

Amel Bennaceur

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Education

- 2009 – 2013 **PhD. in Computer Science**, *Inria - University of Paris VI, France*
Dissertation: Dynamic Synthesis of Mediators in Ubiquitous Environments
Achievement: Mention Très honorable (Highest honours)
Advisor: Valérie Issarny
- 2006 – 2009 **M.S. in Computer Science**, *Ecole Supérieure d'Informatique, Algeria*
Dissertation: A Peer-to-Peer System to Support Distributed Compact Trie Hashing
- 2001 – 2006 **Engineering degree in Computer Science**, *Ecole Supérieure d'Informatique, Algeria*
Dissertation: Integration of a Mobile Client to Distributed Compact Trie Hashing
Achievement: Major de Promotion (Top of the class)

Professional Experience

- 2016 – present **Lecturer**, *The Open University, United-Kingdom*
Teaching and research in the field of networks and security.
- 2013 – 2016 **Research associate**, *The Open University, United-Kingdom*
Investigating the role of requirements-driven mediators in supporting collaborative security. This work is part of the ERC Adaptive Security and Privacy (ASAP) project.
- 2014 – 2016 **Visiting lecturer**, *City University London, United-Kingdom*
Responsible (lectures, tutorials, and exams) for the Requirements Engineering module during two full terms: Winter 2014 and Winter 2015. I taught the module at both the undergraduate and postgraduate level.
- 2009 – 2013 **Graduate research assistant**, *Inria, France*
Took part in the FP7 ICT CONNECT EU project where I contributed to the definition and implementation of a solution whereby the components are discovered, their behaviours learnt, and the mediators that enable them to interoperate are synthesised at runtime. I further investigated the use of dynamic synthesis of mediators to enable interoperability for the Future Internet.
- 2008 – 2009 **Software engineer**, *Inria, France*
Collaborated in the design and implementation of a middleware solution that supports the development of mobile collaborative services. The major outcome of this work was the creation of a startup, Ambientic (<http://www.ambientic.com/en/>).
- 2006 – 2008 **Network and system administrator**, *Ecole Supérieure d'Informatique, Algeria*
Responsible for the installation, configuration, and maintenance of systems hardware (Cisco switches and routers), services, and related infrastructure.

Invited International Seminars

- 2014 **ESF Workshop on Combining Learning and Symbolic Analysis for Software Documentation and Mastering Change, Germany**
Exploring the synergy between machine learning and software analysis, including system integration.
- 2012 and 2015 **Shonnan Workshop on Engineering Autonomic Systems, Japan**
Exploring future research and development that will enhance the state of the art in engineering autonomic systems.
- 2011 **Dagstuhl Seminar on Models at Runtime, Germany**
Identifying the potential benefits of models at runtime and defining a research roadmap for their use in self-adaptive systems.

Academic Community Engagement

- 2016 **Dagstuhl Seminar Organiser**
Co-organising with Karl Meinke (Royal Institute of Technology, Stockholm, Sweden), Dimitra Giannakopoulou (NASA Ames Research Center, USA), and Reiner Hühnle (Technical University Darmstadt, Germany) entitled *Machine Learning for Dynamic Software Analysis: Potentials and Limits*, 25-27 April 2016.
- 2014 – present **Program Committee Member**
- RE:Next 2016 (*China*)
 - ESEC/FSE 2015-NIER (*Italy*)
 - VAQUITA at ECSA 2015 (*Croatia*)
 - IEEE Service 2015 Visionary Track (*USA*)
 - Special Issue of the JUCS 2014 on Adaptive Services for the Future Internet
- I also acted as a reviewer for SEAMS'14; SEAMS'15; MoDELS'13; Journal of Systems and Software; Journal of Software Testing, Verification and Reliability.
- 2015 **Austrian National Project Review Panel Member**
Reviewed grant proposals and participated in the panel discussions for the “ICT of the future” Call of the national research funding agency in Austria (FFG).
- 2014 – present **Member of the C&C Department Athena SWAN Self-Assessment Team, The Open University**
Developing the data visualisation for the Athena SWAN application of the Computing and Communications department.

Training

- 2015 – present **CCNA Routing and Switching v5**, The Open University, UK
- 2014 – present **Foundation Degree in Business**, The Open University, UK
- 2012 **Team and Project Management Module**, University of Paris VI, France
- 2008 **Summer School on Network and Information Security**, ENISA-FORTH, Greece
- 2005 **CCNA Routing and Switching v2**, Ecole Supérieure d'Informatique, Algeria

Membership of Academic Societies

- 2010 – present **Member**, ACM
- 2014 – present **Vice president**, ACM-W UK Professional Chapter

Research Summary and Agenda

My research focuses on opportunistically composing the capabilities of multiple software components in order to satisfy user needs. This opportunistic composition is achieved through the dynamic synthesis of mediators. During my PhD, I focused on enabling heterogeneous software components to interoperate by automatically synthesising and deploying the mediators that reconcile their differences from application down to middleware. During my postdoctoral work, I proposed a systematic, tool-supported approach to represent and reason about the capabilities of multiple components, and dynamically compose them in order to improve security. Figure 1 gives an overview of my research contributions, on which I elaborate in the following.

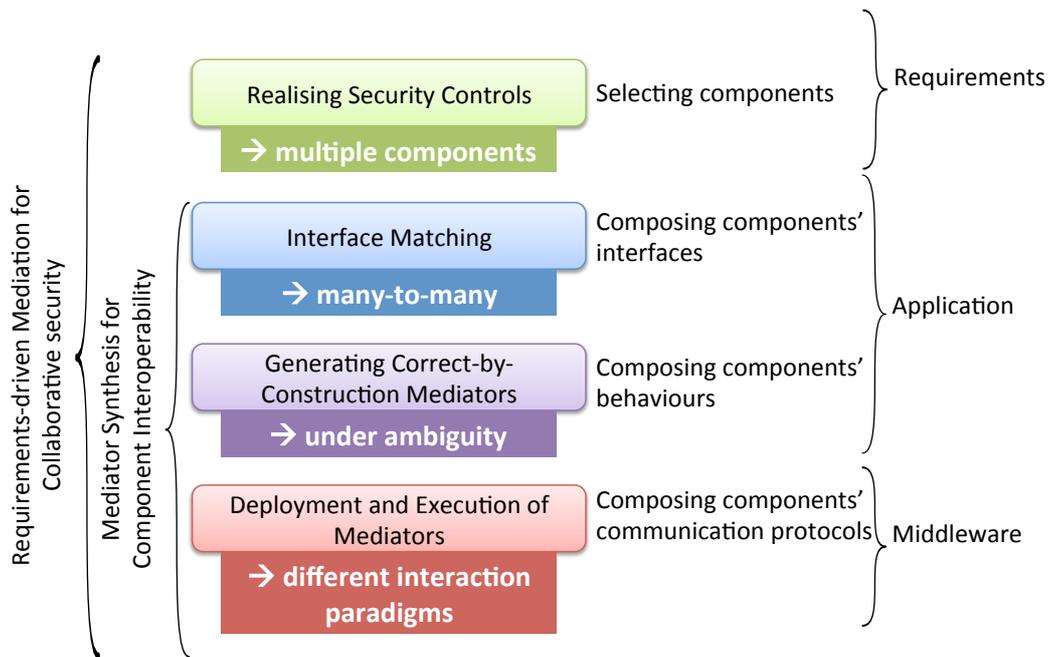


Figure 1. Overview of my research contributions

Mediator Synthesis for Component Interoperability

Interoperability is a major concern for the software engineering field, given the increasing need to compose components dynamically and seamlessly. Although much work has been carried out on interoperability, existing solutions have not fully succeeded in keeping pace with the increasing complexity and heterogeneity of modern software, and meeting the demands of runtime support [B1,B3]. The main contribution of my PhD thesis was to define an approach and provide a supporting tool for the automated synthesis and deployment of mediators in order to enable heterogeneous software components, with compatible functionalities, to interoperate. The synthesised mediators reconcile the differences between the interfaces of the components and coordinate their behaviours from the application down to the middleware layers. I showed that ontology reasoning, constraint programming, automata theory, and middleware techniques can provide the basis for a practical and sound solution to automate the synthesis of mediators at both design time and runtime [C4,J1]. I validated the approach through the development of a tool, MICS (<http://www-roc.inria.fr/arles/software/mics/>), and its experimentation with a number of case studies ranging from heterogeneous chat applications [C5] to emergency management in systems of systems [C2]. Through these case studies, I demonstrated the viability and efficiency of the automated synthesis of mediators to enable functionally-compatible software components to interoperate seamlessly.

The results of this work have been published in leading conferences (e.g., such as ISWC [C5], Middleware [C7], and ECSA [C2]) and the top journal in the field *IEEE Transactions on Software Engineering* [J1]. I have also been invited to present the results of this work in various scientific events, e.g., ESF Workshop, Dagstuhl, and Shonan seminars.

Requirements-driven Mediation for Collaborative Security

Collaborative security exploits the capabilities of the components available in a ubiquitous computing environment in order to protect assets from harm [C3]. By dynamically composing the capabilities of multiple components, collaborative security implements the security controls through which requirements are satisfied. However, this dynamic composition is often hampered by the heterogeneity of the components available in the environment and the diversity of their behaviours. The main contribution of my postdoctoral work was to propose a systematic, tool-supported approach for collaborative security based on a combination of feature modelling and mediator synthesis [U1]. I use features and transition systems to represent and reason about components' capabilities and requirements. I formulate the selection of the optimal set of features to implement adequate security control as a multi-objective constrained optimisation problem and use constraint programming to solve it efficiently. The selected features are then used to scope the behaviours of the components and thereby restrict the state space for synthesising the appropriate mediator. The synthesised mediator coordinates the behaviours of the components to satisfy the behaviour specified by the security control. This approach ensures that the implemented security controls are the optimal ones given the capabilities available in the operating environment. I demonstrated the validity of this approach by implementing a FICS (Feature-driven mediation for Collaborative Security) tool and applying it to a collaborative robots case study. More specifically, I showed using a proof-of-concept demonstrator how two robots—a humanoid robot and a vacuum cleaner—are made to collaborate in order to implement an additional security control for protecting a mobile phone from theft. The tool and all models are available at <http://sead1.open.ac.uk/fics/>. This example provides evidence that the security of our home, workplace, and cities can be improved by effectively exploiting the technology surrounding us.

Research Agenda: Engineering Self-Adaptive Software for Cyber-Physical-Social Systems

My medium to long-term goal is to develop a sound platform that provides secure, adaptive, and optimised support to individuals and groups in their social and professional endeavours. To do so, the proposed platform takes advantage of ubiquitous and mobile technology that connects devices, people, and their environment, and enables them to collaborate seamlessly. I posit that (i) representing, reasoning about the capabilities of devices and people, and (ii) enabling their opportunistic, security-driven collaboration is the way forward. Opportunistic collaboration must also adapt to the physical properties of the environment in which the devices and people operate. To realise this vision, I consider the following research questions:

- How do we capture, represent, and reason about the capabilities of software components in ubiquitous computing environments?
- How can we automatically reason about human behaviour and integrate it in adaptation strategies?
- How do we model and analyse the physical, besides the logical, properties of the environment?
- How can we optimise adaptation strategies to satisfy security and other quality requirements?
- Can we ensure that adaptation satisfies properties such as correctness, safety, and minimality?

During my postdoctoral work, I laid the foundations for a collaborative security framework to represent, reason about, and mediate components' capabilities in order to realise security controls. By opportunistically using available capabilities, collaborative security offers the possibility to react to the discovery of new attacks and vulnerabilities in a timely manner. In the future, this framework needs to be made more dependable by considering the trustworthiness of individual components, i.e. that they implement the capabilities advertised. Indeed, components may not behave as expected, either due to faults or malicious intents. Therefore, we need to monitor and check that the collaborating components actually conform to the behaviour expressed in their capabilities. In the case of deviation from the expected behaviour, a new mediator must be deployed to realise an alternative collaboration. Human agents can also play an active role in implementing complex security controls and satisfying security requirements, acting as sensors, actuators, or decision makers. Yet, human behaviour is more difficult to analyse than the behaviours of software components. A rich formal model to represent and reason about human behaviour is necessary to develop adaptation strategies involving both human agents and software components.

Smart-* Systems: A Software Engineering Playground

A lot of research work has been carried out in the domain of self-adaptive systems. However, this research is often validated only theoretically or using toy examples. I aim to move beyond theoretical results and toy examples to real-world experiments that would impact people's daily lives. My goal is to develop a robust, elegant, and reusable platform that can efficiently compose a large number of capabilities in complex and dynamic environments. Smart-* systems provide a rich exemplar to experiment such a platform. As depicted in Figure 2, different levels of granularity can be considered: smart devices in the context of individuals and self-quantification, smart homes in the context of households, smart cities in the context of communities, and smart nations in a global world context. Engineering such a platform requires addressing many challenges, and in particular: interoperability (from application down to network layer) and security. Released as open source, such a platform would benefit the whole research community, helping them validate their discoveries and approaches as well as general users in their daily lives.

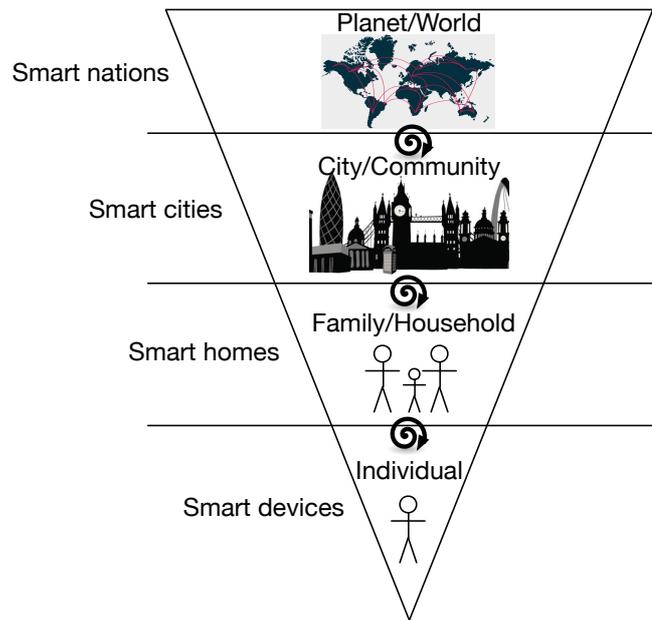


Figure 2 Smart-* Systems

Teaching Experience

I am firmly dedicated to introducing computing to students as well as general audiences. My teaching style is interactive and I always encourage students to ask questions and collaborate with one another. Yet, while interaction in the classroom is important, learning management systems (e.g., Moodle) together with social media (e.g., Twitter) provide us with a toolkit to convey the teaching material more easily to the digital native students. In addition, having been both a CCNA and an OU student myself, I acquired important knowledge and experience of the distance learning process as well as the needs and expectations of the OU students. I am convinced that this knowledge would be valuable should I teach networking (and in particular CCNA) or security at the Open University.

I am also convinced that education is the core of progress and should be available to everyone. I partly realise this conviction through my public outreach and engagement activities. I believe that the role of the Heidelberg Laureate Forum in promoting educational opportunity would allow me to realise further this deep conviction.

Lectures and Tutorials

Requirements Engineering, City University London (Winter 2014 and Winter 2015)

I am the lecturer and leader of the Requirements Engineering module at City University London. The module presents both the theoretical foundation and best-practice solutions in requirements engineering. It is structured around the main requirements-related activities including domain understanding and analysis, modelling, validation and verification, evolution, and traceability. In 2014, I taught the module to 147 students, 74 of which are postgraduates. In 2015, I taught the module to 137 students, 80 of which are postgraduates [C1].

Tutorial on interoperability and mediator synthesis (June 2011 and September 2012)

I worked with my PhD supervisor, Valérie Issarny, to prepare a half-a-day tutorial on interoperability using mediator synthesis. The tutorial was presented at two summer schools SFM-11 (11th International School on Formal Methods for the Design of Computer, Communication and Software Systems) and FMCO'12 (HATS

International School on Formal Models for Components and Objects). I co-authored the book chapters [B3,B4] and assisted Valérie Issarny in the preparation of the lecture slides. In SFM-11, I was also in charge of the hands-on sessions to illustrate the use of connector synthesis for enabling different instant messaging applications to interoperate. For FMCO, I prepared the demo videos that illustrate the use of mediator synthesis in emergency management situations using the GMES (Global Monitoring for Environment and Security) scenario.

Student Supervision

I fully supervised Shashank Tyagi, Institute of Technology, Banaras Hindu University, India during two summer internships (2011/2012), one of which was for his final year undergraduate project. The topic was: “Achieving Interoperability through Semantics-based Technologies: The Instant Messaging Case.” The internship involved implementing a semantic-based solution for the automated generation of the mediators between heterogeneous instant messaging applications. The results of this work were published in one of the major conferences on the Semantic Web, ISWC 2012 [C5].

Outreach Activities

2013 – present **STEMNet Ambassador**, *Milton Keynes, UK*

I designed a workshop and hands-on activities to illustrate my research on mediation and initiate young people (14-17 years old) to Java and Python programming using iRobot Create. STEMNet is a national network that connects researchers and engineers with schools, colleges and STEM employers, to enable young people of all backgrounds and abilities to meet researchers and understand real world applications of STEM subjects.

March 2015 **Voice of the Future**, *Houses of Parliament, UK*

I was selected to represent the Open University during the Voice of the Future event. This event brings together a range of learned societies, institutes and schools to give young researchers and engineers the chance to discuss with MPs and Ministers the national policies related to science and engineering.

2014 – 2015 **Programming courses**, *Milton Keynes, UK*

Upon my arrival to Milton Keynes, I joined the ‘Milton Keynes Women and Work Group’ and held workshops that teach young girls (14-17 years old) the main concepts of programming using Python.

2011 – 2013 **Student Hosting**, *Inria Paris-Rocquencourt, France*

During my PhD at Inria, I twice hosted 15 years old students and introduced them to the research of our team. I chose content and activities that are both significant and challenging for the school pupils, I used examples from software systems with which they are accustomed (e.g., Facebook, Instant Messaging) so that they are stimulated and involved in their own learning process. I also gave a presentation and demonstration (using Drones) to BTS students to introduce them to software development and illustrate my work on mediator synthesis.

Publications

International Journals

- J1. A. Bennaceur and V. Issarny. Automated synthesis of mediators to support component interoperability. *IEEE Transactions on Software Engineering*, 41(3): 221-240, 2015. **(Rank A*)**¹
- J2. A. Bennaceur, E. Andriescu, R. Cardoso, and V. Issarny. A unifying perspective on protocol mediation: Interoperability in the Future Internet. *Journal of Internet Services and Applications*, 6(1): 12:1-12:15, 2015.
- J3. N. Bencomo, A. Bennaceur, P. Grace, G. Blair, and V. Issarny. The role of models@run.time in supporting on-the-fly interoperability. *Springer Computing*, 95(3): 167-190, 2013. **(Rank A)**

International Conferences

- C1. A. Bennaceur, J. Lockerbie, and J. Horkoff, On the Learnability of i*: Experiences from a New Teacher. *In Proc. of iStarT@CAiSE 2015*: 43-48
- C2. A. Bennaceur and V. Issarny, Layered Connectors: Revisiting the Formal Basis of Architectural Connection for Complex Distributed Systems. *In Proc. of the 8th European Conference on Software Architecture, ECSA*: 283-299, Nominated for Best Paper, 2014. Acceptance rate 21.3% **(Rank A)**
- C3. A. Bennaceur, A. Bandara, M. Jackson, W. Liu, L. Montrieux, T. Tun, Y. Yu, and B. Nuseibeh, Requirements-driven mediation for collaborative security. *In Proc. of the 9th International Symposium on Software Engineering for Adaptive and Self-Managing Systems, SEAMS*: 37-42, 2014. Acceptance rate 18%
- C4. A. Bennaceur, C. Chilton, M. Isberner, , and B. Jonsson. Automated mediator synthesis: Combining behavioural and ontological reasoning. *In Proc. of the 11th IEEE International Conference on Software Engineering and Formal Methods, SEFM*: 274-288, 2013. Acceptance rate 36% **(Rank B)**
- C5. A. Bennaceur, V. Issarny, R. Spalazzese, and S. Tyagi. Achieving interoperability through semantics-based technologies. *In Proc. of the 11th International Semantic Web Conference, ISWC*: 17-33, 2012. Acceptance rate 22% **(Rank A)**
- C6. A. Bennaceur, V. Issarny, D. Sykes, F. Howar, M. Isberner, B. Steffen, R. Johansson, and A. Moschitti. Machine learning for emergent middleware. *In Proc. of the Joint workshop on Intelligent Methods for Software System Engineering at ECAI*: 16-29, 2012.
- C7. G. S. Blair, A. Bennaceur, N. Georgantas, P. Grace, V. Issarny, V. Nundloll, and M. Paolucci. The role of ontologies in emergent middleware: Supporting interoperability in complex distributed systems. *In Proc. of the ACM/IFIP/USENIX 12th International Middleware Conference*: 410-430, Big Idea Paper, 2011. Acceptance rate 19.2% **(Rank A)**
- C8. A. Bennaceur, V. Issarny, R. Johansson, A. Moschitti, S. Romina, and D. Sykes. Automatic Service Categorisation through Machine Learning in Emergent Middleware. *In Proc. of the International Conference on Formal Methods for Components and Objects, FMCO*: 133-149, 2011.
- C9. A. Bennaceur, V. Issarny, R. Johansson, A. Moschitti, D. Sykes, and S. Romina. Machine Learning for Automatic Classification of Web Service Interface Descriptions. *In Proc. of ISoLA Workshops*: 220-231, 2011.

¹ All ranking are based on the CORE Computing Research & Education ranking - <http://www.core.edu.au>

- C10. A. Bennaceur, G. S. Blair, F. Chauvel, G. Huang, N. Georgantas, P. Grace, F. Howar, P. Inverardi, V. Issarny, M. Paolucci, A. Pathak, R. Spalazzese, B. Steffen, and B. Souville. Towards an architecture for runtime interoperability. *In Proc. of the 4th International Symposium on Leveraging Applications of Formal Methods, Verification, and Validation, ISO LA: 206-220*, 2010.
- C11. A. Bennaceur, G. S. Blair, F. Chauvel, G. Huang, N. Georgantas, P. Grace, F. Howar, P. Inverardi, V. Issarny, M. Paolucci, A. Pathak, R. Spalazzese, B. Steffen, and B. Souville. Towards an architecture for runtime interoperability. *In Proc. of the 4th International Symposium on Leveraging Applications of Formal Methods, Verification, and Validation, ISO LA: 206-220*, 2010.
- C12. A. Bennaceur, P. Singh, P.-G Raverdy, and V. Issarny. The iBICOOP middleware: Enablers and Services for Emerging Pervasive Computing Environments. *In Proc. of PerCom Workshops: 1-6*, 2009

Book Chapters

- B1. A. Bennaceur and B. Nuseibeh, The Many Facets of Mediation - A Requirements-driven Approach for Trading-off Mediation Solutions. In I. Mistrík, N. Ali, J. Grundy, R. Kazman, and Bradley Schmerl, editors, *Managing trade-offs in adaptable software architectures*, to appear
- B2. A. Bennaceur, R. France, G. Tamburrelli, T. Vogel, et al. Mechanisms for Leveraging Models at Run- time in Self-adaptive Software. In N. Bencomo, R. B. France, B. H. Cheng, and U. Assmann, editors, *Models@run.time*, volume 8378 of *Lecture Notes in Computer Science: 19-46*. Springer, 2014.
- B3. V. Issarny and A. Bennaceur. Composing distributed systems: Overcoming the interoperability challenge. In *HATS International School on Formal Models for Components and Objects*. Springer Verlag: 168-196, 2012.
- B4. V. Issarny, A. Bennaceur, and Y.-D. Bromberg. Middleware-layer connector synthesis: Beyond state of the art in middleware interoperability. In *SFM-11: 11th International School on Formal Methods for the Design of Computer, Communication and Software Systems – Connectors for Eternal Networked Software Systems: 217-255*, 2011.
- B5. P. Grace, N. Georgantas, A. Bennaceur, G. S. Blair, F. Chauvel, V. Issarny, M. Paolucci, R. Saadi, B. Sou- ville, and D. Sykes. The CONNECT architecture. In *SFM-11: 11th International School on Formal Methods for the Design of Computer, Communication and Software Systems – Connectors for Eternal Networked Software Systems: 27-52*, 2011.

Magazines

- M1. A. Bennaceur, P. Inverardi, V. Issarny, and R. Spalazzese. Automated synthesis of connectors to support software evolution. *ERCIM News*, 2012(88), 2012.

The complete list of publications is available as open archive on ORO and on my Web page <http://amel.me/>