Towards Cognitive Cyber-Physical Systems

We are starting a new cycle in the life of CTS.

The center has been developing its activities in major domains of Electrical, Electronics and Computer Engineering, addressing engineered systems with a cyber-physical dimension and their supporting technologies. During the period 2013-2017, CTS had the following main goals: (a) Develop knowledge and enabling technologies for smart interconnected environments, including smart objects/devices, machines, people and systems; (b) Increase internationalization, reflected in the number of projects and presence in committees and initiatives of the related scientific community; (c) Consolidate and strengthen a sustainable PhD education program. Research contributions to these areas were carried out in the context of more than 100 funded projects (43% European R&D projects, 38% national R&D projects, 19% knowledge transfer services). As a result, we had 1163 publications (28.4% in journals, 64.2% in conferences, the remaining as books and book chapters). Among journal articles, 67.6% in Q1 & Q2 (Scimago). Among conference papers, 62.2% were in type A and B conferences (ranking FCT-NOVA). A total of 54 PhD theses were finished in this period.

For the next period, we aim at making substantial scientific and technological contributions to the development of the next generation of cognitive and inter-connected cyber-physical systems. This effort will consolidate CTS as an internationally recognized reference center in the area.

Research activities are expected to focus on systems with growing levels of intelligence, autonomy, and hyper-connectivity. This entails data-rich environments, distributed intelligence, mobility and

autonomy, where sensing, micro-electronics, embedded systems, machine learning, computational intelligence and qualitative reasoning, robotics and automation, interoperability and collaboration, security, and balanced human-systems collaboration play a major role. Global concerns of sustainability, including energy efficiency and systems optimization, encompass the developments.

Addressing such systems requires contributions from multiple knowledge areas. CTS covers a wide spectrum of competences, which provide a great opportunity to adopt a holistic perspective and to further integrate this diversity of knowledge into a truly interdisciplinary approach.

All CTS members are thus strongly encouraged to contribute to this effort, seeking collaboration ties with colleagues from other groups. We need to put an end to the traditional "closed groups" paradigm and instead actively promote cross-fertilization of
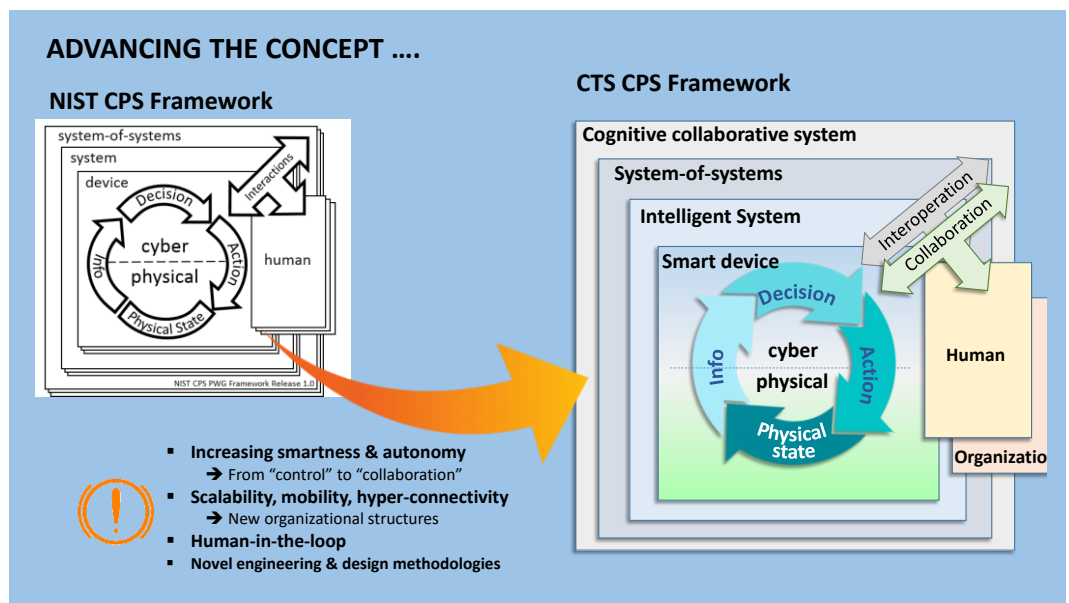
knowledge areas and experiences. Only through an interdisciplinary approach we can effectively contribute to societal challenges and make remarkable scientific impact.

The current governance bodies of CTS will make all efforts to fulfill the adopted **vision**:

> "*Over the next 5 years, CTS will become internationally recognized as a leading research center on inter-connected and cognitive cyber-physical systems. It will guarantee a supportive and agile interdisciplinary research environment, and a culture of excellence and responsible research for its members*."

This shall be done in accordance to the mission of CTS:

- Plan and conduct high quality research on advanced engineering systems [**research excellence**]
- Create value and societal impact with research results [**society engagement excellence**]
- Train the future generation of researchers in the area [**education excellence**].

Let's do it!

Luis M. Camarinha-Matos
Director of CTS

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Call for Contributions

Please contribute with short technical notes and news of interest to the CTS community!

We especially expect contributions **showing collaboration between groups / knowledge areas** and contributing to **cognitive cyber-physical systems**

The IOPT-Tools framework

Cyber-physical systems have been a hot topic during almost one decade. As other buzzwords, such as internet-of-things, embedded systems, system-of-systems, and more recently Industry4.0, they benefit from some fuzzy definition and it is common to find different groups of experts contributing to their characterization and development, both coming from industry as well as from academia.

The IOPT-Tools web-based framework, publicly available at http://gres.uninova.pt/IOPT-Tools/, adopting a model-based development approach where Petri nets play the role of central modeling formalism, intends to provide support for the complete development flow for cyber-physical systems, embedded systems, and internet-of-things, offering tools for engineers as well as for academics.
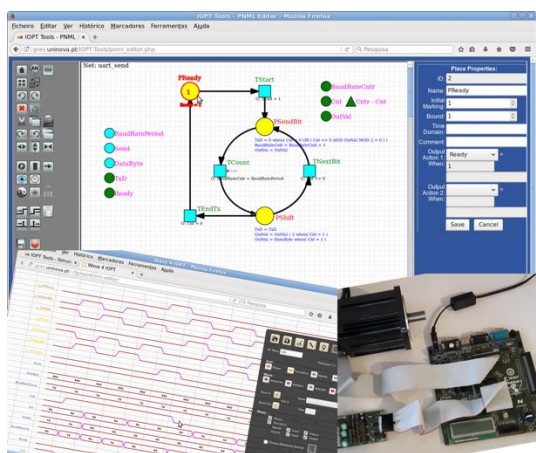
Rapid-prototyping is fully supported, through the use of FPGAs and common platforms (such as Arduino and Raspberry-Pi), and integrating an editor, a simulator, a remote debugger, property verification tools, as well as automatic code generation for hardware (VHDL), software (C), and PLC (IL) based implementations.

The IOPT-Tools rely on a class of Petri nets (the IOPT-nets - Input-Output Place-Transition nets), initially targeted for controller modeling, which has been enriched with new contributions extending their applications to globally-asynchronous locally-synchronous systems (introducing concepts of time domains and communication channels).

The IOPT-Tools framework is a result of a large number of contributions from researchers of GRES (R&D Group on Reconfigurable and Embedded Systems), as well as from several MSc students from FCT. For IOPT-Tools a simple user manual, available at the referred website, may help everyone starting using the tools. Anyway, the developers are close by and ready to react to new users' questions and requests.
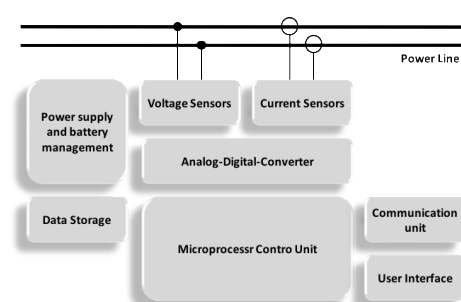
Luis Gomes

Smart Metering – An unstoppable process…

Our modern economy is energy-driven, being electricity the major future energy vector among worldwide end-uses of energy. Accordingly to the International Energy Agency, electricity will make up 40% of the rise in final consumption to 2040 which corresponds to same share of growth experienced by oil within the past twenty-five years. Whatever the expected future for electric grids, metering has always been a key component in the electricity markets: wherever there is a service there is the need to measure it. The first known meter dates from 1872. Samuel Gardiner patented a meter that counted the time in which energy was supplied to a set of lamps. Nowadays it is crucial to consider an advanced metering infrastructure (AMI) based on smart meters, which are expected to play a key role in the transition from a traditional grid into a smart grid. A traditional smart meter can be described as an advanced meter device able to electronically identify and measure power

Smart Meter Architecture

consumption and communicate this information. The widespread of smart meters is nowadays a reality and an unstoppable process. In the USA it was reported that approximately 37 million smart meters were shipped between 2011 and 2014. On Europe, European Union aims to replace at least 80% of electricity meters with smart meters by 2020 wherever it is cost-effective to do so. Close to 200 million smart meters are expected be rolled out in the EU by 2020. 14 European member countries (Austria, Denmark, Estonia, Finland, France, Greece, Ireland, Italy, Luxemburg, Malta, Netherlands, Spain, Sweden and UK) are currently proceeding with large-scale rollout by 2020 or earlier [ref]. For all of these the stated expected penetration by 2020 is 95% or more. Notably, in three of the countries (Finland, Italy and Sweden), close to 45m smart meters are already installed, amounting to almost a quarter of the 2020 total. Several European Projects are also responsible for this roll out. For example, H2020 NOBELGRID project is expected to deploy alone around 500 smart meters over five pilot test sites (http://nobelgrid.eu).

João Martins

This year's edition of the Advanced Doctoral Conference on Computing, Electrical and Industrial Systems (DoCEIS' 2018) will take place on May 2-4. This 9th edition will be dedicated to Technological Innovation for Resilient Systems. Is intended to be an international and professional platform for Doctoral Students, Researchers and Academicians whose scope of work entails the design, application and adaptation of Resilient Systems in relation to Collaborative Systems, Sensing Technologies, Computer Networks, Internet of Things / Cyber Physical Systems (IoT/CPS), Industrial Systems, Energy Systems, Smart Objects and General Management of all aspects of Technology, that focus on Resilience.

For the second time, in conjunction with DoCEIS, UNINOVA & FCT/UNL will host the International Young Engineers Forum on Electrical and Computer Engineering (**YEF-ECE 2018**). The International Young Engineers Forum looks for the latest developments and innovative applications in electrical and computer engineering, dealing with systems' design and utilization, looking forward to efficient devices and systems with appropriate control algorithms to meet the needs of business and industry in a global economy.

Keynotes and Tutorials at DoCEIS/YEF-ECE 2018

Several keynotes and tutorials of relevance to CTS members are planned for DoCEIS/YEF-ECE 2018:

Keynotes:

- Blockchains Beyond Cryptocurrencies – Prof. Laura Ricci, University of Pisa, Italy
- Dependable Internet of Things – Prof. Kay Römer, TU Graz, Austria
- Enabling efficient management of distributed energy resources in the context of smart grids: A cognitive and multi-Agent based approach – Prof. Zita Vale, Polytechnic Institute of Porto, Portugal

Horizontal topics:

- Communicating Science Visually - Marco Neves, NOVA FCSH
- Design Thinking - Guilherme Victorino, NOVA IMS

- Finishing My PhD: The Next 90 Days - Joana Marques, FPUL
- Leadership - Pedro Sousa, FCT NOVA

Tutorials:

- Electricity markets and intelligent agents: The MATREM system and its application to the Iberian Daily Market - Fernando Lopes, Hugo Algarvio, LNEGI
- Wireless Architectures for the Internet of Things - Luis Bernardo, Rodolfo Oliveira, FCT NOVA
- Petri Nets and IOPT-tools application – hands-on exercise - Luis Gomes, Fernando Pereira, Filipe Moutinho, FCT NOVA
- Smart manufacturing and digitalization - José Barata, FCT NOVA

CTS members are invited to attend
these sessions!

Best Paper Award

CTS researchers received the best paper award at I-ESA 2018 in Berlin, for the work developed in the recently concluded C2NET project.

"A Lightweight IoT Hub for SME Manufacturing Industries" describes part of that endeavour, and is focused on one of the components developed, a low-cost middleware providing small and medium sized manufacturing industries the ability to virtualize and integrate the physical devices network installed at the shop-floor with the cloud.

Dr. Carlos Agostinho received the award from Dr.-Ing. Thomas Knothe (Conference Vice-Chair and Head of Business Process and Factory Management at Fraunhofer IPK) and Prof. Guy Doumeingts (I-Vlab General Manager).

CTS-Management Structure

The new management structure of the CTS is composed of the following governing bodies:
1. Director
2. Board of Directors
3. Coordination Committee
4. Scientific Council
5. External Advisory Board
   a. Scientific Advisory Board
   b. Industry Advisory Board

The composition of these governing bodies is as follows:
1. Director [Luis Camarinha-Matos]
2. Board of Directors
   - Director
   - Research Programs Liaison Officer [Ricardo Gonçalves]
   - Industry Liaison Officer [José Barata]
   - Institutional Relationships Liaison Officer [Luis Oliveira]
   - Communication Officer [João Martins]
3. Coordination Committee
   - Director
   - Coordinators of research groups
4. Scientific Council
   - Director
   - All integrated members
5. External Advisory Board
   - Scientific Advisory Board: A selected group of high level researchers (international), covering the main areas of expertise of CTS
   - Industry Advisory Board: A selected group of high level industry members

Some Funding Opportunities

Until August 2018 there are several open calls with potential relevance to CTS and its members. Below you can find an example list of those calls:

H2020:
- INNOSUP-03-2018: Blockchain and distributed ledger technologies for SMEs – 15 May 2018
- UCPM-2018-EX-AG: Union Civil Protection Mechanism Exercises – 15 May 2018
- SU-ICT-03-2018: Establishing and operating a pilot for a Cybersecurity Competence Network to develop and implement a common Cybersecurity Research & Innovation Roadmap – 29 May 2018
- IMI2-2018-14-03: Development of a platform for federated and privacy-preserving machine learning in support of drug discovery – 14 Jun 2018
- EIT-Manufacturing-2018: Added-value manufacturing: a cross-cutting challenge – 12 Jul 2018
- EIT-Urban-Mobility: Urban mobility: a cross-cutting challenge – 12 Jul 2018
- SU-BES02-2018-2019-2020: Technologies to enhance border and external security – 23 Aug 2018
- SU-BES03-2018-2019-2020: Demonstration of applied solutions to enhance border and external security – 23 Aug 2018
- SU-DRS01-2018-2019-2020: Human factors, and social, societal, and organisational aspects for disaster-resilient societies – 23 Aug 2018
- SU-DRS02-2018-2019-2020: Technologies for first responders – 23 Aug 2018
- SU-DRS03-2018-2019-2020: Pre-normative research and demonstration for disaster-resilient societies – 23 Aug 2018
- SU-DS01-2018: Cybersecurity preparedness - cyber range, simulation and economics – 23 Aug 2018
- SU-DS04-2018-2020: Cybersecurity in the Electrical Power and Energy System (EPES): an armour against cyber and privacy attacks and data breaches – 23 Aug 2018
- SU-DS05-2018-2019: Digital security, privacy, data protection and accountability in critical sectors – 23 Aug 2018
- SU-FCT02-2018-2019-2020: Technologies to enhance the fight against crime and terrorism – 23 Aug 2018
- SU-FCT03-2018-2019-2020: Information and data stream management to fight against (cyber)crime and terrorism – 23 Aug 2018
- SU-INFRA01-2018-2019-2020: Prevention, detection, response and mitigation of combined physical and cyber threats to critical infrastructure in Europe – 23 Aug 2018
- SU-ICT-01-2018: Dynamic countering of cyber-attacks – 28 Aug 2018

AAL
- Smart Solutions for Ageing well – 28 May 2018
- Smart Ageing Prize – 28 May 2018

P2020
- Modelos de apoio à vida independente (MAVI) – 7 May 2018
- Programa de parcerias para o impacto – 10 May 2018

INTERREG
- Interreg - Atlantic Area – 1 Jun 2018
- Interreg – Europe – 22 Jun 2018

EEA
- EEA and Norway Grants Fund for Regional Cooperation – 1 Jul 201

Publications Update (2017 **Q1** journal articles from CTS members)

1. B. Nowacki; Nuno Paulino; João Goes, "A Third-Order MASH ΣΔ Modulator Using Passive Integrators", IEEE Trans on Circuits & Systems I: Regular Papers, 2017.

2. H. Serra, R. Santos-Tavares and N. Paulino, "A Numerical Methodology for the Analysis of Switched-Capacitor Filters Taking Into Account Non-Ideal Effects of Switches and Amplifiers," in IEEE Transactions on Circuits and Systems I: Regular Papers, vol. 64, no. 1, pp. 61-71, Jan. 2017

3. Ricardo Povoa; Nuno Lourenco; Ricardo Martins; Antonio Canelas; Nuno Horta; João Goes, "Single-Stage Amplifier biased by Voltage-Combiners with Gain and Energy-Efficiency Enhancement", IEEE Transactions on Circuits and Systems II: Express Briefs, 2017.

4. L. B. Oliveira, N. Paulino, J. P. Oliveira, R. Santos-Tavares, N. Pereira and J. Goes, "Undergraduate Electronics Projects Based on the Design of an Optical Wireless Audio Transmission System," IEEE Transactions on Education, vol. 60, no. 2, pp. 105-111, May 2017.

5. M. A. Vieira, M. Vieira, P. Louro, L. Mateus, P. Vieira, "Indoor positioning system using a WDM device based on a-SiC: H technology" Journal of Luminescence 191, 135-138

6. Fantoni, M. Fernandes, Y. Vygranenko, P. Louro, M. Vieira, E. Alegria, A. Ribeiro, D. Teixeira, "A Simulation Study of Surface Plasmons in Metallic Nanoparticles: Dependence on the Properties of an Embedding a-Si:H Matrix," December 2017, physica status solidi (a)

7. Remigiusz Wisniewski, Andrei Karatkevich, Marian Adamski, Anikó Costa, Luis Gomes, "Prototyping of Concurrent Control Systems with Application of Petri Nets and Comparability Graphs", IEEE Transactions on Control Systems Technology; April 2017

8. Remigiusz Wisniewski, Grzegorz Bazydlo, Luis Gomes, Anikó Costa, "Dynamic Partial Reconfiguration of Concurrent Control Systems Implemented in FPGA Devices"; IEEE Transactions on Industrial Informatics; Volume: 13, Issue: 4, August 2017, Page(s): 1734 – 1741; accepted for publication 10 May 2017

9. F. Moutinho, L. Paiva, J. Köpke and P. Maló, "Extended Semantic Annotations for Generating Translators in the Arrowhead Framework," in IEEE Transactions on Industrial Informatics, vol. PP, no. 99, pp. 1-1.

10. M.D. Ortigueira, A.M. Lopes, and J.T. Machado, "On the computation of the multidimensional Mittag-Leffler function," Commun Nonlinear Sci Numer Simulat 53 (2017) 278–287.

11. S. Tomic, M. Beko, R. Dinis, "3-D Target Localization in Wireless Sensor Networks using RSS and AoA Measurements'', IEEE Transactions on Vehicular Technology, vol. 66, no. 4, pp. 3197-3210, April 2017

12. S. Tomic, M. Beko, R. Dinis, "Distributed Algorithm for Target Localization in Wireless Sensor Networks using RSS and AoA Measurements'', Elsevier Journal on Pervasive and Mobile Computing, vol. 37, pp. 63-77, June 2017.

13. S. Tomic, M. Beko, R. Dinis, "A Robust Bisection-based Estimator for TOA-based Target Localization in NLOS Environments'', IEEE Communications Letters. vol. 21, no. 11, pp. 2488-2491, November 2017.

14. S. Tomic, M. Beko, "A Bisection-based Approach for Exact Target Localization in NLOS Environments'', Elsevier Journal on Signal Processing, vol. 143, pp. 328-335, Feb. 2018

15. Argo Rosin, Siim Link, Madis Lehtla, João Martins, Imre Drovtar, Indrek Roasto, "Performance and feasibility analysis of electricity price based control models for thermal storages in households", Sustainable Cities and Society, Volume 32, Pages 366-374, 2017.

16. A. Pombo, Murta-Pina, J., Pires, V., "Multiobjective formulation of the integration of storage systems within distribution networks for improving reliability", Electric Power Systems Research, 148, pp. 87-96, July 2017.

17. D. Cavalheiro, F. Moll, S. Valtchev, TFET-based Power Management Circuit for RF Energy Harvesting, IEEE Journal of the Electron Devices Society, vol. 5, no. 1, pp. 7-17

18. Lucas Máximo Alves, Rui F. M. Lobo, "The possibility to predict crack patterns on dynamic fracture", Int J Fract (2017)

19. Cavalheiro, D., F. Moll, S. Valtchev, Tunnel FET-based Power Management Circuit for DC Nanowatt Energy Harvesting Sources, IEEE Journal of the Electron Devices Society

20. N. Antzoulatos, E. Castro, L. de Silva, A. D. Rocha, S. Ratchev, J. Barata (2017). A multi-agent framework for capability-based reconfiguration of industrial assembly systems. International Journal of Production Research 55(10), pp 2950-2960.

21. A. D. Rocha, P. Lima-Monteiro, M. Parreira-Rocha, J. Barata (2017). Artificial immune systems based multi-agent architecture to perform distributed diagnosis. Journal of Intelligent Manufacturing.

22. P. Graça, L. M. Camarinha-Matos, Performance Indicators for Collaborative Business Ecosystems – Literature review and trends, Technological Forecasting & Social Change, vol. 116, Mar 2017, pp 237-255.

23. L. M. Camarinha-Matos, A. I. Oliveira, F. Ferrada, V. Thamburaj, Collaborative services provision for solar power plants, Industrial Management & Data Systems, vol 117, issue 5, pp 946-966, doi: 10.1108/IMDS-06-2016-0246.

24. I. Polyantchikov, E. Shevtsenko, T. Karaulova, T. Kangilaski, Luis M. Camarinha-Matos, Virtual Enterprise Formation in the Context of a Sustainable Partner Network. Industrial Management & Data Systems vol 117, issue 7, pp 1446-1468.

25. Andres, R. Poler, L. M. Camarinha-Matos, H. Afsarmanesh, A simulation approach to assess partners selected for a collaborative network, International Journal of Simulation Modelling, Vol. 16, No. 3, pp 399-411, Sep 2017.

26. A. Moitinho, A. Krone-Martins, H. Savietto, M. Barros, C. Barata, A. Falcão, T. Fernandes, J. Alves, A.F. Silva, M. Gomes et al., Gaia Data Release 1 - The archive visualisation service, Astronomy and Astrophysics, A&A, 605 (2017) A52

27. F. van Leeuwen et al. (including A. J. Falcão and R.A. Ribeiro) Gaia Data Release 1 - Open cluster astrometry: performance, limitations, and future prospects, Gaia Collaboration, Astronomy and Astrophysics, A&A, 601 (2017) A19,

28. G. Clementini et al. (including A. J. Falcão and R. A. Ribeiro) Gaia Data Release 1 - Testing parallaxes with local Cepheids and RR Lyrae stars, Gaia Collaboration. Astronomy and Astrophysics, A&A 605 A79 (2017)

29. J. Mäkelä, V. Kandavalli and A.S. Ribeiro (2017) Rate-limiting steps in transcription dictate sensitivity to variability in cellular components. Scientific Reports 7:10588.

30. S Tripathi, J Lloyd-Price, AS Ribeiro, O Yli-Harja, M Dehmer, and F Emmert-Streib (2017) sgnesR: An R package for simulating gene expression data from an underlying real gene network structure considering delay parameters. BMC Bioinformatics 18:325.

31. M Kislin, J Sword, I Fomitcheva, D Croom, E Pryazhnikov, E Lihavainen, D Toptunov, H Rauvala, AS Ribeiro, L Khiroug, and S Kirov (2017) Reversible disruption of the neuronal mitochondria by ischemic and traumatic injury revealed by quantitative two-photon imaging in the neocortex of anesthetized mice. The Journal of Neuroscience 37(2), 333-348.

32. J. Ferreira, J. Sarraipa, M. Ferro-Beca, C. Agostinho, R. Costa, R. Jardim-Goncalves, 2016. End-to-end manufacturing in factories of the future, International Journal of Computer Integrated Manufacturing Volume 30, Issue 1

33. S. Ghimire, T. Nodehi, R. Jardim-Goncalves, 2017. IoT based situational awareness framework for real-time project management. International Journal of Computer Integrated Manufacturing Volume 30, Issue 1

34. E. Marcelino-Jesus, J. Sarraipa, M. Ferro-Beca, R. Jardim-Goncalves, 2017. A framework for technological research results assessment. International Journal of Computer Integrated Manufacturing, Volume 30, Issue 1, pp.1–19

35. R. Jardim-Goncalves, D. Romero, A. Grilo, 2017. Factories of the Future: Challenges and leading innovations in Intelligent Manufacturing, International Journal of Computer Integrated Manufacturing Volume 30, Issue 1, 2017

36. A. Mehrbod, A. Zutshi, A. Grilo, R. Jardim-Goncalves, 2017. Matching heterogeneous e-catalogues in B2B marketplaces using vector space model. International Journal of Computer Integrated Manufacturing, Volume 30, Issue 1, 2017

37. T. Nodehi, R. Jardim-Goncalves, A. Zutshi, A. Grilo, A. 2017. ICIF: an inter-cloud interoperability framework for computing resource cloud providers in factories of the future. International Journal of Computer Integrated Manufacturing, Volume 30, Issue 1, 2017

38. M. Zdravković, J. Zdravković, A. Aubry, N. Moalla, W. Guedrina, J. Sarraipa, 2017. Domain framework for implementation of open IoT ecosystem, International Journal of Production Research.

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