

LOIC HELOUET PUBLICATIONS

1 Publications

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1. Publications

Foreword: I list below my publications, sorted by category. Listed references are sorted with the following convention:

[LH-Jxx] for a journal publication

[LH-BKxx] for a book involving

[LH-Cxx] for a conference publication

[LH-Wxx] for a workshop publication

All references [LH-xx] are hyperlinks to the corresponding publication.

1.1) International journals

[\[LH-J1\]](#) L. H elou et, *Distributed system requirements modeling with Message Sequence Charts, the case of the RMTP2 protocol*, International Journal of Information and Software Technology, 2002. [\[PDF\]](#)

[\[LH-J2\]](#) L. H elou et, C. Jard, B. Caillaud, *An Event Structure Semantics for Message Sequence Charts*, special issue on graph transformation in "Mathematical Structures in Computer Science" (MSCS) journal, vol. 12, pp. 377-403, 2002. [\[PDF\]](#)

[\[LH-J3\]](#) T. Gazagnaire, L. H elou et, S. Yang, *Logic-based diagnosis for distributed systems*, in Perspectives in Concurrency, a festschrift for P.S. Thiagarajan, 2009. [\[PDF\]](#)

[\[LH-J4\]](#) T. Gazagnaire, B. Genest, L. H elou et, P. S. Thiagarajan, Shaofa Yang: *Causal Message Sequence Charts*, Theoretical Computer Science (TCS), 410(41), pp. 4094-4110, 2009. [\[PDF\]](#)

[\[LH-J5\]](#) L. H elou et, V. Rehak, P. Slovak, J. Strejcek, *Decidable Race Condition and Open Coregions in HMSC*. ECEASST, 29, 2010. [\[PDF\]](#)

[\[LH-J6\]](#) S. Akshay, B. Genest, L. H elou et, S. Yang: *Regular set of representatives for time-constrained MSC graphs*, Information Processing Letters, vol.112, issue 14-15, pp. 592-598, 2012. [\[PDF\]](#)

- [LH-J7] B. Genest, T. Gazagnaire, L. Hérouët, H. Marchand, *Diagnosis from scenarios*, Discrete Event Dynamic Systems 24(4), pp. 353-415, 2014. [\[PDF\]](#)
- [LH-J8] Rouwaida Abdallah, Loïc Hérouët, Claude Jard. *Distributed Implementation of Message Sequence Charts*. Software and Systems Modeling, vol. 14, issue 2, pp 1029-1048, 2015. [\[PDF\]](#)
- [LH-J9] E. Badouel, R. Fondze Jr, L.Hérouët, G.E. Kouamou, C. Morvan, *Active Workspaces: Distributed Collaborative Systems based on Guarded Attribute Grammars* . In ACM Sigapp Applied Computing Review, vol. 13, issue 3, 2015. [\[PDF\]](#)
- [LH-J10] S.Akshay, L. Hérouët, C.Jard, P.A. Reynier, *Robustness of Time Petri Nets under Guard Enlargement* . In Fundamenta Informaticae no143, pp 1-27, 2016. [\[PDF\]](#)
- [LH-J11] B. Bérard, L. Hérouët, J. Mullins, *Non-interference in partial order models*, ACM Transactions on Embedded Computing Systems (TECS), vol. 16, issue 2, (Special issue for ACSD 2015), December 2016. [\[PDF\]](#)
- [LH-J12] E. Badouel, L. Hérouët, Ch. Morvan, *Petri Nets with Structured Data*, Fundamenta Informaticae, 146(1): pp 35-82, 2016. [\[PDF\]](#)
- [LH-J13] E. Fabre, L. Hérouët, E. Lefauchaux, H. Marchand, *Diagnosability of Repairable Faults* . In Journal of Discrete Events Systems, no 28, issue 2, p183-213, 2018. [\[PDF\]](#)
- [LH-J14] L. Hérouët, K. Kecir, *Realizability of Schedules by Stochastic Time Petri Nets with Blocking Semantics*, In Science of Computer Programming, 157:71-102, 2018. [\[PDF\]](#)
- [LH-J15] S. Akshay, L. Hérouët, R. Phawade, *Combining Free Choice and Time in Petri Nets (Extended Version)*, Journal of Logical and Algebraic Methods in Programming, 2018. [\[PDF\]](#)
- [LH-J16] L. Hérouët, N. Markey, R. Raha, *Reachability games with relaxed energy constraints (extended version)*, Information and Computation, 2021.
- [LH-J17] L. Hérouët, R. Singh, Z. Miklos, *Reducing the Cost of Aggregation in Crowdsourcing (extended version)*, Transactions on Large-Scale Data- and Knowledge-Centered Systems XLIX. Lecture Notes in Computer Science, vol 12920, p33-69, 2021.
- [LH-J18] M. L. Tessitore, M. Samà, A. D'Ariano, L. Hérouët, D. Pacciarelli, *A Simulation-Optimization Framework for Traffic Disturbance Recovery in Metro Systems*, Transportation Research Part C: Emerging Technologies, Vol 136, March 2022.

1.2) Reviewed international conferences

- [LH-C1] L. Hérouët, *A Simulation Framework for Message Sequence Charts*, 9th SDL Forum, pp. 473-488, Montréal, 1999. [\[PDF\]](#)
- [LH-C2] L. Hérouët., *Some pathological message sequence charts and how to detect them*, In 10th SDL Forum, LNCS no 2078 , pp. 348--364, 2001. [\[PDF\]](#)
- [LH-C3] B. Genest, L. Hérouët, A. Muscholl, *High-level Message Sequence Charts projection*, proceedings of CONCUR 2003, LNCS no 2761, pp. 308-322, 2003. [\[PDF\]](#)
- [LH-C4] T. Ziadi, L. Hérouët, J.M. Jézéquel, *Revisiting Statechart Synthesis with an algebraic approach*, Proc. of ICSE'04, pp. 242-251, Edinburgh, 2004. [\[PDF\]](#)
- [LH-C5] T. Chatain, C. Jard, L. Hérouët, *From automata networks to HMSCs: a reverse model engineering perspective*, Proc. of FORTE'05, LNCS no 3731, pp. 489-502, Taiwan, 2005. [\[PDF\]](#)
- [LH-C6] J. Klein, L. Hérouët, J.M. Jézéquel, *Semantic-based weaving of Scenarios*, Proceedings. of AOSD 2006, pp. 27-38, 2006. [\[PDF\]](#)
- [LH-C7] T. Gazagnaire, B. Genest, L. Hérouët, P.S. and Yang, S. Thiagarajan. *Causal Message Sequence Charts*, In Proceedings of CONCUR 2007, LNCS no 4703, pp. 166-180, 2007. [\[PDF\]](#)

- [\[LH-C8\]](#) T. Gazagnaire, L. Hélouët. *Event Correlation with boxed pomsets*. In Proceedings of FORTE 2007, LNCS no 4574, pp. 160-176, 2007. [\[PDF\]](#)
- [\[LH-C9\]](#) P. Darondeau, B. Genest, L. Hélouët, *Products of Message Sequence Charts*. FOSSACS 2008, LNCS 4962, pp. 459-474, 2008. [\[PDF\]](#)
- [\[LH-C10\]](#) B. Bollig, L. Hélouët, *Realizability of Dynamic MSC Languages*, CSR 2010, LNCS no 6072, pp. 48-59, Kazan, Russia, 2010. [\[PDF\]](#)
- [\[LH-C11\]](#) A. Benveniste, L. Hélouët, *Document Based Modeling of Web Services Choreographies Using Active XML*, International Conference on Web Services (ICWS) 2010, pp. 291-298, Miami, Florida, 2010. [\[PDF\]](#)
- [\[LH-C12\]](#) Ph. Darondeau, L. Hélouët, M. Mukund. *Assembling Sessions*, In Automated Technology for Verification and Analysis (ATVA), LNCS no 6996, pp. 259-274, Taiwan, 2011. [\[PDF\]](#)
- [\[LH-C13\]](#) S. Akshay, B. Genest, L. Hélouët, S. Yang: *Symbolically Bounding the Drift in Time-Constrained MSC Graphs*. Theoretical Aspects of Computing (ICTAC) 2012, LNCS no 7521, pp. 1-15, Bangalore, 2012. [\[PDF\]](#)
- [\[LH-C14\]](#) S. Akshay, L. Hélouët, C. Jard, D. Lime, O.H.Roux, *Robustness of Time Petri Nets under Architectural Constraints*, in FORMATS 2012, , LNCS no 7595, pp 11-26, 2012. [\[PDF\]](#)
- [\[LH-C15\]](#) R. Abdallah, A. Gotlieb, L. Hélouët, C. Jard: *Scenario Realizability with Constraint Optimization*. FASE 2013, LNCS no 7793, pp. 194-209, 2013. [\[PDF\]](#)
- [\[LH-C16\]](#) B. Bollig, A. Cyriac, L. Hélouët, A. Kara, T. Schwentick: *Dynamic Communicating Automata and Branching High-Level MSCs*. LATA 2013, pp. 177-189, 2013. [\[PDF\]](#)
- [\[LH-C17\]](#) S. Akshay, N. Bertrand, S. Haddad, L. Hélouët: *The Steady-State Control Problem for Markov Decision Processes*. QEST 2013, pp. 290-304, 2013. [\[PDF\]](#)
- [\[LH-C18\]](#) S. Akshay, L. Hélouët, M. Mukund, *Sessions with an unbounded number of Agents*. In ACSD'14, International Conference on Application of Concurrency to System Design, IEEE Computer society, pp. 166-175, 2014. [\[PDF\]](#)
- [\[LH-C19\]](#) N. Bertrand, E. Fabre, S. Haar, S. Haddad, L. Hélouët, *Active Diagnosis for Probabilistic Systems*. In 17th International Conference on Foundations of Software Science and Computation Structures, FoSSaCS'14, LNCS no 8412, pp. 29-42, 2014. [\[PDF\]](#)
- [\[LH-C20\]](#) E. Badouel, L. Hélouët, Ch. Morvan, *A Grammatical Approach to Data-centric Case Management in a Distributed Collaborative Environment*, Symposium on Applied Computing, SAC' 2015, 2015. [\[PDF\]](#)
- [\[LH-C21\]](#) B. Bérard, L. Hélouët, J. Mullins, *Non-interference in Partial Order Models*. In ACSD'15, International Conference on Application of Concurrency to System Design, IEEE Computer society, pp 80-89, 2015. [\[PDF\]](#)
- [\[LH-C22\]](#) E. Badouel, L. Hélouët, C. Morvan, *Petri nets with semi-structured data*. In Petri Nets'15, LNCS 9115, pp 212-233, 2015. [\[PDF\]](#)
- [\[LH-C23\]](#) L. Hélouët, K. Kecir, *Realizability of Schedules by Stochastic Time Petri Nets with Blocking Semantics*, In Petri Nets '16, LNCS 9698, pp 155-175, 2016. [\[PDF\]](#)
- [\[LH-C24\]](#) S. Akshay, B. Genest, L. Hélouët, *Decidable Classes of Unbounded Petri Nets with Time and Urgency*, In Petri Nets '16, LNCS 9698, pp 301-322, 2016. [\[PDF\]](#)
- [\[LH-C25\]](#) S. Akshay, L. Hélouët, R. Phawade, *Combining Free Choice and Time in Petri Nets*. TIME 2016, 23rd International Symposium on Temporal Representation and Reasoning, IEEE, pp 120-129, 2016. [\[PDF\]](#)
- [\[LH-C26\]](#)¹E. Fabre, L. Hélouët, E. Lefauchaux, H. Marchand, *Diagnosability of repairable faults*, WODES 2016, 13th International Workshop on Discrete Event Systems, IEEE, pp 230-236, 2016. [\[PDF\]](#)
- [\[LH-C27\]](#) L. Hélouët, H. Marchand, *On the cost of diagnosis with disambiguation*. In QEST, 2017, LNCS 10503, p 140-156, 2016. [\[PDF\]](#)
- [\[LH-C28\]](#) B. Adeline, A. D'ariano, P. Dersin, L. Hélouët, K. Kecir, *From reactive to predictive regulation in Metros* . In ECSSO, European Conference on Stochastic Optimization, 2017. [\[PDF\]](#)

¹ Unlike its name suggests, WODES is a conference with peer-review and proceedings published by IEEE. Since 2010, it is indexed by DBLP as a conference.

- [[LH-C29](#)] B. Adeline, P. Dersin, E. Fabre, L. Hérouët, K. Kecir, *An efficient evaluation scheme for KPIs in regulated urban train systems*. In RSSRAIL, 2017. [[PDF](#)]
- [[LH-C30](#)] L. Hérouët, H. Marchand, L.Ricker, *Note on Opacity with powerful attackers*, WODES'18, 2018. [[PDF](#)]
- [[LH-C31](#)] L. Hérouët, H. Marchand, J. Mullins, *Concurrent secrets with reasonable suspicion*, ACSD'18, p 75-84, IEEE, 2018. [[PDF](#)]
- [[LH-C32](#)] B. Bérard, S.Haar, L. Hérouët, *Hyper Partial Order Logic*, p20:1-20:21, FSTTCS'18, 2018. [[PDF](#)]
- [[LH-C33](#)] N. Bertrand, B. Bordais, L. Hérouët, T. Mari, J. Parreaux, O. Sankur, *Performance Evaluation of Metro Regulations Using Probabilistic Model-checking*, RSSRAIL'19, p59-76, LNCS 11495, 2019. [[PDF](#)]
- [[LH-C34](#)] L. Hérouët, N. Markey, R. Raha, *Reachability games with relaxed energy constraints*, GANDALF'19, p17-33, 2019. [[PDF](#)]
- [[LH-C35](#)] L. Hérouët, R. Singh, Z. Miklos, *Reducing the Cost of Aggregation in Crowdsourcing*, ICWS'20, 2020. [[PDF](#)]
- [[LH-C36](#)] S.Akshay, B. Genest, L. Hérouët, S. Mittal, *Timed Negotiations*, FOSSACS'20, 2020. [[PDF](#)]
- [[LH-C37](#)] L. Hérouët, Z. Miklos, R. Singh, *Data Centric Workflows for Complex Crowdsourcing Applications*, Petri Nets 2020, LNCS, volume 12152, June 2020. [[PDF](#)]
- [[LH-C38](#)] L. Hérouët, H. Marchand, L. Ricker, G. Zinck, *Enforcing Opacity in Modular Systems*, 2020. IFAC 2020 - Ifac world Congress. Virtual, Germany, pp. 1–8., Nov. 30, 2020. [[PDF](#)]
- [[LH-C39](#)] L. Hérouët, Z. Miklos, R. Singh, *Cost and Quality in Crowdsourcing Workflows*, Petri Nets'21, 2021.
- [[LH-C40](#)] S. Akshay, B. Genest, L. Hérouët, S. Krishna, S. Roychowdhury, *Resilience of Timed Systems*, FSTTCS'21, 2021
- [[LH-C41](#)] M. L. Tessitore, M. Samà, A. D'Ariano, L. Hérouët, D. Pacciarelli, *Assessment of Disturbance Recovery Strategies in a Busy Metro System*, RailBeing 2021.

1.3) Books and book chapters

Conference proceedings :

- [[LH-BK1](#)] H.Marchand, L. Hérouët, *Modélisation des systèmes réactifs*, MSR 2013, Journal européen des Systèmes automatisés, Vol 47, no 1-2-3, Hermes, 2013.

Standards :

- [[LH-S1](#)] ITU-T, *Standard Z.120 –High-level Message Sequence Charts*, International Telecommunication Union (ITU), nov. 2011.
- [[LH-S2](#)] L. Hérouët, *Application of MSC, Amendment 2 to standard Z.120 –High-level Message Sequence Charts -*, International Telecommunication Union (ITU), sept. 2009.

1.4) Other international publications (posters, short papers)

Habilitation, PhD Thesis:

- [[LH-PHD-00](#)] L. Hérouët, *Analyse des exigences des systèmes distribués exprimées par des langages de Scenarios*, PhD thesis, Rennes 1 University, 2000.
- [[LH-Habil-13](#)] L. Hérouët, *Scenario Automata: theory and applications*, Habilitation thesis, Rennes 1 University, 2013.

Reviewed International Workshops:

- [LH-W1] L. Hérouët, C. Jard, *Conditions for synthesis of communicating automata from HMSCs*, 5th International Workshop on Formal Methods for Industrial Critical Systems (FMICS), Berlin, 2000.
- [LH-W2] P. Le Maigat, L. Hérouët, *A (max, +) approach for time in Message Sequence Charts*, 5th Workshop on Discrete Event Systems (WODES 2000), Ghent, 2000.
- [LH-W3] L. Hérouët, P. Le Maigat, *Decomposition of Message Sequence Charts*, 2nd Workshop on SDL and MSC (SAM2000), pp. 47-60, Grenoble, France, 2000.
- [LH-W4] P. Darondeau, B. Caillaud, L. Hérouët, G. Lesventes, *HMSCs as partial specifications...with Petri Nets as completion*, MOdelling and Verification of Parallel Processes (MOVEP'2000), LNCS no 2076, pp. 125-152, Nantes, France, 2000, (**invited paper**)
- [LH-W5] T. Ziadi, L. Hérouët, J.M. Jézéquel, *Modeling Behaviors in Product Lines*, proceedings of REPL'02, International workshop on Requirements Engineering for Product Lines, Essen, Germany, 2002.
- [LH-W6] L. Hérouët, M. Zeitoun, C. Jard, *Covert channels detection in protocols using scenarios*, Proc. of SPV'03, Security Protocols Verification, 2003
- [LH-W7] T. Ziadi, L. Hérouët, J.M. Jézéquel, *Towards a UML profile for Software Product Lines*, PFE5 (Product Family engineering), LNCS no 3014, pp. 129-139, 2003.
- [LH-W8] L. Hérouët, *Finding covert channels in protocols with Message Sequence Charts: the case of RMTP2*, Proc. of SAM'04, Conference on SDL and MSCs, LNCS no 3319, pp. 189-207, Ottawa, 2004.
- [LH-W9] L. Hérouët, M. Zeitoun, A. Degorre, *Scenarios and covert channels: yet another game*, Proc. of GDV'04, (Games in design and Validation), Electronic Notes in Theoretical Computer Science no 118, pp. 93-116, Boston, 2004.
- [LH-W10] J. Klein, B. Caillaud, L. Hérouët, *Merging Scenarios*, Proc. of FMICS'04 (Formal Methods for Industrial and Critical Systems), Electronic Notes in Theoretical Computer Science no 133, pp. 193-215, Linz, 2004.
- [LH-W11] T. Ziadi, L. Hérouët, J.M. Jézéquel, *Behaviors generation from product lines requirements*, Proc. of UML2004 workshop on Software Architecture Description, 2004 .
- [LH-W12] L. Hérouët, T. Hénin, C. Chevrier, *Automating Scenario merging*, Proc. Of SAM'06, LNCS no 4320, pp. 64-81, 2006.
- [LH-W13] L. Hérouët, T. Gazagnaire, B. Genest, *Diagnosis from scenarios*, Proc. of WODES'06, pp. 307-312, 2006.
- [LH-W14] V. Rehak, P. Slovak, J. Strejcek, L. Hérouët, *Decidable Race Condition for HMSC*, GT-VMT, 9th Int. Workshop on Graph Transformation and Visual Modeling Techniques, Paphos, Cyprus, 2010.
- [LH-W15] L. Hérouët, A. Roumy, *Covert channel detection using Information Theory*, SECCO 2010, satellite of CONCUR 2010, EPTCS no 51, pp. 34-51, Paris, France, 2010.
- [LH-W16] B. Bollig, S. Haar, L. Hérouët, *Diagnosis with Dynamic MSC Languages*, Proc. of DOTS, satellite of CONCUR 2010, Paris, France, 2010.
- [LH-W17] B. Masson, L. Hérouët, A. Benveniste, *Compatibility of Data-Centric Web Services*. In WS-FM, 8th International Workshop on Web Services and Formal Methods, LNCS no 7176, pp. 32-47, Clermont Ferrand, France, 2011.
- [LH-W18] S. Akshay, L. Hérouët, C. Jard and P.A. Reynier, *Robustness of Time Petri Nets under Guard Enlargement*, in RP 2012, LNCS no 7550, pp. 92-107, 2012.
- [LH-W19] S. Akshay, L. Hérouët, R. Phawade, *Combining Free choice and Time in Petri Nets*, 6th IFIP WG 1.8 Workshop on Trends in Concurrency Theory, satellite of CONCUR'17, 2017.
- [LH-W20] M. L. Tessitore, M. Samà, A. D'Ariano, L. Hérouët, D. Pacciarellia, *Combining Simulation and Optimization for Traffic Disturbance Recovery in a Busy Metro System*, EWGT20, Euro Working Group on TRansportation, 2020.

1.5) National journals

[LH-RN1] T. Ziadi, L. H elou et, J-M. J ez equel, *Mod elisation de lignes de produits en UML*, L'OBJET 9(1-2), pp 227-240, 2003.

1.6) Reviewed national conferences

[LH-CN1] L. H elou et, C. Jard. *La manipulation formelle de sc enarios pour les syst emes r epartis : l'exemple des HMSC*, MSR'01, Mod elisation des Syst emes R epartis, Hermes, 2001. **(invited talk)**.

[LH-CN2] L. H elou et, R. Singh, Z. Miklos, *Reducing the Cost of Aggregation in Crowdsourcing*, BDA 2020, 36 eme Conf erence sur la Gestion de Donn ees – Principes, Technologies et Application, Oct. 2020.

[LH-CN3] L. H elou et, R. Singh, Z. Miklos, *Cost and Quality in Crowdsourcing Workflows*, BDA 2021, 37 eme Conf erence sur la Gestion de Donn ees – Principes, Technologies et Application, Oct. 2021.

1.7) Research reports and publications under review

Research Reports:

[LH-RR1] T. Chatain, L. H elou et, C. Jard , *On the use of unfoldings to abstract communicating automata into sets of scenarios*, Inria research report, N o RR-5778, 2005.

[LH-RR2] T. Gazagnaire, L. H elou et, C. Jard, *Online abstraction of distributed executions*, Inria research Report, N o RR-5736 , 2005.

[LH-RR3] L. H elou et, *Weakening the weak sequential composition in Message Sequence Charts*, Inria research Report, N o RR-6262 , 2005.

[LH-RR4] T. Gazagnaire, L. Helou et, P.S. Thiagarajan, S. Yang, *Causal Message Sequence charts*, Inria research Report, N o RR-6301 , 2007.

[LH-RR5] P. Darondeau, B. Genest, L. H elou et , *Products of Message Sequence Charts*, Inria Research report N o RR-6258, 2007.

[LH-RR6] L. H elou et, A. Benveniste, *Distributed Active XML and Service Interfaces*, Inria research Report, N o RR-7082 , 2011.

[LH-RR7] B.Masson, L.H elou et, A.Benveniste, *Compatibility between DAXML Schemas*, Inria research Report, N o RR-7559 , 2011.

[LH-RR8] C. Jard, R. Abdallah, L. H elou et, *Realistic Implementation of Message Sequence Charts* Inria research report, N o RR-7597, 2011.

[LH-RR9] S. Akshay, B.Genest, L. H elou et, S.Yang, *Regular Set of Representatives for Time-Constrained MSC Graphs*, Inria research report, N o RR-7823 , 2011

[LH-RR10] E. Badouel, L. H elou et, G.E. Kouamou, C. Morvan, *A Grammatical Approach to Data-centric Case Management in a Distributed Collaborative Environment*, Inria Research report RR-8528, 2014.

[LH-RR11] S. Akshay, B. Genest, L. H elou et, S. Krishna, S. Roychowdhury, *Resilience of timed systems*, Research report, 2020.

2. Technology development: software or other realization

[Soft1] SOFAT (2001-2011): a toolbox for the design and analysis of scenarios.

SOFAT [Soft1] is a toolbox for the specification of distributed systems specifications, described with scenarios, a formal model based on composition of partial orders. It includes most of my research results on scenario languages between 2000 and 2012. This software allows for verification, simulation, diagnosis, and automatic code generation (communicating automata or Restful Web Services) from descriptions given as scenarios (Message Sequence Charts). The overall software size is 15000 lines of JAVA code, and includes the results from two PhDs. Other scenario tools were developed in the teams of Dr S. Leue (Univ. Waterloo in the considered period), S. Uchitel (Imperial College), and R. Morin (Univ. Marseille). Scenario manipulations are also considered in professional Case tools such as Object Geode or Telelogic Tau. SOFAT is the only tool that complies with the Z.120 standard, and does not impose semantic restrictions to the official scenario model. Functionalities such as code synthesis and diagnosis provided by the tool are also unique in the community.

Research/Transfer : SOFAT was used as a research platform for the demonstration of verification algorithms on scenarios it includes the results from two PhDs. It was also used as a support for **standardization activities** at the ITU (Standard Z.120) [LH-S1, LH-S2]. The tool is registered at the APP (no IDDN.FR.001.080027.000.S.P.2003.00.10600), and is distributed on a [webpage](#) at Inria Rennes. The software was mainly downloaded by researchers developing scenario tools. It was used as demonstrator during the RNRT project Persiform (2004-2008) and customized to meet needs of France Telecom in the collaborative research project CO2 (2004-2006).

[Soft2] DAXML (2010-2013): A formal distributed and executable data-centric model for web services.

DAXML [Soft2] is an **interpreter for data-centric service specifications** described in Active XML [ABMMW02] (a language developed by S. Abiteboul). DAXML provides a way to design distributed systems composed of capsules that embed structured data (XML) with services, invoke one another over the web and exchange structured data. The intended use of DAXML is to serve as a middleware for the development of web-services with data as a first class citizen, while being able to address directly verification questions from the design formalism. DAXML is hence a **formal distributed and executable data-centric model for web services**. Services are built as orchestrations of queries on data stored in capsules, but the query language used to extract data is orthogonal to the system itself. A subclass of DAXML can be automatically verified. The implementation is built over a REST architecture, and was successfully deployed on a cluster of five machines.

[Soft3] SIMSTORS (2015-2019): A simulator for stochastic timed and regulated systems. Used for transfer during a collaboration with Alstom Transport.

SIMSTORS [Soft3] is a tool for the simulation of stochastic systems that are controlled by regulation algorithms. It was developed in the context of the [P22 project](#) with Alstom Transport (see pages 13, 35), and was used to model a case study: the regulation of metro Line 1 of Santiago. This simulator implements a formal model for metro networks and their regulation algorithms. The case study demonstrated the performance of our tool on a real size case study (simulation of 4 hours of operation with 50 trains crossing 24 stations in 19s). Simstors is **registered at the APP**. It was used to model two existing metro lines and used by Alstom to answer a call for tender for an existing metro line.

[Soft4] MOCHY (2020-now): Models for Concurrent and Hybrid Systems.

The objective of this platform is to provide tools to simulate and perform efficient analysis (statistical analysis,...) for cyber physical systems involving several independent agents, and equipped with control mechanisms. The tool is open source, and tailored for transport networks. <https://adt-mochy.gitlabpages.inria.fr/mochy/>

Mochy is a platform developed to design and verify concurrent and hybrid systems. The main novelty of MOCHY is to exploit concurrency to speed up computation of occurrence dates of discrete events and

update of systems states after realization of an event. The software is also tailored to include corrective mechanisms (controllers) during simulation. The concurrent nature of the modeled systems guarantees limited dependencies among variables, and allows fast simulation.

MOCHY is designed to allow modeling of cyber-physical systems with a lot of concurrency such as train fleets in metro networks. It is a key ingredient to test in silico traffic management solutions proposed in our activities around transport, and an additional argument to support project proposals in a European or national context.

The software is freely available on the project webpage. A **first open source distribution (under LGPL licence) was released in February 2021**, a second one in October 2021.

The software was used to develop novel traffic management techniques to train neural networks and then use them as advisors for speed and dwell time decisions in metros. This new approach is at the heart of a new starting collaboration with Alstom Transport.

3. Socio-economic impact and transfer

3.1 Standardization activity at International Telecommunication Union.

In 2008, due to my good knowledge of scenarios, I have been contacted by R. Reed, rapporteur of SG17Q12 to become co-rapporteur for the Z.120 standard on Message Sequence Charts. Another co-rapporteur during the same period was D. Amyot (damyot@uottawa.ca). From 2008 to 2011, I have contributed to the Z.120 standard at ITU [[LH-S1](#)]. This contribution involved bi-annual group meetings in Geneva, technological surveillance and continuous exchanges among co-rapporteurs. I have been the **main actor of the 2011 release of the Z.120 standard**. I have **corrected important errors in the standard** that had led to incompatibility of the 2004 and 2008 versions of Z.120. In parallel with this maintenance activity, I have pushed the creation of a new **appendix to the Z.120 standard** on Analysis of Message Sequence Charts [[LH-S2](#)]. This was an occasion to transfer to an audience of engineers and case tools developers a large part of the knowledge acquired by the formal methods community on scenarios. This appendix and the 2011 version of the standard have been **adopted in plenary session of study group 17 in September 2011**.

3.2 Formal analysis of Traffic Management algorithms at ALSTOM Transport

This transfer was done during a continuous collaboration between Alstom Transport and INRIA from 2014 to 2018. It consisted in a joint project (Project P22) of the ALSTOM-INRIA Lab. The project funded a CIFRE PhD grant. Regular meetings were held : physical meetings every month, and weekly phone meetings to progress work.

One of the main difficulties of the project was to find a correct match between operational needs of Alstom and the research activities of the SUMO team. Another challenge was to convince our Alstom partners that the models and solution proposed were addressing their concerns at the right abstraction level.

This collaboration with Alstom Transport had several positive effects. The first obvious effect is the use of the **transferred tool** in the company. In 2018, Alstom hired an engineer **to transfer SIMSTORS** and used it to **answer a call for tender** for the equipment of an existing metro network. In the long term, the objective of ALSTOM is to improve the models and the associated software to obtain a simulation environment and to use it to demonstrate the advantages of Alstom's regulation techniques at early design stages of metro projects. A second effect of this collaboration is a **long-term collaboration with Alstom Transport**.