COST Action
Final Achievement Report
(17/12/2014 to 16/12/2018)

IC1402: Runtime Verification beyond Monitoring (ARVI)

The Action was approved by the Committee of Senior Officials (CSO) on 15-5-2014 and has the MoU reference COST 042/14.

This report was submitted on 26-02-2019 by the Action Chair on behalf of the Management Committee in fulfilment of the requirements of the rules for COST Action Management, Monitoring and Final Assessment.

Action leadership and participants

Leadership positions

Position	Name	Contact details	Country*
Chair	Prof Martin Leucker	leucker@isp.uni-luebeck.de +04515005551	Germany

Position	Name	Contact details	Country*
Vice Chair	Prof Volker Stolz	volker.stolz@hvl.no +4745062439	Norway

Working groups

#	WG Title	# of participants	WG Leader	Country*
1	Core runtime verification	30	Dr Ylies FALCONE ylies.falcone@imag.fr	n/a
2	Standardization, benchmarks, tool interoperability	30	Dr Giles Reger giles.reger@manchester.ac.uk	n/a
3	Challenging computational domains	30	Dr Cesar Sanchez cesar.sanchez@imdea.org	n/a
4	Application areas (outside "pure" software reliability).	30	Dr Christian Colombo christian.colombo@um.edu.mt	n/a

Other key leadership positions

Position	Name	Contact details	Country*
STSM Coordinator	Dr Cesar Sanchez	cesar.sanchez@imdea.org	Spain
GH Scientific Representative	Prof Martin Leucker	leucker@isp.uni-luebeck.de	Germany

* The country displayed is: for the Action Chair, the country of the person's primary work affiliation; for the Vice Chair the country that nominated the person as a Management Committee Member, for all other leadership positions, if the person is a MC Member the country displayed is the country of nomination, otherwise it is the country of the person's primary work affiliation.

Participants

COST members having accepted the MoU

AT	26/09/2014	**CY**	26/10/2017	**CZ**	04/05/2015	**DK**	06/06/2014	**EE**	27/05/2014
FI	16/11/2017	**FR**	23/10/2014	**DE**	17/06/2014	**EL**	04/03/2015	**IS**	10/07/2014
IE	20/02/2015	**IL**	12/04/2015	**IT**	30/01/2015	**LT**	22/12/2014	**LU**	06/01/2015
MT	09/06/2014	**NL**	15/12/2014	**MK**	11/06/2014	**NO**	13/06/2014	**PT**	03/07/2014
RS	22/12/2014	**ES**	27/05/2014	**SE**	02/09/2014	**CH**	20/08/2014	**TR**	05/12/2017
UK	20/05/2014								

Other participants

Institution Name	Country
Australian National University	Australia

Summary

Main aim/ objective

The main objective of the Action is to consolidate a network of runtime verification experts and practitioners in application domains, so that they jointly find new principles for reliable system engineering using monitoring as a building block.

The Action addressed this as described below

The field of runtime verification which was the object of study in this Action was considerably enriched during the last four years. The existing knowledge has been streamlined, new knowledge but also new challenges have been identified, foundations for precise comparisons of different practical approaches have been laid, and application potential in different industrial domains have been shown.

Within 26 Short-Term-Scientific-Missions, concrete research question could have been addressed most of them resulting in high-quality scientific publications.

Staring with 17 countries, the Action finally included more than 70 MC members from 26 countries showing the enormous interest in the topic of this Action. Ten countries are so-called Inclusiveness Target Countries which shows that we achieved a reasonable distribution over the European countries. Also Australia became a partner country within this Action.

In total, we consider the Action a true success.

Action website

https://www.cost-arvi.eu/

Achievement of MoU objectives, deliverables and additional outputs/ achievements

MoU objectives

The Action reported the following achievement of its specific objectives.

MoU objective	Level of achievement	Further information (hyperlink or other)
the development of a common infrastructure that enables the development of a collection of runtime verification problems and benchmarks for the comparison of algorithms and tools, and to increase their collaboration	76 - 100%	Within the COST ACTION, the Runtime Verification Competition site was set up under the URL https://www.rv-competition.org with the following aims: • Stimulate the development of new efficient and practical runtime verification tools and the maintenance and improvement of the already developed ones. • Produce a benchmark suite for runtime verification tools, by sharing case studies and programs that researchers and developers can use in the future to test and to validate their prototypes. • Discuss the metrics employed for comparing the tools. • Provide a comparison of the tools on different benchmarks and evaluate them using different criteria. • Enhance the visibility of presented tools among the different communities (verification, software engineering, cloud computing and security) involved in software monitoring. The site has stipulated actively several competitions.
the development and sharing of current challenges in runtime verification and monitoring	76 - 100%	Within the COST Action, a journal publication has been developed within working group 3 that describes • 47 challenges, • from 7 domains • spanning over 63 pages This journal publication, for which the preliminary version has been accepted by Formal Methods and System Design and for which final version has just

been submitted is expected to serve a common source for challenges in this field and to stipulate further directed research making runtime verification techniques even further applicable in practical application areas.

Also, in cooperation with a further European project, an open data portal has been developed which is accessible under the URL https://dkan.isp.uni-luebeck.de.

the development of an interaction between the runtime verification community of experts at large with practitioners from application domains that could benefit from this technology, and influence its developments	76 - 100%	Within several dedicated workshops, the interaction between the runtime verification community and application domains experts could supported. Especially, application areas addressing • Medical devices, • Legal contracts, • Financial transaction, • Security and privacy, • Li-on batteries have been considered within this COST Action.
education of young researchers and potential users of monitoring technologies	76 - 100%	Within this COST Action, two training schools for educating especially young researchers have been organized. The first school took place 23-25 Sept. 2016 in Madrid while the second was held on March 19-23, 2018 in Praz sur Arly near Grenoble. Additionally, an LNCS tutorial volume on Runtime Verification was produced with the help of this Action, which available under this link https://link.springer.com/book/10.1007/978-3-319-75632-5.
coordination of European research on monitoring, runtime verification and its applications	76 - 100%	Within this Action, in total 14 meetings have been organized, each with a huge number of researchers and practitioners from monitoring, runtime verification and its applications. At these meetings, a common understanding of the field of runtime verification as well as typical applications and challenges have been worked out.

Deliverables

The Action reported the following deliverables:

Deliverable	Timing of deliverable	Further information (hyperlink or other)
Collaborative research papers: a document with a complete list of papers producing during the COST Action (WG1)	Delivered	https://www.cost-arvi.eu/wp-content/uploads/2019/01/WG1-Report.pdf
Document describing a set of challenges and roadmap for each of the directions (WG1)	Delivered	https://arxiv.org/abs/1811.06740
Series of documents giving a roadmap for the application of RV techniques identifying connections with respective sub-areas of computer science (WG3)	Delivered	https://arxiv.org/abs/1811.06740
Concrete case study in which RV solution for multicore systeme will be developed using monitoring hardware based on FPGA (WG3)	Delivered	https://doi.org/10.1007/978-3-319-47169-3_28
Document describing challenges and potential applications of RV (WG4)	Delivered	https://www.cost-arvi.eu/wp-content/uploads/2019/02/WG4-Report-Areas.pdf
Concrete case study in medical domain identifying the safety enhancements of medical devices (WG4)	Delivered	http://ceur-ws.org/Vol-1337/paper3.pdf
One common computation infrastructure including description of the formats and implementations for programming languages of interest (WG2)	Delivered	https://www.rv-competition.org
Two collection of benchmarks for WG2	Delivered	https://www.rv-competition.org

Additional outputs/ achievements

The following outputs/ achievements also resulted from the Action:

The Action reported 40 publications on the topic of the Action, co-authored by at least two Action participants from two countries participating in the Action, and for which the Action networking was necessary.

Co-authored Action publications - peer-reviewed

1. doi:10.1007/978-3-319-98047-8_1 Title

	Smart Contracts: A Killer Application for Deductive Source Code Verification
Authors	Wolfgang Ahrendt; Gordon J. Pace; Gerardo Schneider
DOI	doi:10.1007/978-3-319-98047-8_1
Type	Chapter
Published in	Principled Software Development
Published by	Springer International Publishing
Link	http://link.springer.com/content/pdf/10.1007/978-3-319-98047-8_1

2. doi:10.1109/IRC.2018.00053 Title

	MoVEMo: A Structured Approach for Engineering Reward Functions
Authors	Piergiuseppe Mallozzi; Raul Pardo; Vincent Duplessis; Patrizio Pelliccione; Gerardo Schneider
DOI	doi:10.1109/IRC.2018.00053
Type	Paper conference
Published in	2018 Second IEEE International Conference on Robotic Computing (IRC)
Published by	IEEE
Link	http://xplorestaging.ieee.org/ielx7/8328658/8329863/08329917.pdf?arnumber=8329917

3. doi:10.1145/3193992.3193995 Title

	Runtime verification of hyperproperties for deterministic programs
Authors	Srinivas Pinisetty; Gerardo Schneider; David Sands
DOI	doi:10.1145/3193992.3193995
Type	Paper conference
Published in	Proceedings of the 6th Conference on Formal Methods in Software Engineering - FormaliSE '18
Published by	ACM Press
Link	http://dl.acm.org/ft_gateway.cfm?id=3193995&ftid=1988629&dwn=1

4. doi:10.1007/978-3-319-95582-7_11 Title

	Timed Epistemic Knowledge

		Bases for Social Networks
	Authors	Raúl Pardo; César Sánchez; Gerardo Schneider
	DOI	doi:10.1007/978-3-319-95582-7_11
	Type	Chapter
	Published in	Formal Methods
	Published by	Springer International Publishing
	ISSNs	0302-9743; 1611-3349
	Link	http://link.springer.com/content/pdf/10.1007/978-3-319-95582-7_11

5. doi:10.1007/978-3-030-03421-4_2

	Title	Monitoring Hyperproperties by Combining Static Analysis and Runtime Verification
	Authors	Borzoo Bonakdarpour; Cesar Sanchez; Gerardo Schneider
	DOI	doi:10.1007/978-3-030-03421-4_2
	Type	Chapter
	Published in	The Handbook of Environmental Chemistry
	Published by	Springer Berlin Heidelberg
	ISSNs	1867-979X; 1616-864X
	Link	http://link.springer.com/content/pdf/10.1007/978-3-030-03421-4_2

6. doi:10.1007/978-3-319-75632-5_2

	Title	Discovering Concurrency Errors
	Authors	João M. Lourenço; Jan Fiedor; Bohuslav Křena; Tomáš Vojnar
	DOI	doi:10.1007/978-3-319-75632-5_2
	Type	Chapter
	Published in	Lectures on Runtime Verification
	Published by	Springer International Publishing
	ISSNs	0302-9743; 1611-3349
	Link	http://link.springer.com/content/pdf/10.1007/978-3-319-75632-5_2

7. doi:10.1109/ICST.2017.25

	Title	Verifying Concurrent Programs Using Contracts
	Authors	Ricardo J. Dias; Carla Ferreira; Jan Fiedor; Joao M. Lourenco; Ales Smrcka; Diogo G. Sousa; Tomas Vojnar
	DOI	doi:10.1109/ICST.2017.25
	Type	Paper conference
	Published in	2017 IEEE International Conference on Software Testing, Verification and Validation (ICST)
	Published by	IEEE
	Link	http://xplorestaging.ieee.org/ielx7/7

922464/7927908/07927975.pdf?arn
umber=7927975

8. doi:10.1007/s10703-018-0320-4 Title

	Introduction to the special issue on runtime verification
Authors	Yliès Falcone; César Sánchez
DOI	doi:10.1007/s10703-018-0320-4
Type	Journal article
Published in	Formal Methods in System Design
Published by	Springer Nature America, Inc
ISSNs	0925-9856; 1572-8102
Subjects	Theoretical Computer Science; Hardware and Architecture; Software
Links	http://link.springer.com/article/10.1007/s10703-018-0320-4/fulltext.html; http://link.springer.com/content/pdf/10.1007/s10703-018-0320-4.pdf

9. doi:10.1016/j.is.2017.08.002 Title

	Decentralized enforcement of document lifecycle constraints
Authors	Sylvain Hallé; Raphaël Khoury; Quentin Betti; Antoine El-Hokayem; Yliès Falcone
DOI	doi:10.1016/j.is.2017.08.002
Type	Journal article
Published in	Information Systems
Published by	Elsevier BV
ISSN	0306-4379
Subjects	Hardware and Architecture; Software; Information Systems
Links	https://api.elsevier.com/content/article/PII:S0306437916306494?httpAccept=text/xml; https://api.elsevier.com/content/article/PII:S0306437916306494?httpAccept=text/plain

10. doi:10.1007/978-3-319-75632-5 Title

	Lectures on Runtime Verification
DOI	doi:10.1007/978-3-319-75632-5
Type	Book
Published in	Lecture Notes in Computer Science
Published by	Springer International Publishing
ISSNs	0302-9743; 1611-3349
Links	http://link.springer.com/content/pdf/10.1007/978-3-319-75632-5.pdf; http://link.springer.com/content/pdf/10.1007/978-3-319-75632-5

11. doi:10.1007/s00165-017-0422-6 Title

	Concurrency-preserving and sound monitoring of multi-threaded component-based systems: theory, algorithms,

	Authors		implementation, and evaluation Hosein Nazarpour; Yliès Falcone; Saddek Bensalem; Marius Bozga
	DOI		doi:10.1007/s00165-017-0422-6
	Type		Journal article
	Published in		Formal Aspects of Computing
	Published by		Springer Nature
	ISSNs		0934-5043; 1433-299X
	Links		http://link.springer.com/article/10.1007/s00165-017-0422-6/fulltext.html; http://link.springer.com/content/pdf/10.1007/s00165-017-0422-6.pdf

12. doi:10.4230/LIPIcs.CONCUR.2018.34

Title		On Runtime Enforcement via Suppressions
Authors		Luca Aceto; Ian Cassar; Adrian Francalanza; Anna Ingólfsdóttir
DOI		doi:10.4230/LIPIcs.CONCUR.2018.34
Type		Journal article
Published in		Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik GmbH, Wadern/Saarbruecken, Germany
Published by		Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik GmbH, Wadern/Saarbruecken, Germany

13. doi:10.1145/3290365

Title	Adventures in monitorability: from branching to linear time and back again
Authors	Luca Aceto; Antonis Achilleos; Adrian Francalanza; Anna Ingólfsdóttir; Karoliina Lehtinen
DOI	doi:10.1145/3290365
Type	Journal article
Published in	Proceedings of the ACM on Programming Languages
Published by	Association for Computing Machinery (ACM)
ISSN	2475-1421
Link	http://dl.acm.org/ft_gateway.cfm?id=3290365&ftid=2027674&dwn=1

14. doi:10.1007/978-3-319-89366-2_11

Title		A Framework for Parameterized Monitorability
Authors		Luca Aceto; Antonis Achilleos; Adrian Francalanza; Anna Ingólfsdóttir
DOI		doi:10.1007/978-3-319-89366-2_11

	Type	Chapter
	Published in	Lecture Notes in Computer Science
	Published by	Springer International Publishing
	ISSNs	0302-9743; 1611-3349
	Link	http://link.springer.com/content/pdf/10.1007/978-3-319-89366-2_11

15. doi:10.1007/s10703-017-0273-z

	Title	Monitorability for the Hennessy–Milner logic with recursion
	Authors	Adrian Francalanza; Luca Aceto; Anna Ingolfsdottir
	DOI	doi:10.1007/s10703-017-0273-z
	Type	Journal article
	Published in	Formal Methods in System Design
	Published by	Springer Nature
	ISSNs	0925-9856; 1572-8102
	Links	http://link.springer.com/article/10.1007/s10703-017-0273-z/fulltext.html; http://link.springer.com/content/pdf/10.1007/s10703-017-0273-z.pdf

16. doi:10.1007/978-3-319-92994-1

	Title	Tests and Proofs
	DOI	doi:10.1007/978-3-319-92994-1
	Type	Book
	Published in	Lecture Notes in Computer Science
	Published by	Springer International Publishing
	ISSNs	0302-9743; 1611-3349
	Links	http://link.springer.com/content/pdf/10.1007/978-3-319-92994-1.pdf; http://link.springer.com/content/pdf/10.1007/978-3-319-92994-1

17. doi:10.1007/978-3-319-69483-2

	Title	Dependable Software Engineering. Theories, Tools, and Applications
	DOI	doi:10.1007/978-3-319-69483-2
	Type	Book
	Published in	Lecture Notes in Computer Science
	Published by	Springer International Publishing
	ISSNs	0302-9743; 1611-3349
	Links	http://link.springer.com/content/pdf/10.1007/978-3-319-69483-2.pdf; http://link.springer.com/content/pdf/10.1007/978-3-319-69483-2

18. doi:10.1145/3131851.3131864

	Title	Causally consistent reversible choreographies

	Authors	Claudio Antares Mezzina; Jorge A. Pérez
	DOI	doi:10.1145/3131851.3131864
	Type	Paper conference
	Published in	Proceedings of the 19th International Symposium on Principles and Practice of Declarative Programming - PPDP '17
	Published by	ACM Press
	Link	http://dl.acm.org/ft_gateway.cfm?id=3131864&ftid=1913691&dwn=1
19. doi:10.1145/3019612.3019625	Title	Efficient compensation handling via subjective updates
	Authors	Jovana Dedeić; Jovanka Pantović; Jorge A. Pérez
	DOI	doi:10.1145/3019612.3019625
	Type	Paper conference
	Published in	Proceedings of the Symposium on Applied Computing - SAC '17
	Published by	ACM Press
	Link	http://dl.acm.org/ft_gateway.cfm?id=3019625&ftid=1875699&dwn=1
20. doi:10.1007/978-3-030-03427-6_21	Title	Reliable Smart Contracts: State-of-the-Art, Applications, Challenges and Future Directions
	Authors	César Sánchez; Gerardo Schneider; Martin Leucker
	DOI	doi:10.1007/978-3-030-03427-6_21
	Type	Chapter
	Published in	Lecture Notes in Computer Science
	Published by	Springer International Publishing
	ISSNs	0302-9743; 1611-3349
	Link	http://link.springer.com/content/pdf/10.1007/978-3-030-03427-6_21
21. doi:10.1007/978-3-030-03769-7_2	Title	COST Action IC1402 Runtime Verification Beyond Monitoring
	Authors	Christian Colombo; Yliès Falcone; Martin Leucker; Giles Reger; Cesar Sanchez; Gerardo Schneider; Volker Stolz
	DOI	doi:10.1007/978-3-030-03769-7_2
	Type	Chapter
	Published in	Runtime Verification
	Published by	Springer International Publishing

| | | ISSNs | 0302-9743; 1611-3349 |
| | | Link | http://link.springer.com/content/pdf/10.1007/978-3-030-03769-7_2 |

22. doi:10.1145/3167132.3167338

	Title	TeSSLa
	Authors	Martin Leucker; César Sánchez; Torben Scheffel; Malte Schmitz; Alexander Schramm
	DOI	doi:10.1145/3167132.3167338
	Type	Paper conference
	Published in	Proceedings of the 33rd Annual ACM Symposium on Applied Computing - SAC '18
	Published by	ACM Press
	Link	http://dl.acm.org/ft_gateway.cfm?id=3167338&ftid=1983727&dwn=1

23. doi:10.4230/DagRep.7.11.59

	Title	A Shared Challenge in Behavioural Specification (Dagstuhl Seminar 17462)
	Authors	Klaus Havelund; Martin Leucker; Giles Reger; Volker Stolz
	DOI	doi:10.4230/DagRep.7.11.59
	Type	Journal article
	Published in	Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik GmbH, Wadern/Saarbruecken, Germany
	Published by	Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik GmbH, Wadern/Saarbruecken, Germany

24. doi:10.1007/978-3-030-03421-4_1

	Title	A Broader View on Verification: From Static to Runtime and Back (Track Summary)
	Authors	Wolfgang Ahrendt; Marieke Huisman; Giles Reger; Kristin Yvonne Rozier
	DOI	doi:10.1007/978-3-030-03421-4_1
	Type	Chapter
	Published in	The Handbook of Environmental Chemistry
	Published by	Springer Berlin Heidelberg
	ISSNs	1867-979X; 1616-864X
	Link	http://link.springer.com/content/pdf/10.1007/978-3-030-03421-4_1

25. doi:10.1145/3178126.3178131

	Title	Localizing Faults in Simulink/Stateflow Models with STL
	Authors	Ezio Bartocci; Thomas Ferrère; Niveditha Manjunath; Dejan Ničković
	DOI	doi:10.1145/3178126.3178131
	Type	Paper conference

	Published in	Proceedings of the 21st International Conference on Hybrid Systems: Computation and Control (part of CPS Week) - HSCC '18
	Published by	ACM Press
	Link	http://dl.acm.org/ft_gateway.cfm?id=3178131&ftid=1955828&dwn=1

26.	doi:10.1007/978-3-030-01090-4	Title	Automated Technology for Verification and Analysis
		DOI	doi:10.1007/978-3-030-01090-4
		Type	Book
		Published in	Lecture Notes in Computer Science
		Published by	Springer International Publishing
		ISSNs	0302-9743; 1611-3349
		Links	http://link.springer.com/content/pdf/10.1007/978-3-030-01090-4.pdf; http://link.springer.com/content/pdf/10.1007/978-3-030-01090-4

27.	doi:10.1007/978-3-319-99154-2	Title	Quantitative Evaluation of Systems
		DOI	doi:10.1007/978-3-319-99154-2
		Type	Book
		Published in	Lecture Notes in Computer Science
		Published by	Springer International Publishing
		ISSNs	0302-9743; 1611-3349
		Links	http://link.springer.com/content/pdf/10.1007/978-3-319-99154-2.pdf; http://link.springer.com/content/pdf/10.1007/978-3-319-99154-2

28.	doi:10.1145/3127041.3127050	Title	Monitoring mobile and spatially distributed cyber-physical systems
		Authors	Ezio Bartocci; Luca Bortolussi; Michele Loreti; Laura Nenzi
		DOI	doi:10.1145/3127041.3127050
		Type	Paper conference
		Published in	Proceedings of the 15th ACM-IEEE International Conference on Formal Methods and Models for System Design - MEMOCODE '17
		Published by	ACM Press
		Link	http://dl.acm.org/ft_gateway.cfm?id=3127050&ftid=1909580&dwn=1

29.	doi:10.1007/978-3-030-03427-6	Title	Leveraging Applications of Formal Methods, Verification and Validation. Industrial Practice

	DOI	doi:10.1007/978-3-030-03427-6
	Type	Book
	Published in	Lecture Notes in Computer Science
	Published by	Springer International Publishing
	ISSNs	0302-9743; 1611-3349
	Links	http://link.springer.com/content/pdf/10.1007/978-3-030-03427-6.pdf; http://link.springer.com/content/pdf/10.1007/978-3-030-03427-6

30. doi:10.1007/978-3-319-75632-5_1

	Title	Introduction to Runtime Verification
	Authors	Ezio Bartocci; Yliès Falcone; Adrian Francalanza; Giles Reger
	DOI	doi:10.1007/978-3-319-75632-5_1
	Type	Chapter
	Published in	Lectures on Runtime Verification
	Published by	Springer International Publishing
	ISSNs	0302-9743; 1611-3349
	Link	http://link.springer.com/content/pdf/10.1007/978-3-319-75632-5_1

31. doi:10.1007/978-3-319-75632-5_5

	Title	Specification-Based Monitoring of Cyber-Physical Systems: A Survey on Theory, Tools and Applications
	Authors	Ezio Bartocci; Jyotirmoy Deshmukh; Alexandre Donzé; Georgios Fainekos; Oded Maler; Dejan Ničković; Sriram Sankaranarayanan
	DOI	doi:10.1007/978-3-319-75632-5_5
	Type	Chapter
	Published in	Lectures on Runtime Verification
	Published by	Springer International Publishing
	ISSNs	0302-9743; 1611-3349
	Link	http://link.springer.com/content/pdf/10.1007/978-3-319-75632-5_5

32. doi:10.1007/s10703-017-0287-6

	Title	Introduction to the special issue on runtime verification
	Authors	Ezio Bartocci; Rupak Majumdar
	DOI	doi:10.1007/s10703-017-0287-6
	Type	Journal article
	Published in	Formal Methods in System Design
	Published by	Springer Nature

ISSNs 0925-9856; 1572-8102
Links http://link.springer.com/article/10.1007/s10703-017-0287-6/fulltext.html;
http://link.springer.com/content/pdf/10.1007/s10703-017-0287-6.pdf

33. doi:10.1007/s10009-017-0454-5 Title First international Competition on Runtime Verification: rules, benchmarks, tools, and final results of CRV 2014

Authors Ezio Bartocci; Yliès Falcone; Borzoo Bonakdarpour; Christian Colombo; Normann Decker; Klaus Havelund; Yogi Joshi; Felix Klaedtke; Reed Milewicz; Giles Reger; Grigore Rosu; Julien Signoles; Daniel Thoma; Eugen Zalinescu; Yi Zhang

DOI doi:10.1007/s10009-017-0454-5
Type Journal article
Published in International Journal on Software Tools for Technology Transfer
Published by Springer Nature
ISSNs 1433-2779; 1433-2787
Links http://link.springer.com/content/pdf/10.1007/s10009-017-0454-5.pdf;
http://link.springer.com/article/10.1007/s10009-017-0454-5/fulltext.html

34. doi:10.1016/j.scico.2015.12.005 Title Efficiently intertwining widening and narrowing

Authors Gianluca Amato; Francesca Scozzari; Helmut Seidl; Kalmer Apinis; Vesal Vojdani

DOI doi:10.1016/j.scico.2015.12.005
Type Journal article
Published in Science of Computer Programming
Published by Elsevier BV
ISSN 0167-6423
Subject Software
Links https://api.elsevier.com/content/article/PII:S0167642315004165?httpAccept=text/plain;
https://api.elsevier.com/content/article/PII:S0167642315004165?httpAccept=text/xml

35. doi:10.1007/978-3-319-27810-0_14 Title Enhancing Top-Down Solving with Widening and Narrowing

Authors Kalmer Apinis; Helmut Seidl; Vesal Vojdani

DOI doi:10.1007/978-3-319-27810-0_14

	Type	Chapter
	Published in	Semantics, Logics, and Calculi
	Published by	Springer International Publishing
	ISSNs	0302-9743; 1611-3349
	Link	http://link.springer.com/content/pdf/10.1007/978-3-319-27810-0_14

36. doi:10.1145/3123569.3123570

	Title	eAOP: an aspect oriented programming framework for Erlang
	Authors	Ian Cassar; Adrian Francalanza; Luca Aceto; Anna Ingólfsdóttir
	DOI	doi:10.1145/3123569.3123570
	Type	Paper conference
	Published in	Proceedings of the 16th ACM SIGPLAN International Workshop on Erlang - Erlang 2017
	Published by	ACM Press
	Link	http://dl.acm.org/ft_gateway.cfm?id=3123570&ftid=1902013&dwn=1

37. doi:10.4230/LIPIcs.FSTTCS.2017.7

	Title	Monitoring for Silent Actions
	Authors	Luca Aceto; Antonis Achilleos; Adrian Francalanza; Anna Ingólfsdóttir
	DOI	doi:10.4230/LIPIcs.FSTTCS.2017.7
	Type	Journal article
	Published in	Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik GmbH, Wadern/Saarbruecken, Germany
	Published by	Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik GmbH, Wadern/Saarbruecken, Germany

38. doi:10.1109/SANER.2018.8330250

	Title	LICCA: A tool for cross-language clone detection
	Authors	Tijana Vislavski; Gordana Rakic; Nicolas Cardozo; Zoran Budimac
	DOI	doi:10.1109/SANER.2018.8330250
	Type	Paper conference
	Published in	2018 IEEE 25th International Conference on Software Analysis, Evolution and Reengineering (SANER)
	Published by	IEEE
	Link	http://xplorestaging.ieee.org/ielx7/8326467/8330182/08330250.pdf?arnumber=8330250

39. doi:10.1016/j.jlamp.2018.12.002

	Title	Precise subtyping for

Authors	synchronous multiparty sessions Silvia Ghilezan; Svetlana Jakšić; Jovanka Pantović; Alceste Scalas; Nobuko Yoshida
DOI	doi:10.1016/j.jlamp.2018.12.002
Type	Journal article
Published in	Journal of Logical and Algebraic Methods in Programming
Published by	Elsevier BV
ISSN	2352-2208
Subjects	Political Science and International Relations; Cultural Studies; Sociology and Political Science
Links	https://api.elsevier.com/content/article/PII:S2352220817302237?httpAccept=text/xml; https://api.elsevier.com/content/article/PII:S2352220817302237?httpAccept=text/plain

40. doi:10.1007/978-3-030-03769-7_14

Title	A Taxonomy for Classifying Runtime Verification Tools
Authors	Yliès Falcone; Srđan Krstić; Giles Reger; Dmitriy Traytel
DOI	doi:10.1007/978-3-030-03769-7_14
Type	Chapter
Published in	Runtime Verification
Published by	Springer International Publishing
ISSNs	0302-9743; 1611-3349
Link	http://link.springer.com/content/pdf/10.1007/978-3-030-03769-7_14

Projects

The Action reported 7 project(s) and 8 proposal(s) resulting from the Action networking.

Key details of the projects are shown below:

1. UNIFYING CORRECTNESS FOR COMMUNICATING SOFTWARE
   (National)
2. COEMS - Continuous Observation of Embedded Multicore Systems
   (H2020)
3. LISTENER - Log-drIven, Search-based TEst geNERation for Ground Control Systems
   (National)
4. Theoretical foundations for monitorability, TheoFoMon
   (National)
5. Epistemic logic for distributed monitoring
   (National)
6. High-assurance software development with sound interactive static analysis
   (National)
7. Software trustworthiness
   (National)

Other outputs / achievements

The following other outputs/ achievements contributing to the COST mission resulted from the Action:

1. Lectures of one of the training schools have been recorded and are available as additional training material on the cost-arvi.eu web page:

   https://www.cost-arvi.eu/?page_id=1163

   on

   https://www.youtube.com/playlist?list=PLfz3Xwel7th23rrbTPc442W5V2BPMi1CC

Impacts

The Action reported the following impact(s):

Description of the impact, i.e. what will change, and for whom, as a result of what the Action achieved	Type of impact	Timing of impact
Niveditha, a PhD student of Dejan Nikovic, has visited Milan last year using an STSM. Niveditha, Ezio Bartocci, Dejan Nicovic and Leonardo Mariani are now actively working together on the topic of Failure analysis in CPS. Niveditha's STSM allowed her to work with experts from software engineering, a complety new domain for her, resulting in broadening her knowledge and the scope of her thesis. Meanwhile, she got a position in Sweden.	• Scientific / Technological	Achieved
Two mutually exchanging STSMs between Novi Sad (Serbia) and Coimbra (Portugal), with Nuno Antunes and Gordana Rakic involved, lead to a new contact and subsequently for an application to an EU project and a successful application for an Erasmus+ mobility programme.	• Scientific / Technological	Achieved
Nuno Antunes was promoted from PhD to Assistant Professor. ARVI had a positive impact in that, although it is very hard to measure such impact.	• Scientific / Technological	Achieved
The STSM visit of Ezio Bartocci visiting Ylies Falcone led to the organisation of a corresponding track at Isola'2018.	• Scientific / Technological	Achieved
Martin Sachenbacher from LionSmart GmbH was asked to give lectures on software engineering, especially in the context of battery management systems, to to teach scientific knowledge with industrial practice to students.	• Scientific / Technological	Achieved
A proposal for a Dagstuhl seminar on contracts from Marieke Huismann, Giles Reger, Dilian Gurov, Reiner Hähnle resulted from this Action.	• Scientific / Technological	Achieved
The tutorial volume worked out during this COST Action will straight-line the understanding of runtime verification both within academia as well as industry.	• Scientific / Technological	Foreseen within two years

Dissemination and exploitation of Action results

Dissemination and exploitation approach of the Action

The Action's dissemination and exploitation approach as well as all activities undertaken to ensure dissemination and exploitation of Action results and the outcomes of these activities are described below.

Dissemination and Exploitation Activities ranged over information, demonstration, qualification, and realization, which a focus on information and qualification. The COST action itself as well as their results was announced during corresponding scientific conferences, training schools have been organized to disseminate the research results of the Action in detail. In certain project proposals, results have or will be exploited. For example, the COEMS project funded by Horizon 2020 benefits from the results of this COST Action.

Dissemination meetings funded by the Action

The Action funded Dissemination Meetings as shown below:

Title	ARVI@RV		
Date	21-09-2015 to 21-09-2015	Country	Austria
Event	The Runtime Verification Conference 2015		

Other dissemination activities

The Action also undertook the following dissemination activities:

Activity	Presentation of COST ARVI Results at the RV 2018 conference on Cyprus
Target	Runtime Verification Community and Industrial Adopters. The conference participants involves especially international participants from all over the world.
Outcome	The results worked out during the COST Action were highly appreciated. Especially the results on foundations, and the collection of benchmarks is expected to influence future research significantly.
Link	https://rv2018.isp.uni-luebeck.de/program/

Activity	International Training School on Runtime Verification Techniques and Tools in Madrid.
Target	PhD Students and youn researchers form all over the world.
Outcome	By holding the training school, the results especially from WG1 were streamlined and presented to both within the COST Action but also to international young researchers. It was also the basis for the LNCS tutorial volume on RV techniques.
Link	https://rv2016.imag.fr/?page_id=128

Activity	International Training School on Runtime Verification Techniques and Tools in the Alps.
Target	PhD students and young researchers, both within the COST action but also from all over the world.
Outcome	During the training school the lectures were recorded and edited afterwards and now serve as freely available dissemination material in the internet.
Link	https://www.cost-arvi.eu/?page_id=1163

Activity	Dissemination Talk on Data portal for RV challenges created within this Action given at RV 2017 within

	the RV-Cubes workshop.
Target	International Researcher working in the field of runtime verification and related topics.
Outcome	The concept of this COST results were highly appreciated by the audience.
Link	http://rv2017.cs.manchester.ac.uk/rv-cubes/

Exploitation activities

The Action undertook the following activities to ensure exploitation (use, in particular in a commercial context) of the Action's achievements:

No exploitation activities were reported by the Action.

Action Success(es)

The Action's two most significant successes were the following:

- The field of runtime verification that was the object of study in the Action was considerably enriched during the Action. The existing knowledge has been streamlined, new knowledge but also new challenges have been identified, foundations for precise comparisons of different practical approaches have been laid, and application potential in different industrial domains have been shown. In total, we consider the Action a true success.

Action Expenditure

The table below shows the budget allocated to the Action for each Grant Period:

#	Grant Period	Start Date	End Date	Budget allocated to Action (EUR)
1	CGA-IC1402-1	1-3-2015	31-8-2015	28,750.17 (EUR)
2	CGA-IC1402-1B	1-9-2015	30-4-2016	95,995.39 (EUR)
3	AGA-IC1402-3	1-5-2016	30-4-2017	116,173.00 (EUR)
4	AGA-IC1402-4	1-5-2017	30-4-2018	130,000.00 (EUR)
5	AGA-IC1402-5	1-5-2018	16-12-2018	94,392.00 (EUR)

Action Expenditure