Contents

Keynote Talks

The Risk Assessment of ERTMS-Based Railway Systems from a Cyber Security Perspective: Methodology and Lessons Learned .......................... 3
   Robin Bloomfield, Marcus Bendele, Peter Bishop, Robert Stroud, and Simon Tonks

Using Formal Proof and B Method at System Level for Industrial Projects .................. 20
   Denis Sabatier

A Novel Approach to HW/SW Integration Testing of Route-Based Interlocking System Controllers ........................................... 32
   Jan Peleska, Wen-ling Huang, and Felix Hübner

Security

A Formal Security Analysis of ERTMS Train to Trackside Protocols ................ 53
   Joeri de Ruiter, Richard J. Thomas, and Tom Chothia

Operational Security – A Coming Evolution of Railway Operational Procedures Under the IT Security Threat .................................. 69
   Po-Chi Huang and Birgit Milius

Risk Assessment of the 3Des in ERTMS .............................................. 79
   Florent Pépin and Maria Grazia Vigliotti

Systems

Failure Analysis of Chinese Train Control System Level 3 Based on Model Checking ................................................................. 95
   Xiao Han, Tao Tang, Jidong Lv, and Haifeng Wang

Correct Formalization of Requirement Specifications: A V-Model for Building Formal Models .......................................................... 106
   Marco Filax, Tim Gonschorek, and Frank Ortmeier

Static Verification of Railway Schema and Interlocking Design Data .................. 123
   Alexei Iliasov, Paulius Stankaitis, and David Adjepon-Yamoah

Verification of Railway Interlocking - Compositional Approach with OCRA .......... 134
   Christophe Limbrée, Quentin Cappart, Charles Pecheur, and Stefano Tonetta
Safety Verification of Heterogeneous Railway Networks ......................... 150
  Paulius Stankaitis and Alexei Iliasov

Comparing Formal Verification Approaches of Interlocking Systems .......... 160
  Anne Elisabeth Haxthausen, Hoang Nga Nguyen,
  and Markus Roggenbach

Predictive Reasoning and Machine Learning for the Enhancement
of Reliability in Railway Systems ........................................... 178
  Luke J.W. Martin

**Verification and Validation**

Applying Abstract Interpretation to Verify EN-50128 Software
Safety Requirements ................................................................. 191
  Daniel Kästner and Christian Ferdinand

The PERF Approach for Formal Verification .................................. 203
  Nazim Benaissa, David Bonvoisin, Abderrahmane Feliachi,
  and Julien Ordioni

Abstract Software Specifications and Automatic Proof of Refinement ...... 215
  Claire Dross and Yannick Moy

S3: Proving the Safety of Critical Systems ...................................... 231
  Nicolas Breton and Yoann Fonteneau

Increasing Proofs Automation Rate of Atelier-B Thanks to Alt-Ergo ........ 243
  Sylvain Conchon and Mohamed Iguernlala

**Author Index** ................................................................. 255