 242-253
**Capacity of cellular networks deployed in TV White Space**
Torsten Dudda (Ericsson Research, Germany); Tim Irnich (Ericsson Research, Germany)
pp. 254-265

**IEEE DySPAN 2012 Demonstrations**

**Demonstrating Radio Environment Map Construction from Massive Data Sets**
Janne Riihijärvi (RWTH Aachen University, Germany); Jad Nasreddine (RWTH Aachen University, Germany); Petri Mähönen (RWTH Aachen University, Germany)
pp. 266-267

**Real-Time Interference Reduction for OFDM-based Dynamic Spectrum Access Networks**
Ahmed Selim (Trinity College, Dublin, Ireland); Linda Doyle (Trinity College Dublin, Ireland)
pp. 268-269

**Cognitive Radio Universal Software Hardware**
George Elchinger, III (MIT Lincoln Laboratory, USA); Kaushik Chowdhury (Northeastern University, USA); Miriam Leeser (Northeastern University, USA)
pp. 270-271

**REM-enabled opportunistic LTE in the TV band**
Jaap van de Beek (Huawei Technologies, Sweden); Erik Lidström (Huawei Technologies, Sweden); Tao Cai (Huawei Technologies Sweden AB, Sweden); Yong Xie (Huawei Technologies, P.R. China); Valentín Rakovic (Ss. Cyril and Methodius University in Skopje, Macedonia, the former Yugoslav Republic of); Vladimir Atanassovski (Ss Cyril and Methodius University in Skopje, Macedonia, the former Yugoslav Republic of); Liljana Gavrilovska (Ss Cyril and Methodius University - Skopje, Macedonia, the former Yugoslav Republic of); Janne Riihijärvi (RWTH Aachen University, Germany); Petri Mähönen (RWTH Aachen University, Germany); Antoine Dejonghe (IMEC, Belgium); Peter Van Wesemael (IMEC, Belgium); Mattias Desmet (IMEC, Belgium)
pp. 272-273

**Interference Robust SDR FE receiver**
Peter Van Wesemael (IMEC, Belgium); Sofie Pollin (IMEC / UC Berkeley, USA); Mattias Desmet (IMEC, Belgium); Antoine Dejonghe (IMEC, Belgium)
pp. 274-275

**Receiver-driven handover between Independent Networks**
Justin Tallon (University of Dublin, Trinity College & CTVR, Ireland); Jacek Kibilda (Wrocławskie Centrum Badan EIT+ & Trinity College Dublin, Poland); Timothy K. Forde (University of Dublin, Trinity College, Ireland); Luiz A. DaSilva (Virginia Polytechnic Institute and State University & Trinity College Dublin, Ireland); Linda Doyle (Trinity College Dublin, Ireland)
pp. 276-277

**Enforcing Dynamic Spectrum Access with Spectrum Permits**
Zengbin Zhang (University of California, Santa Barbara, USA); Lei Yang (Intel Labs, USA); Yibo Zhu (University of California, Santa Barbara, USA); Ben Y. Zhao (University of California at Santa Barbara, USA); Haitao Zheng (University of California, Santa Barbara, USA)
pp. 278-279

**Design and Implementation of an Underlay Control Channel**
Daryl Leon Wasden (University of Utah, USA); Jose A Loera (Idaho National Laboratory, USA); Arslan Majid (University of Utah, USA); Hussein Moradi (Idaho National Laboratory, USA); Behrouz Farhang-Boroujeny (University of Utah, USA)
pp. 280-281

**IEEE DySPAN 2012 Posters**

**Separating the Wheat from the Chaff: Sensing Wireless Microphones in TVWS**
Sun Huanhuan (University of Science and Technology of China, P.R. China); Taotao Zhang (University of Science and Technology of China, P.R. China); Wenyi Zhang (University of Science and Technology of China, P.R. China)
p. 282
Eigenvalue-based Signal Detection in Cognitive Femtocell Networks using a Decentralized Lanczos Algorithm
Federico Penna (Fraunhofer Heinrich Hertz Institute, Germany); Slawomir Stanczak (Fraunhofer Heinrich Hertz Institute, Germany)
pg. 283

Robust Interference Identification for Multi-RAT Optimization in Wireless Cellular Networks
Emmanuel Pollakis (Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute, Germany); Renato Luis Garrido Cavalcante (Fraunhofer Heinrich Hertz Institute, Germany); Slawomir Stanczak (Fraunhofer Heinrich Hertz Institute, Germany); Federico Penna (Fraunhofer Heinrich Hertz Institute, Germany)
pg. 284

Enriching Cellular Networks with Dynamic Spectrum Access and Energy Harvesting: A Network Planning Case
Przemyslaw Pawelczak (Delft University of Technology, The Netherlands); Meng Zheng (Shenyang Institute of Automation, P.R. China); Slawomir Stanczak (Fraunhofer Heinrich Hertz Institute, Germany); Haibin Yu (Shenyang Institute of Automation China Academy of Sciences, P.R. China)
pg. 285

Physical Layer Authentication Using Controlled Inter Symbol Interference
Vireshwar Kumar (Virginia Polytechnic Institute and State University, USA); Jung-Min Park (Virginia Polytechnic Institute and State University, USA); Jaeweon Kim (National Instruments, USA); Ahsan Aziz (National Instruments, USA)
pg. 286

Measurement-calibrated Conflict Graphs for Dynamic Spectrum Distribution
Xia Zhou (University of California, Santa Barbara, USA); Zengbin Zhang (University of California, Santa Barbara, USA); Gang Wang (UC Santa Barbara, USA); Xiaoxiao Yu (Tsinghua University, P.R. China); Ben Y. Zhao (University of California at Santa Barbara, USA); Haitao Zheng (University of California, Santa Barbara, USA)
pg. 287

Outage and SER Performance of An Opportunistic Multi-User Underlay Cognitive Network
Fahd Ahmed Khan (King Abdullah University of Science and Technology, Saudi Arabia); Kamel Tourki (Texas A&M University at Qatar, Qatar); Mohamed-Slim Alouini (King Abdullah University of Science and Technology (KAUST), Saudi Arabia); Khalid A. Qaraq (Texas A&M University at Qatar, USA)
pg. 288

T4: LTE and cellular I

Opportunistic spectrum access in TVWS: A Comparative Coexistence Study for LTE
Christoph Thein (Leibniz Universität Hannover, Germany); Martin Fuhrwerk (Leibniz Universität Hannover, Germany); Jürgen Peissig (Leibniz Universität Hannover, Germany); Malte Schellmann (Huawei Technologies Duesseldorf GmbH, Germany)
pp. 289-298

LTE Signal Classification and Center Frequency Detection without Priori Information
Tugba Erpek (Shared Spectrum Company, USA); Karl Steadman (Shared Spectrum Company, USA); Ram Krishnan (Shared Spectrum Company, USA); Qiao Chen (Shared Spectrum Company, USA)
pp. 299-304

Supporting Dynamic Spectrum Access in Heterogeneous LTE+ Networks
Juan Deaton (Idaho National Lab, USA); Luiz A. DaSilva (Virginia Polytechnic Institute and State University & Trinity College Dublin, Ireland); Michael Benonis (Virginia Polytechnic Institute and State University, USA); Ryan Irwin (Raytheon BBN Technologies, USA)
pp. 305-316
T5: LTE and cellular II

Mechanisms for LTE Coexistence in TV White Space
Mihaela Beluri (Interdigital, USA); Erdem Bala (InterDigital, USA); Yuying Dai (Interdigital Communications, USA); Rocco Di Girolamo (InterDigital, Canada); Martino Freda (Interdigital, Canada); Jean-Louis Gauvreau (InterDigital, Canada); Scott Laughlin (InterDigital, Canada); Debashish Purkayastha (InterDigital Communication Corporation, USA); Athmane Touag (InterDigital, Canada)
pp. 317-326

Distributed TV Spectrum Allocation for Cognitive Cellular Network under Game Theoretical Framework
Di Li (RWTH-Aachen University, Germany); James Gross (Royal Institute of Technology (KTH), Sweden)
pp. 327-338

Opportunistic Traffic Scheduling in Cellular Data Networks
Utpal Paul (Stony Brook University, USA); Milind Madhav Buddhikot (Bell Labs, Alcatel-Lucent, USA); Samir R. Das (Stony Brook University, USA)
pp. 339-348

P4: Spectrum Sharing and Market Mechanisms

When is electromagnetic spectrum fungible?
Martin B. H. Weiss (University of Pittsburgh, USA); Prashant Krishnamurthy (University of Pittsburgh, USA); Linda Doyle (Trinity College Dublin, Ireland); Konstantinos Pelechrinis (University of Pittsburgh, USA)
pp. 349-357

Clearing Secondary Spectrum Market with Spatio-temporal Partitioning
Sudip Saha (Virginia Tech, USA); Achla Marathe (Virginia Tech, USA); Guanhong Pei (Virginia Tech, USA); Balaaji Subbiah (Virginia Tech, USA); Junwhan Kim (Virginia Tech, USA); Anil Kumar S Vullikanti (Virginia Tech, USA)
pp. 358-367

Should primaries be considered victims or police?
Kristen Woyach (UC Berkeley, USA); Anant Sahai (UC Berkeley, USA)
pp. 368-377

Business model analysis for spectrum sharing with the spectrum broker
Michał H Szydelko (Wroclaw Research Centre EIT+ ltd, Poland)
pp. 378-388

T6: Sensing and related issues 1

GLRT Based Cooperative Spectrum Sensing with Soft Combination in Heterogeneous Networks
Jun Luo (University of Electronic Science and Technology of China, P.R. China); Jun Wang (University of Electronic Science and Technology of China, P.R. China); Qiang Li (University of Electronic Science & Technology of China, P.R. China); Shaoqian Li (University of Electronic Science and Technology of China, Taiwan)
pp. 389-396

Channel Sensing Order in Multi-user Cognitive Radio Networks
Jie Zhao (Stony Brook University, USA); Xin Wang (Stony Brook University, USA)
pp. 397-407

Design of Sensing and Power Allocation Strategies For Energy-Aware Multi-Channel Cognitive Radio Networks
Guangjie Huang (Auburn University, USA); Jitendra Tugnait (Auburn University, USA)
pp. 408-415
**White Spaces potentially available in Italian scenarios based on the geo-location database approach**
Marina Barbiroli (University of Bologna, Italy); Claudia Carciofi (FUB, Italy); Doriana Guiducci (Fondazione Ugo Bordoni, Italy); Valeria Petrini (Fondazione Ugo Bordoni, Italy)
p. 416-421

**Plen3: Plenary session 3**

**Practical Radio Environment Mapping with Geostatistics**
Caleb T Phillips (University of Colorado, USA); Douglas Sicker (University of Colorado, USA); Dirk Grunwald (University of Colorado, USA)
p. 422-433

**Cognitive Interference Modeling with Applications in Power and Admission Control**
Nurul H. Mahmood (Aalborg University, Denmark); Ferkan Yilmaz (King Abdullah University of Science and Technology, Saudi Arabia); Mohamed-Slim Alouini (King Abdullah University of Science and Technology (KAUST), Saudi Arabia); Geir E. Øien (NTNU, Norway)
p. 434-439

**Competition in Secondary Spectrum Markets: Price War or Market Sharing?**
Emir Kavurmacioglu (Boston University, USA); Murat Alanyali (Boston University, USA); David Starobinski (Boston University, USA)
p. 440-451

**P5: Spectrwm Sharing and TV White Spaces**

**Secondary Spectrum Access in TV-Bands with Combined Co-Channel and Adjacent Channel Interference Constraints**
Lei Shi (KTH, Sweden); Ki Won Sung (Royal Institute of Technology (KTH), Sweden); Jens Zander (KTH Royal Institute of Technology, Sweden)
p. 452-460

**Is Wireless Broadband Provision to Rural Communities in TV Whitespaces Viable? A UK Case Study and Analysis**
Santosh Kawade (British Telecom, United Kingdom); Maziar Nekovee (BTexact Technologies, British Telecom, United Kingdom)
p. 461-466

**Geolocation Database beyond TV White Spaces? Matching Applications with Database Requirements**
Matthias Barrie (IBBT-SMIT, Vrije Universiteit Brussel, Belgium); Simon Delaere (IBBT-SMIT, Vrije Universiteit Brussel, Belgium); Gintarė Sukarevičienė (Vytautas Magnus University, Belgium); John Gesquiere (Televic, Belgium); Ingrid Moerman (Ghent University - IBBT, Belgium)
p. 467-478

**T7: Access policies**

**Overlay Spectrum Reuse in a Broadcast Network: Covering the Whole Grayscale of Spaces**
Alberto Rico-Alvariño (University of Vigo, Spain); Carlos Mosquera (Universidad de Vigo, Spain)
p. 479-488

**Ontology-based Spectrum Access Policies for Policy-based Cognitive Radios**
Behnam Bahrak (Virginia Polytechnic Institute and State University, USA); Jung-Min Park (Virginia Polytechnic Institute and State University, USA); Hao Wu (Virginia Tech, USA)
p. 489-500
QP-CSMA-CA: A Modified CSMA-CA-based Cognitive Channel Access Mechanism with Testbed Implementation
Chittabrata Ghosh (University of Cincinnati, USA); Hossein Safavi-Naeini (University of Washington, Seattle, Finland); Sumit Roy (University of Washington, USA); Klaus Doppler (Nokia, Finland); Joshua Stahl (University of Washington, Seattle, USA)
pp. 501-509

T8: Phy and MAC

Efficient Sidelobe Suppression for OFDM Systems with Peak-to-Average Power Ratio Reduction
Ahmed Selim (Trinity College, Dublin, Ireland); Baris Ozgul (Xilinx, Ireland); Linda Doyle (Trinity College Dublin, Ireland)
pp. 510-516

Adaptive Frequency Hopping Algorithms for Multicast Rendezvous in DSA Networks
Mohammad J. Abdel Rahman (University of Arizona, USA); Hanif Rahbari (University of Arizona, USA); Marwan Krunz (University of Arizona, USA)
pp. 517-528

A Neighbor Cooperation Framework for Time-efficient Asynchronous Channel Hopping Rendezvous in Cognitive Radio Networks
Quan Liu (National University of Defense Technology, P.R. China); Deming Pang (National University of Defense Technology, P.R. China); Gang Hu (National University of Defense Technology, P.R. China); Xiaodong Wang (National University of Defence Technology, P.R. China); XingMing Zhou (School of Computer, National University of Defense Technology, P.R. China)
pp. 529-539

T9: Sensing and related issues II

Application of Cognitive Radio Techniques to Satellite Communication
Marko Höyhtyä (VTT Technical Research Centre of Finland, Finland); Jukka Kyröläinen (Elektrobit, Finland); Ari Hulkkonen (Elektrobit, Finland); Juha Ylitalo (Elektrobit, Finland); Antti Roivainen (Centre for Wireless Communications, Finland)
pp. 540-551

TV white space databases: Algorithms for the calculation of maximum permitted radiated power levels
Hamid Reza Karimi (Ofcom, United Kingdom); Valeria Petrini (Fondazione Ugo Bordoni, Italy)
pp. 552-560

Single-tone Spectrum Allocation under SINR Requirements
BragE Ellingsæter (University of Oslo, Norway)
pp. 561-570