CSS Technical Committee on Discrete Event Systems

CDC 2020

2020.12.18

Agenda

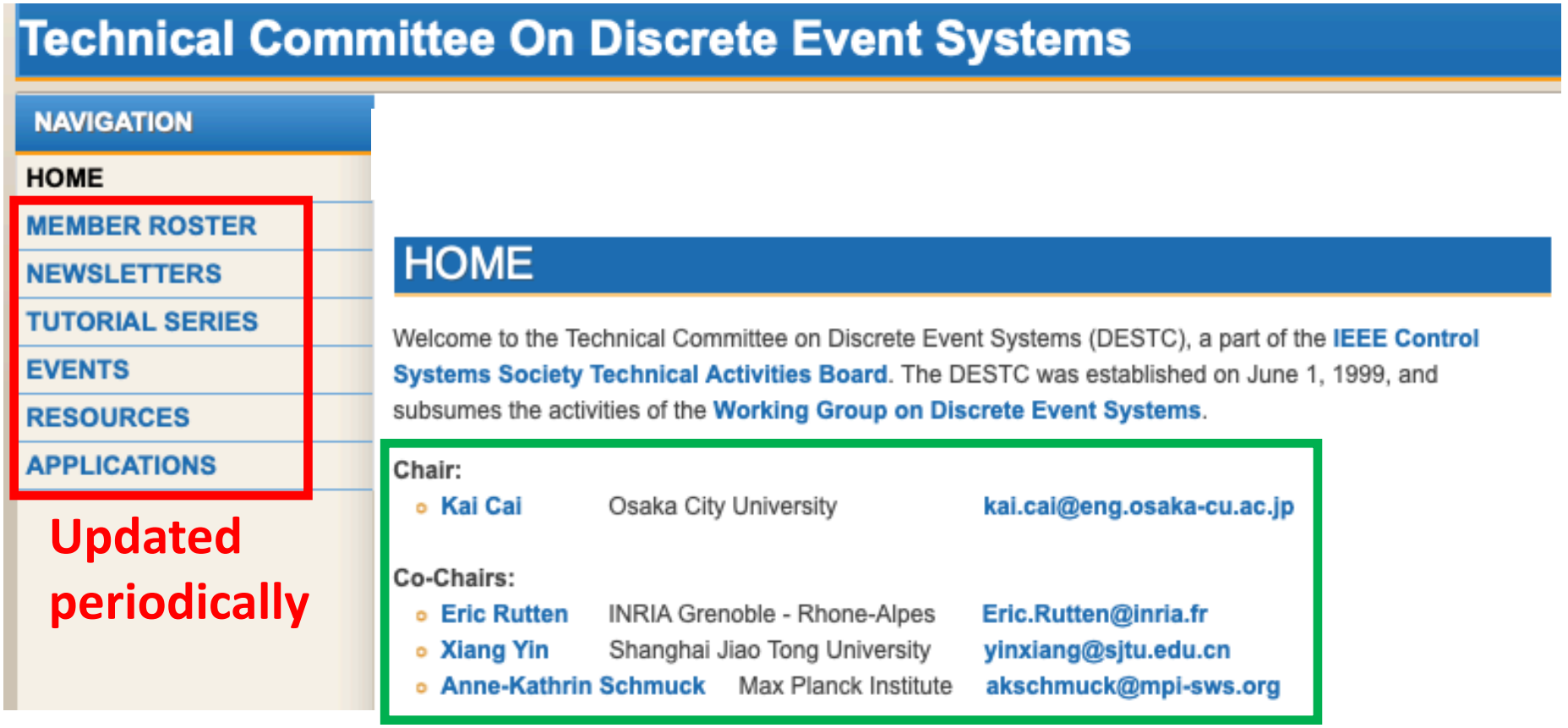
- Kai Cai
- Anne-Kathrin Schmuck (co-chair)
- Eric Rutten (co-chair)
- Xiang Yin (co-chair)
- Stephane Lafortune (J-DEDS)
- Mariagrazia Dotoli (MED2021)

Content

- General information about TC (for new members)
- TC membership statistics
- Ongoing journal special issues
- 2020 TC Outstanding Student Paper Prize
- 2021 online talk series “Lightning Tutorials”

General info on CSS website

http://discrete-event-systems.ieeecss.org



Membership

As of December 1, 2020:

- On CSS website: 168

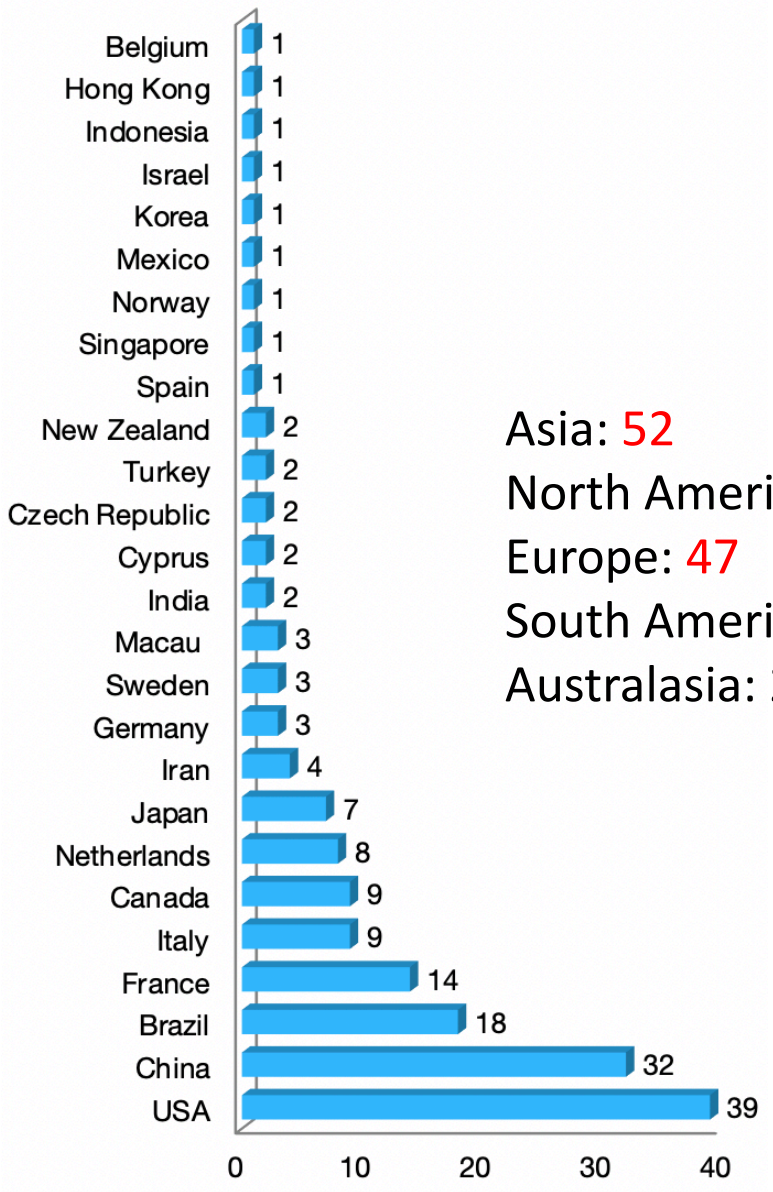
"Member rosters"

http://discrete-event-systems.ieeecss.org/discrete-member-roster

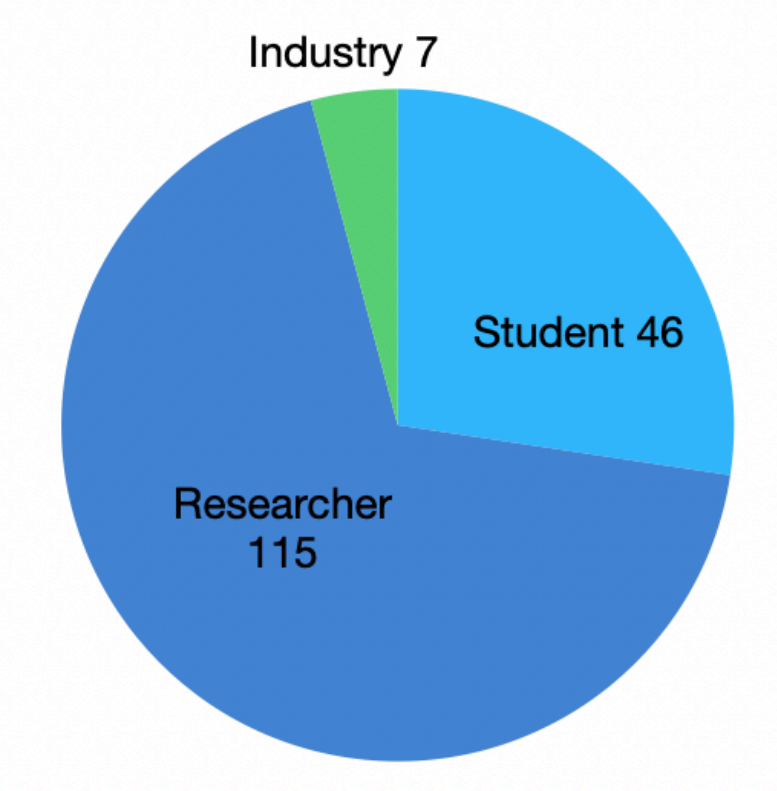
- On Google group: 168

"IEEE CSS Technical Committee on Discrete Event Systems"
https://groups.google.com/a/nd.edu/forum/?hl=en#!forum/csstcdes-list

Member statistics



Asia: 52
North America: 49
Europe: 47
South America: 18
Australasia: 2



Journal special issues

- NAHS Special issue “Security, Privacy and Safety of Cyber-Physical Systems”
  - https://www.editorialmanager.com/NAHS/default.asp
  - Choose: “VSI: Security”
  - Deadline: January 31, 2021

- J-DEDS Special issue “Modeling, Analysis and Control for Cybersecurity of Discrete Event Systems”
  - http://DISC.edmgr.com
  - Choose
  - “T.C.: Cybersecurity”
  - Deadline: January 15, 2021

TC Outstanding Student Paper Prize

- IEEE CSS is kicking off a new TC-specific award to
  - Recognize young talents associated with a technical area
  - Promote student membership and participation in the TCs

- The first such awards will be for papers published at the proceedings of CDC 2020. The selection will start after CDC 2020, and the award will be given at CDC 2021.

- For this first time, our TC and TC Hybrid Systems will jointly select one (1) award.

- Nominations by January 31, 2021
  (send me an email and state the primary author is student)

Online talk series “lightning tutorials”

- Our TC is starting in 2021 a new online talk series to
  - Enhance communications in our community during this pandemic

- Jan: Christoforos Hadjicostis
  Feb: Stephane Lafortune
  Mar: Necmiye Ozay
  Apr: Stavros Tripakis
  May: Mariagrazia Dotoli
  Jun: Xiren Cao
  Jul: Alessandro Giua
  Aug: n/a
  Sep: Martin Fabian
  Oct: Thomas Moor
  Nov: Joanna van de Mortel-Fronczak
  Dec: Christos Cassandras

- 40min talk + 20min main room discussions
  + 30min breakout rooms discussions

- Website: http://discrete-event-systems.ieeecss.org/tc-discrete/tutorial-series-2021
- Registration required

MAX PLANCK INSTITUTE
FOR SOFTWARE SYSTEMS

Community Exchange: Supervisory Control and Reactive Synthesis

Anne-Kathrin Schmuck

MPI-SWS, Kaiserslautern, Germany

IEEE CSS TC DES Meeting, CDC 2020 (virtual), 18.12.2020

A (very) brief (incomplete) history

SCT for non-terminating processes
[Thistle & Wonham ’91,’94a,’94b, Thistle ’95]

⇒ inspired by the state-of-the-art in RS

⇒ the connection got lost over time

A (very) brief (incomplete) history

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[Thistle & Wonham ’91,’94a,’94b, Thistle ’95]

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Transferring ideas from RS to SCT (terminating proc.)

- Efficient synthesis algorithms

  ⇒ B.Lennartson & co-workers
- Supervisor Synthesis under Partial Observation

  ⇒ X.Yin & S.Larfortune
- ...

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- ...

Bridging the gap between SCT & RS (terminating processes)
[Ehlers,Lafortune,Tripakis&Vardi ’16]

⇒ SCT spec as a CTL* fragment

⇒ “ SCT $\subseteq$ RS for CTL* ”

The recent past

Bridging the gap
(terminating processes)
[Ehlers,Lafortune,Tripakis&Vardi ’16]

SCT → “RS for CTL*”

The recent past

Bridging the gap
(terminating processes)
[Ehlers,Lafortune,Tripakis&Vardi ’16]

SCT → “RS for CTL*”

Algorithmic comparison
(terminating processes)
[Ramezani,Krook,Fei,Fabian,Akesson ’19]

`Supremica` vs. `TuLib`

The recent past

Bridging the gap
(terminating processes)
[Ehlers,Lafortune,Tripakis&Vardi ’16]

SCT → “RS for CTL*”

“Exploiting” CTL*-fragment
[Rawlings,Lafortune,Ydstie ’20]

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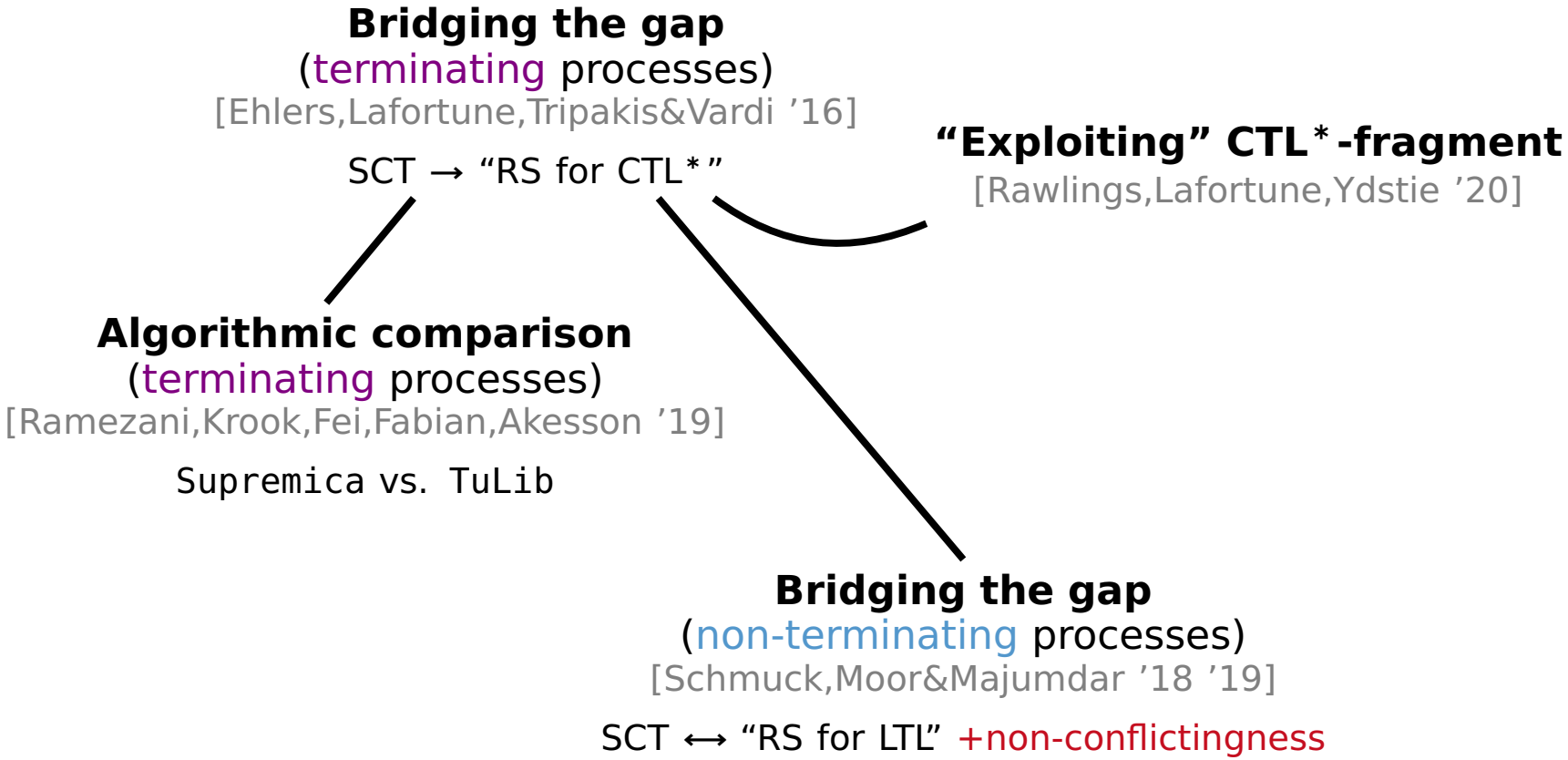
The recent past



The recent past

Bridging the gap
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[Ehlers,Lafortune,Tripakis&Vardi ’16]

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Algorithmic comparison
(terminating processes)
[Ramezani,Krook,Fei,Fabian,Akesson ’19]

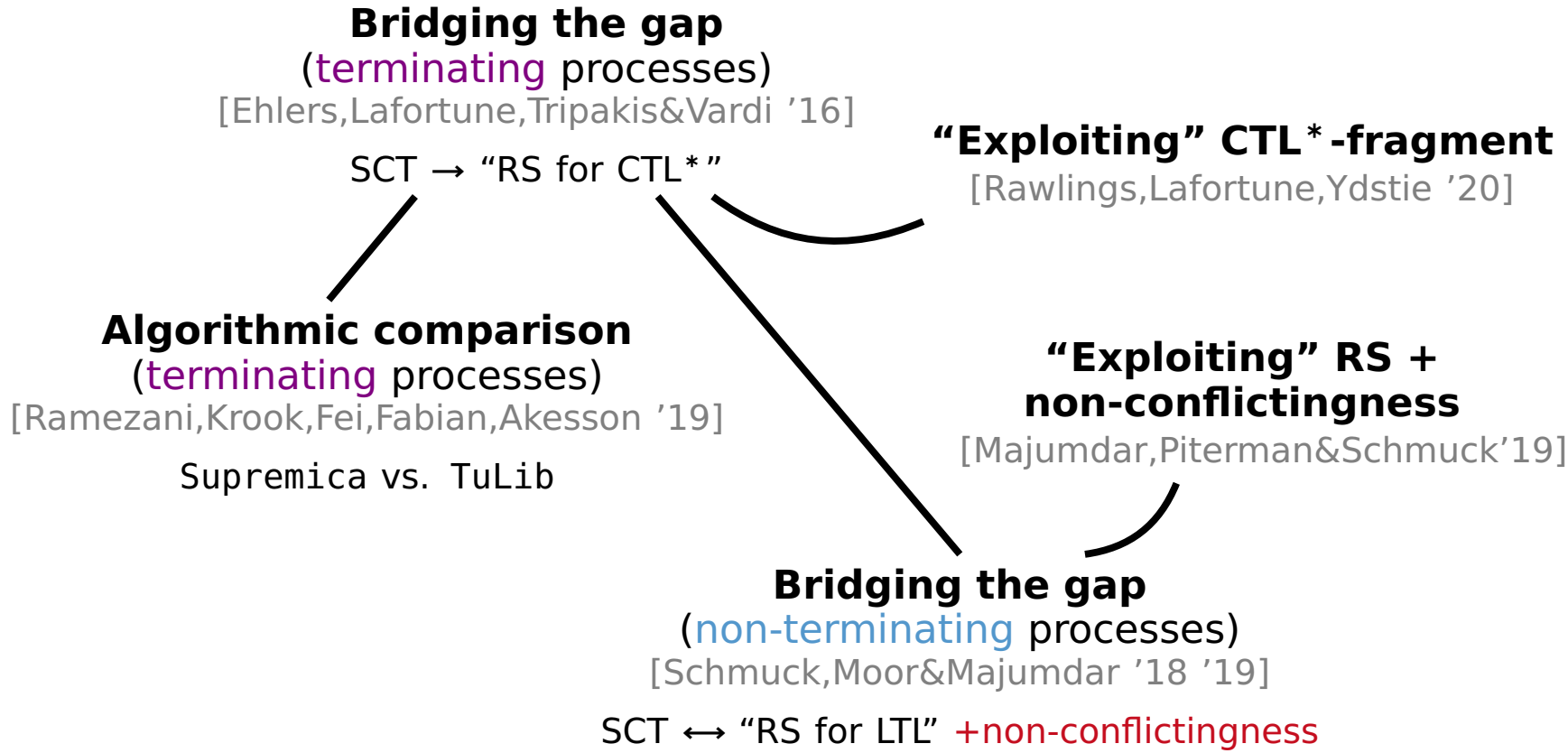
`Supremica vs. TuLib`

“Exploiting” RS + non-conflictingness
[Majumdar,Piterman&Schmuck’19]

Bridging the gap
(non-terminating processes)
[Schmuck,Moor&Majumdar ’18 ’19]

SCT ⟷ “RS for LTL” +non-conflictingness

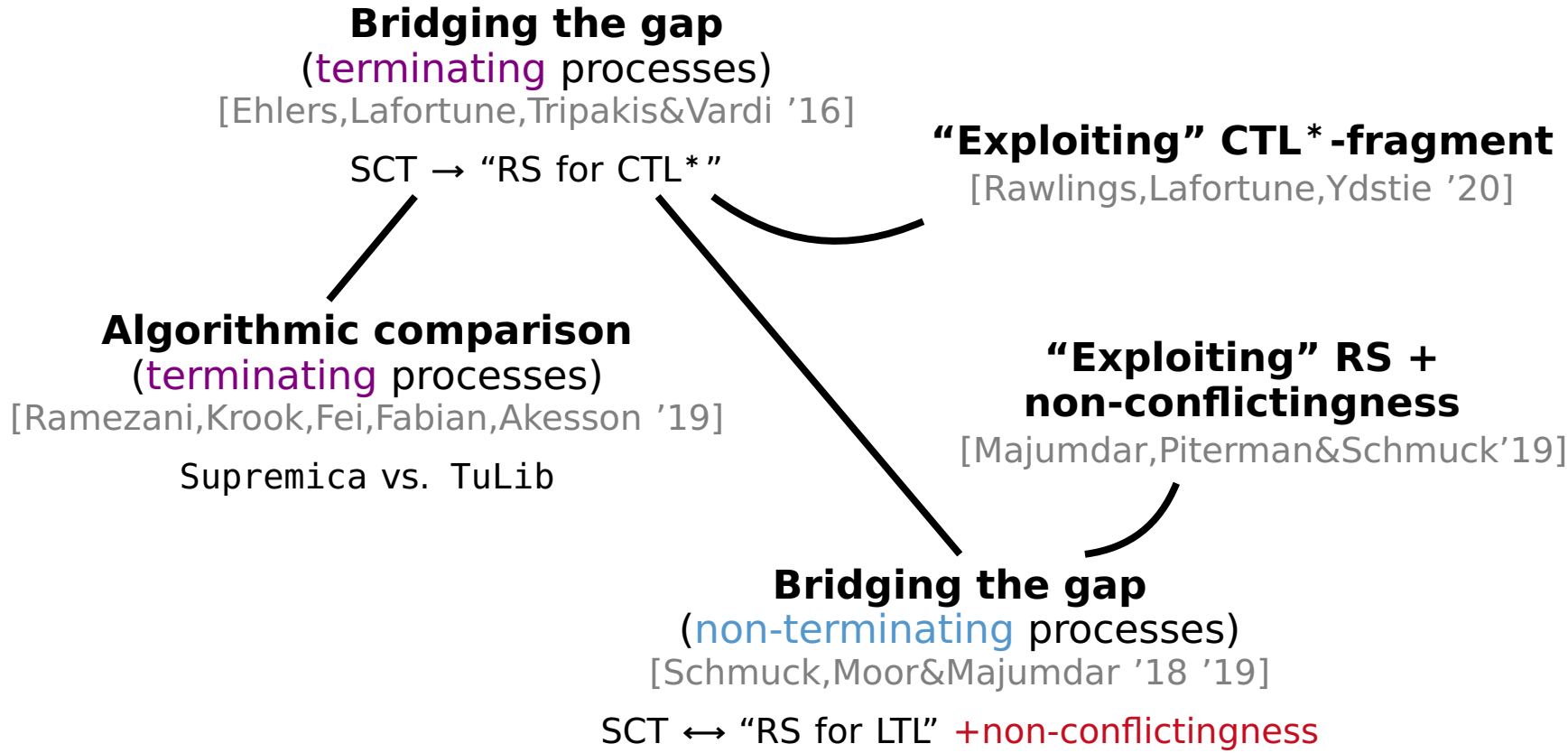
The recent past



"Exploiting" RS tools w/o non-conflictingness

T.Ushio & coworkers

The recent past



"Exploiting" RS tools w/o non-conflictingness
T.Ushio & coworkers

SCT & Formal Methods
N. Ozay & coworkers,
X. Yin, M. Zamani & coworkers,...

Open Questions

- How to connect synthesis techniques/ algorithms for

⇒ partial observation

⇒ distributed/modular synthesis

⇒ hierarchical/abstraction-based approaches

Open Questions

- How to connect synthesis techniques/ algorithms for

⇒ partial observation

⇒ distributed/modular synthesis

⇒ hierarchical/abstraction-based approaches

- How to exploit the obtained understanding to transfer more (efficient) algorithms?

⇒ Tools?

⇒ Benchmarks?

Future Plans

Past Plans for 2020:

- Invited Session at IFAC WC 2020

  ⇒ did only get 4 papers
- Propose a Dagstuhl Seminar on the topic for 2021

  ⇒ no call due to COVID-19 pandemic

Future Plans for 2021:

- Propose Invited Session at CDC 2021
- Propose a Dagstuhl Seminar on the topic for 2022

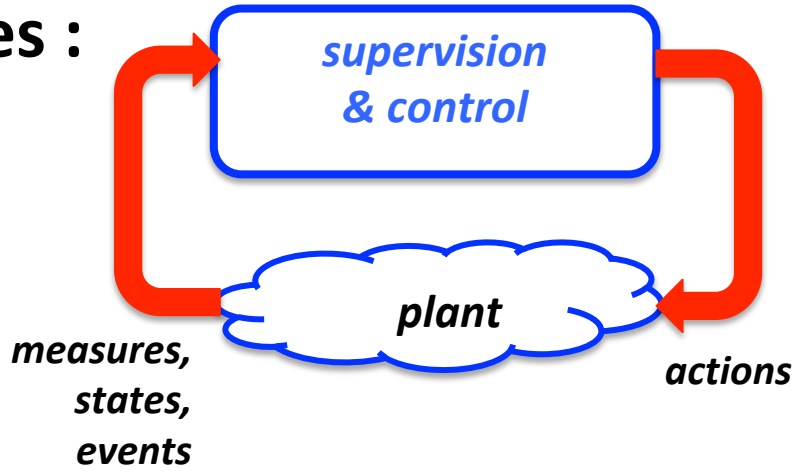
  (whenever there is a new call)

IEEE DES TC meeting : ***DES Applications***

Eric RUTTEN
INRIA / LIG, Ctrl-A team
Grenoble, France

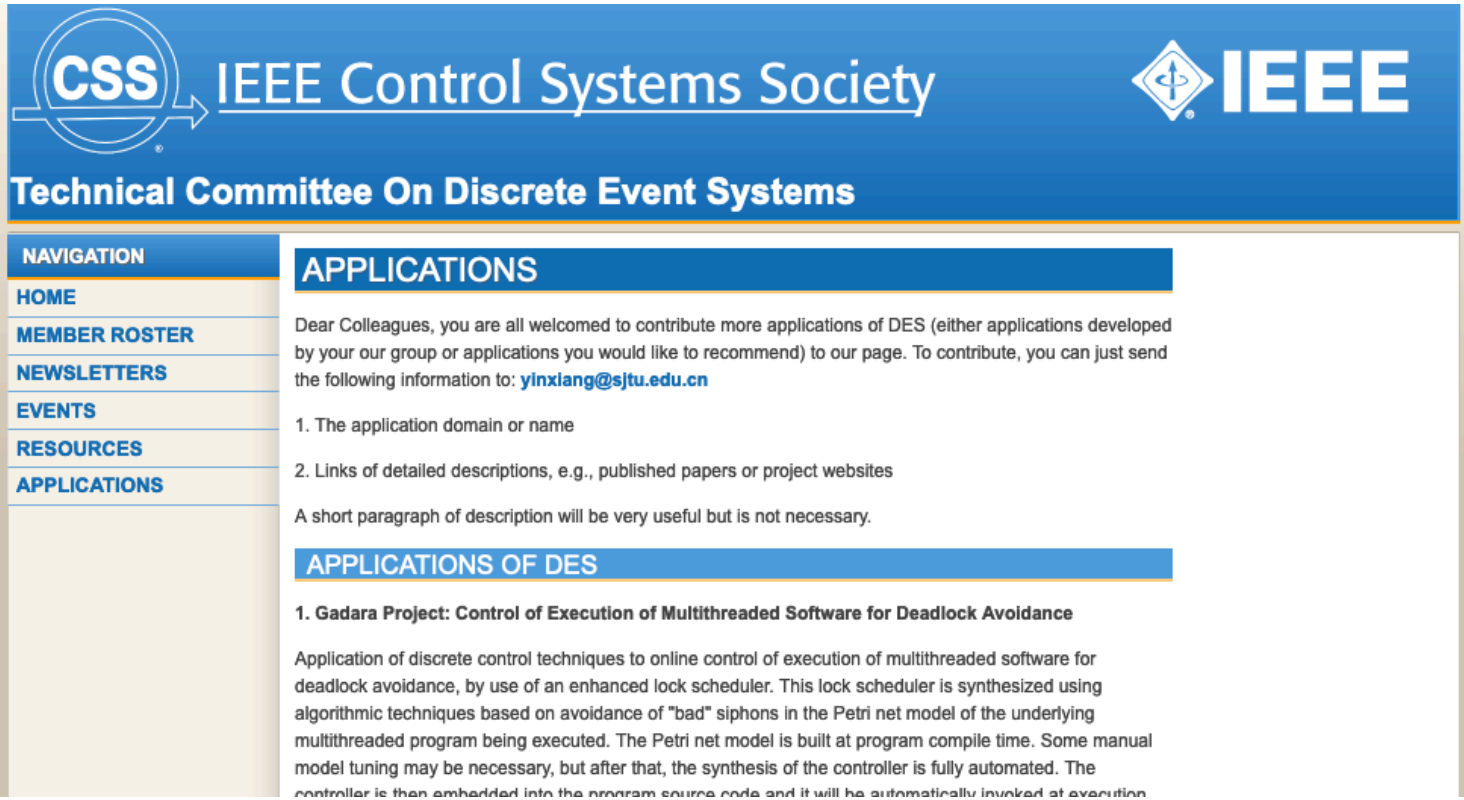
DES application-related topics

- **DES application domains :**
  mostly manufacturing, but not only
- **DES application-related issues :**
  - at **design time**
    - modelling : patterns for
      behaviors & reqs
    - synthesis tools,
      executable code generation
  - in the **feedback loop**
    - implementation : sensors/actuators, synchronization, cycle time
  - controller **evaluation**
    - check requirements (incomplete, too strict)
      w/ simulation (hybrid aspects)
    - performance gain w.r.t. application domain



IEEE DES TC web site (i)

- **web site**： http://discrete-event-systems.ieeecss.org/
- **contributions welcome !**

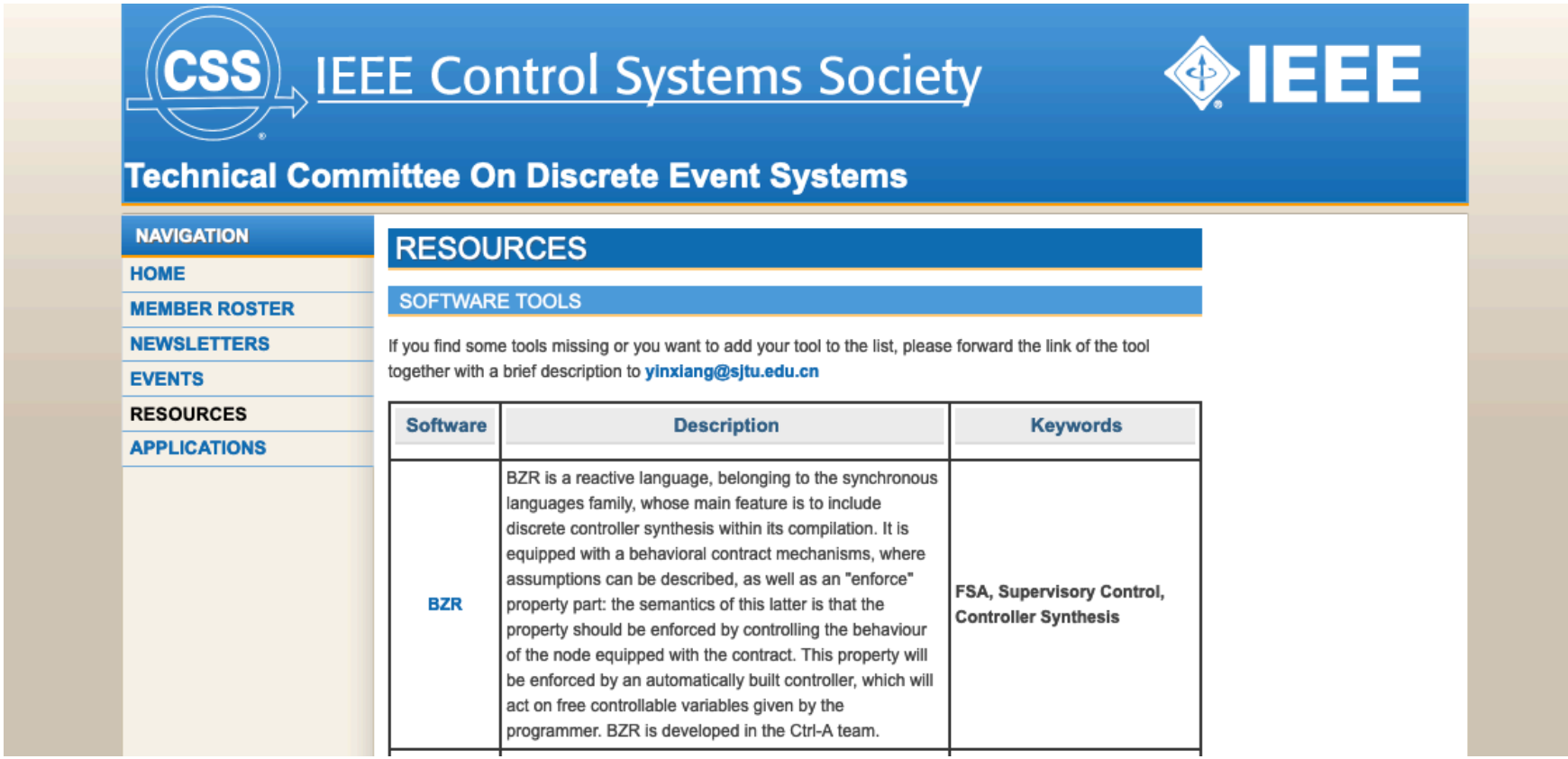


IEEE DES TC web site (ii)

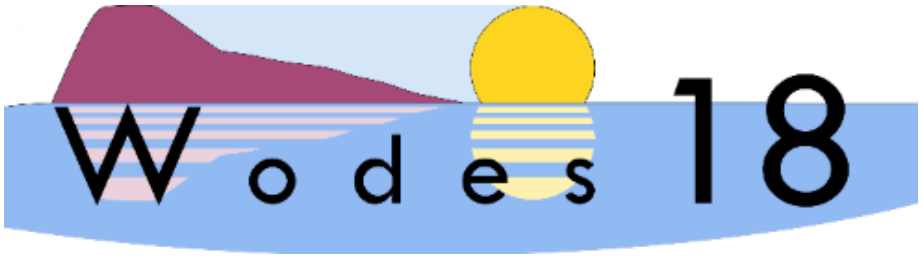
- **applications**
  - Gadara Project: Control of Execution of **Multithreaded Software** for Deadlock Avoidance
  - Management and Resource Planning of Intermodal **Freight Transport** Terminals using Petri Nets
  - **Reconfigurable Hardware** architectures based on FPGA
  - **Cloud Computing** Infrastructures
  - **Software Components** and Their Reconfiguration
  - Fault Diagnosis of Fixed-Block **Railway Signaling** Systems
  - Supervisory Control for **Lock-Bridge Systems**
  - Teloco: Test of **programmable logic controllers** from IEC 60848 specifications
  - Software Engineering: Concurrency Control and **Service Composition**

IEEE DES TC web site (iii)

- **software tools** : 30 ! + links to more
- **contributions welcome !**



typical topics in special sessions (i)



session program (i)

- Symbolic Limited Lookahead Control for Best-effort Dynamic **Computing Resource Management** Berthier, Marchand, Rutten
- Exercising Symbolic Discrete Control for Designing **Low-power Hardware Circuits**: an Application to Clock-gating Mete Özbaltan, Nicolas Berthier
- On-line Optimization of **Power Efficiency in 3D Multicore Processors** Chen, Xiao, Wardi, Yalamanchili
- Modeling and Synthesis of the **Lane Change Function of an Autonomous Vehicle** Krook, Zita, Kianfar, Mohajerani, Fabian
- Controller Design for **Avoiding Collisions in Automated Guided Vehicle Systems** via Labeled Petri Nets Wan, Luo, Zhang, Wu, Zhou
- Demonstration of **Indoor Location Privacy** Enforcement using Obfuscation Góes, Rawlings, Recker, Willett, Lafortune

typical topics in special sessions (ii)

session program (ii)

- An **Engineering Perspective** on Model-Based Design of Supervisors
  Reniers, van de Mortel-Fronczak
- Hybrid Petri Nets to Re-design Low-Automated Production Processes: the Case Study of a **Sardinian Bakery**
  Cavone, Dotoli, Epicoco, Franceschelli, Seatzu
- Robust production **scheduling under machine failures** - A DES based evaluation approach
  Himmiche, Marangé, Aubry, Pétin
- Supervisor Aware **Service Composition** Framework: An Implementation and Evaluation
  Atampore, Dingel, Rudie
- Modeling and **detection of cyber attacks** on discrete event systems
  Raphael Fritz, Ping Zhang
- **Opacity Enforcement** by Insertion Functions under **Energy Constraints**
  Ji, Yin, Lafortune

typical topics in special sessions (iii)

WODES 2020

Rio de Janeiro, Brazil

session program

- Synthesis of Supervisors for a **PID-Controlled Industrial Process** and Implementation on Foundation Fieldbus — de Oliveira, de Queiroz, Cury
- Automatic Translation of **Blocking Flexible Job Shop Scheduling** Problems to Automata Using the Supervisory Control Theory — Sarsur, Pena, Takahashi
- Probabilistic Verification of **Attack Detection** Using Logical Observer — Lefebvre, Seatzu, Hadjicostis, Giua
- **Multi-Robot Path Planning** with Boolean Specifications and Collision Avoidance — Mahulea, Kloetzer, Lesage
- A Compositional Approach to Abstraction for **Planning** Problems — Vilela, Hill
- Supervisory Control in **Construction Robotics**: In the Quest for Scalability and Permissiveness — Rosa, Cury, Baldissera

conclusion & perspectives

- **DES applications**
  - DES still not very much applied
    - non-trivial theory
    - model construction from real world
  - mainly manufacturing, but not only
- **Perspectives**
  - need for methods for model construction
  - need for tools, implem support (code gen.)
  - new application domains?
- **propose special sessions !** WODES, CCTA, …

IEEE TC DES Meeting (CDC'20)

Security & Safety for CPSs

Xiang Yin

Department of Automation, Shanghai Jiao Tong University

yinxiang@sjtu.edu.cn

IEEE Conference on Decision and Control (CDC)

Dec 18, 2020

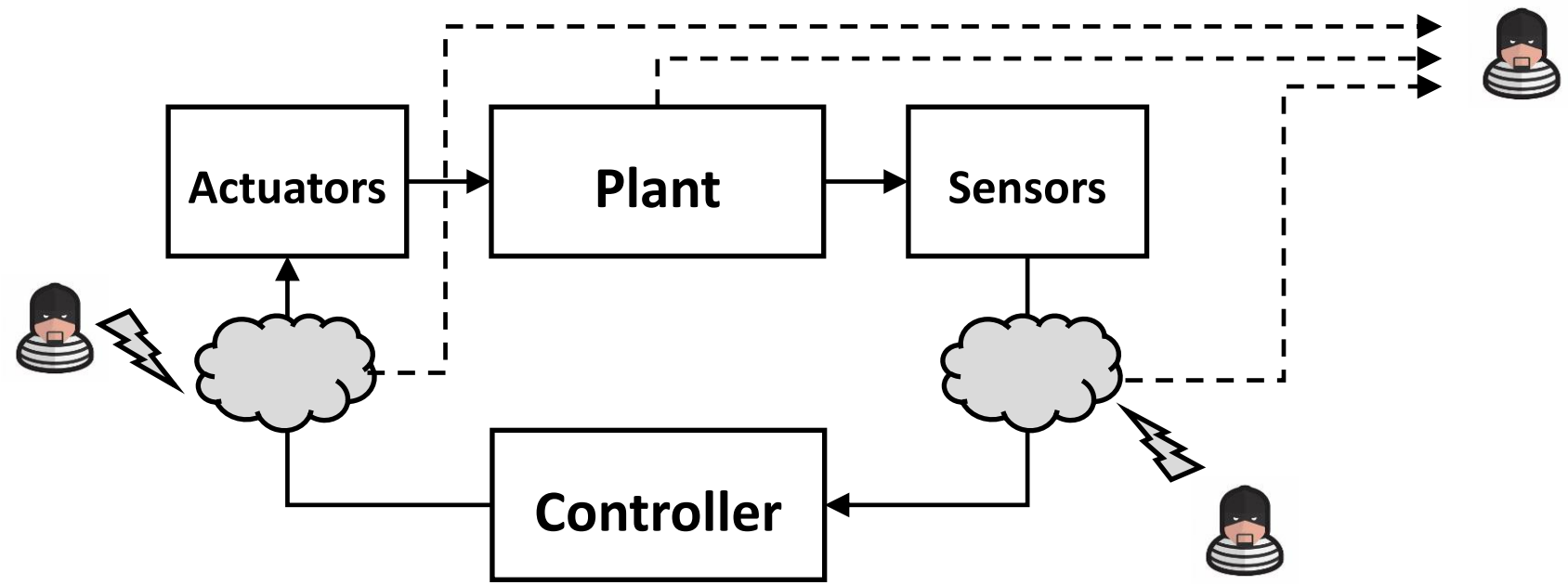
上海交通大學

SHANGHAI JIAO TONG UNIVERSITY

Cyber-Security in Cyber-Physical Systems

Safety and Security Issues in Control Systems

- Safety-Critical Cyber-Physical Systems
- Networked control environments: cloud, edge, fog -> communications
- Active attacks: DoS, override sensor reading or actuator decision…
- Passive attacks: privacy, information-flow security…



Overall Safety & Security: Physical, Functional and Information

DES Approach to Safety and Security

Why DES Approach

- Cyber-Attacks are mostly at the high-levels of CPSs:
  - what DES modeling techniques can provide
- Critical infrastructures needs safety and correctness guarantees:
  - what DES verification & synthesis techniques can provide

We have many mature techniques

- Observational property analysis -> Opacity analysis
- Fault diagnosis -> Intrusion detection
- Supervisor synthesis against environment -> Resilient synthesis against attacks
- All about inference & decision making at the high-level -> Our advantages!

TC Activities: Invited Sessions

2020 IFAC World Congress

- Cyber-Security and Safety of Discrete-Event Systems
- Organizer: Xiang Yin, Kai Cai
- 10 Papers

2020 WODES

- Resilience of DES (I): Cyber Security and Opacity Related Analysis and Control
- Resilience of DES (II): About the Impacts of Time in Analysis and Control of Discrete Event Systems
- Organizer: Rong Su, Liyong Lin, Raymond Kwong, Michel Reniers
- 12 Papers

2020 IEEE CDC

- Security, Safety and Resilience of Control Systems
- Organizer: Xiang Yin, Rong Su, Kai Cai, Yin Tong
- 8 Papers

TC Activities: Invited Workshop

Analysis and Control for Resilience of Discrete Event Systems

Speakers

Christoforos Hadjicostis

Department of Electrical and Computer Engineering, Cyprus University of Technology

Notions of Opacity for Privacy and Security in Discrete Event Systems

More

Joao Carlos Basilio

Department of Electrical Engineering, Universidade Federal do Rio de Janeiro

Robust Failure Diagnosis of Discrete Event Systems and Its Applications

More

Thomas Moor

Friedrich-Alexander Universitt Erlangen-Nrnberg

Fault-Tolerant Supervisory Control in Terms of Formal Languages

More

Stephane Lafortune

University of Michigan, Ann Arbor

Resilience to Sensor Deception Attacks in Supervisory Control

More

Rong Su

Nanyang Technological University

Supervisory Control for Cyber Security of Discrete Event Systems

More

Organizers

Assoc Prof Rong Su, School of Electrical and Electronic Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798,
Email: rsu@ntu.edu.sg

This workshop is technically co-sponsored by the Smart Cities Technical Committee and the Discrete Event Systems Technical Committee in IEEE Control Systems Society.

- Topic 1: Cyber Security and Information Condentiality
- Topic 2: Fault Tolerance Analysis and Control

TC Activities: Journal Special Issue

Paper Submission

Authors are encouraged to submit original work that has neither appeared in, nor is under consideration by other journals.

Springer offers authors, editors and reviewers of Discrete Event Dynamic Systems a web-enabled online manuscript submission and review system. Our online system offers authous the ability to track the review process of their manuscript. This online system offers easy login and submission procedures and supports a wide range of submission file formats. Manuscript should be submitted to **http://DISC.edmgr.com**. Choose "**T.C.: Cybersecurity**" as the submission type.

Important Submission Dates:

- Open: July 15, 2020
- Due: January 15, 2021
- 1st reviews due: April 15, 2020
- 1st revisions due: July 15, 2021

www.Springer.com/10626

ISSN: 0924-6703 (print)
1573-7594 (electronic)

Editor-in-Chief:
Stéphane Lafortune
University of Michigan, USA

Discrete Event Dynamic Systems ~ Special Topical Collection~

Modeling, Analysis and Control for Cybersecurity of Discrete Event Systems

Guest Editors:
Rong Su, School of Electrical and Electronic Engineering, Nanyang Technological University,
Email: rsu@ntu.edu.sg
João Carlos Basilio, Department of Electrical Engineering, Universidade Federal do Rio de Janeiro,
Email: basilio@dee.ufrj.br

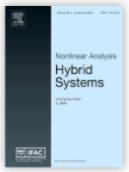
The recent advancement of information and communication technologies and Internet-of-Things infrastructure make a fully connected society a reality, leading to much improved living quality and production efficiency. However, the price paid for such unprecedented connectivity is an increase in cybercrime and violations, making cybersecurity a key research focus in many different research communities. Generally speaking, cybersecurity is the protection of computer systems and networks from the theft of or damage to their hardware, software, or electronic data, as well as from the disruption or misdirection of the services they provide. Discrete event systems (DES) are particularly vulnerable to cyber intrusions, because their enumerative and typically qualitative formal models lack of necessary details and effective representations of (temporal) correlation among data, and they heavily depend on the accuracy of data to ensure absolutely correct interpretation of actions in the system to achieve correct tracking, analysis and control, making it difficult for them to handle data corruptions. An intruder to a DES may intercept sensor and/or command signals and interrupt the execution order of events (or functions). This special topical collection focuses on two key cybersecurity concerns, i.e., cyber attacks and privacy/confidentiality breaching (including but not limited to opacity violations), and aims to report the latest DES research and application results pertinent to cybersecurity.

This special topical collection solicits papers, addressing relevant theoretical issues and important application issues related to cybersecurity, with an evident DES model and relevant technical treatments, possibly complemented with other frameworks to deal with interdisciplinary issues. A non-exhaustive list of some potential topics is provided below:

- New modeling frameworks for cyber attacks
- Analysis of impacts of attacks on closed-loop system behaviors
- Formal synthesis of attack models
- New concepts and models of resilience of supervisors
- Formal synthesis of supervisors resilient to specific attacks
- Game theoretical frameworks for analysis and resilient control
- Fault diagnosis in the presence of cyber attacks
- New modeling frameworks for privacy and confidentiality (e.g., opacity)
- New analysis methods to determine system ability of preserving privacy and confidentiality (e.g., new opacity analysis methods)
- Formal synthesis of supervisors for privacy/confidentiality preservation
- Applications of cybersecurity methods in real discrete event systems

- **JDEDS**
- **Modeling, Analysis and Control for Cybersecurity of Discrete Event Systems**
- **Rong Su, Joao C. Basilio**
- **Due： Jan 16, 2021**

TC Activities: Journal Special Issue



Nonlinear Analysis: Hybrid Systems

A journal of IFAC, the International Federation of Automatic Control

Editor-in-Chief: A. Giua

ISSN: 1751-570X

CiteScore: 8.5 Impact Factor: 5.881

Special Issue: "Security, Privacy and Safety of Cyber-Physical Systems"

Guest Editors: Kai Cai, Osaka City University (kai.cai@eng.osaka-cu.ac.jp)
Maria Prandini, Politecnico di Milano (prandini@elet.polimi.it)
Xiang Yin, Shanghai Jiao Tong University (yinxiang@sjtu.edu.cn)
Majid Zamani, University of Colorado Boulder (Majid.Zamani@colorado.edu)

Cyber-physical systems are engineered systems that are built from and depend upon the synergy of computational and physical components. They are pervasive in today's technological society. Cyber-physical systems usually involve complex interactions of continuous dynamics with discrete logic, referred to as "hybrid" behavior. The development of controller design and verification algorithms for such complex systems are crucial and challenging tasks, due in particular to the theoretical difficulties of analyzing hybrid behavior and to the computational challenges associated with the synthesis of hybrid controllers.

Ever-increasing demands for safety, privacy, security and certification of cyber-physical systems put stringent constraints on their analysis and design, and necessitate the use of formal model-based approaches. In recent years, we have witnessed a substantial increase in the use of formal techniques for the verification and design of privacy-sensitive, safety-critical cyber-physical systems. The main objective of this special issue to gather recently developed novel approaches devoted to analysis and enforcement of security, privacy and safety of cyber-physical systems using formal techniques. We seek submissions including but not limited to the following topics:

– Security and privacy analysis of cyber-physical systems, including opacity, differential privacy, noninterference and other related notions
– Fault diagnosis, intrusion detection, and attack mitigation of cyber-physical systems
– Supervisory control for safety of discrete-event systems
–Formal methods and reactive synthesis for safety of cyber-physical systems
– Data-driven verification and synthesis of cyber-physical systems
– Distributed approaches for large scale cyber-physical systems and hybrid systems
– Algorithms and tools for verification and synthesis of safety-critical systems
– Applications in security and/or safety of manufacturing systems, transportation systems, energy systems, robotic networks, telecommunications, and computer networks.

Important Submission Dates:
– Open: October 1, 2020
– Due: December 31, 2020
Manuscript should be submitted to https://www.editorialmanager.com/NAHS/default.asp
Please choose the article type (identifier of this special issue): **VSI: Security**

- **Nonlinear Analysis: Hybrid Systems**
- **Security, Privacy and Safety of CPSs**
- **Kai Cai, Maria Prandini, Xiang Yin, Majid Zamani**
- **Due： Jan 31, 2021**

Conclusion & Plans for 2021

- **DES approach to cyber-security and safety is very promising**
- **Our TC has many related activities last year**
- **For 2021:**
  - ✓ **still organize sessions for CDC and ACC**
  - ✓ **try to connect to more conferences**

    HSCC, ICCPS, CASE, SMC et al?
  - ✓ **tutorial series:**

    Christoforos Hadjicostis, Stephane Lafortune, Alessandro Giua

Thank You!