CyberSEA Research Lab
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Systems and Computer Engineering
Carleton University
1125 Colonel By Drive
Ottawa, ON K1S 5B6

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Position Available: Ph.D. Candidate (Cotutelle)

Human-Related Factors in Collaborative Decision Making for Secure Architecture Design

A cotutelle PhD position is available jointly between the Institut de Recherche en Informatique de Toulouse (IRIT) in Toulouse, France and Carleton University in Ottawa, ON, Canada starting in September 2023.

Project Description

The development of secure, large, and complex software systems requires the collaboration of many team members with varying levels of experience and expertise. As a result, it is necessary to consider the role played by human factors in secure architecture design. *Human-related factors* can be understood very broadly to include individual, institutional, and societal dimensions. Hence, a study of the human factors of security must not only consider individual human behaviours, but also the social structures that enable collective action by groups and communities of various sizes, as well as the different types of public and private institutional assemblages that shape societal responses.

Collaborative processes are usually defined as a structured or unstructured process where two or more different stakeholders are working together to fulfill a shared, collective, and bounded goal. Collaborative processes are often subject to different decision stakeholders ranging from the distribution of physical teams (local, distributed teams), domain knowledge and expertise (security policies, business rules, laws and regulations, etc.), responsibilities (project manager, architects, developers, etc.). This situation is especially true for secure software development processes and particularly in the processes of collaborative software architecture design, where the software architecture is used as a means for coordination and a repository of common understanding between the different stakeholders. Resolution of design errors and conflicts at this level will reduce considerably the presence of errors and conflicts in the next phases. Architectural decision is commonly used as the primary means for designing, describing and documenting the software architecture, the collaboration in the process of architecture decision making becomes one of the most important activities of software architecture design.

Existing tools and methods for collaborative architectural decision-making focus mainly on sharing and reusing of knowledge, making trade-offs, and achieving consensus, but they do not consider the various stakeholders' decision-making constraints due to the human factors in the development process. For example, when engineering secure and trustworthy systems, it is important to understand the benefits and limitations of possible solutions such as cryptography, authentication, access control, and auditing, etc. Traditional security controls may not be suitable in all cases as there are a number of factors that may constrain viable solutions. For example, decisions must carefully consider domain-specific security objectives and policies, data control and processing requirements, business rules, regulations, etc., in additional to technical resource limitations, exceptional circumstances and other non-technical factors. Equally important is the need to account for the different levels of expertise and experience of the individual team members tasked with collaborating to arrive at an acceptable decision. Previous works have not considered the profiles of the human members of the development team involved in the security architecture decision making process. Such considerations are necessary to better understand and explain how decisions are made and to provide better traceability of the decisions and their resulting consequences to the systems security objectives.

Objective

This PhD project aims to develop a framework that takes in account human factors related to the expertise and experience of the team members involved in collaborative decision-making processes when developing secure software architectures. More broadly, this research will further the understanding of how collaborative decisions are made and provide better traceability of decisions impacting system security to gain confidence in the decisions taken by a team of diverse members.

Related Literature References

[1] B. Hamid and J. Jaskolka. Work in progress: Considering human factors in collaborative decision making for secure architecture design. In *Proceedings of the 12th International Workshop on Socio-Technical Aspects in Security*, STAST 2022, page 12, Copenhagen, Denmark, 2022.

[2] J. Jaskolka and B. Hamid. Towards the integration of human factors in collaborative decision making for secure architecture design. In *Proceedings of the 2022 Workshop on Human Centric Software Engineering and Cyber Security*, HCSE&CS-2022, page 8, Oakland Center, MI, USA, 2022.

[3] J. Jaskolka, B. Hamid, and S. Kokaly. Software design trends supporting multi-concern assurance. *IEEE Software*, 39(4):22–26, July/August 2022.

[4] J. Jaskolka. Recommendations for effective security assurance of software-dependent systems. In K. Arai, S. Kapoor, and R. Bhatia, editors, *Intelligent Computing, SAI 2020*, volume 1230 of Advances in Intelligent Systems and Computing, pages 511–531. Springer, Cham, July 2020.

[5] P. Gaubatz, I. Lytra, and U. Zdun. Automatic enforcement of constraints in real-time collaborative architectural decision making. *Journal of Systems and Software*, 103:128–149, 2015.

[6] J. Kaur and N. Mustafa. Examining the effects of knowledge, attitude and behaviour on information security awareness: A case on SME. In *Proceedings of the 2013 International Conference on Research and Innovation in Information Systems*, ICRIIS 2013, pages 286–290, November 2013.

Desired Candidate Skills/Qualifications

Suitable candidates will have a Master's degree in Software Engineering, Computer Science, or a related field. Ideal candidates will be self-motivated with an ability to work independently and to communicate effectively in a team environment. A background in logic and discrete mathematics, computer security, software/system modelling and software engineering processes and concepts is highly desirable. Experience with assurance/certification approaches and techniques, and argumentation and reasoning is considered an asset.

All candidates must satisfy the Minimum Admission Requirements for Doctoral Programs at Carleton University.

What is a Cotutelle?

A cotutelle is the French term for "Joint Enrolment". This refers to a bilateral doctoral enrolment/co-enrolment and exchange agreement between two universities (the home university and the partner university) in different countries. Under such an arrangement, a doctoral student completes all of the requirements of the PhD program in both the home and partner university, and conducts his/her dissertation research collaboratively, sequentially, and for roughly equal amounts of time in both universities and is supervised by a faculty member from each of the universities. The dissertation will be examined by a committee whose members are drawn from both institutions.

Students completing a cotutelle will graduate with a single PhD degree from both the home and partner institution. This typically occurs with the student receiving a diploma from each university, each carrying a notation that the degree was obtained through a cotutelle agreement. A cotutelle offers you a unique international experience adding significant value to your PhD degree.

Host Research Institute Information

Carleton University is a public comprehensive university, founded in 1942, in Ottawa, Ontario, Canada. The research-intensive Faculty of Engineering and Design at Carleton University is recognized as one of Canada's leading institutions in the study and research of engineering, architecture, industrial design and information technology. Since the inception of engineering at Carleton in 1945, our experts have pushed the bounds of innovation and discovery.

Carleton focuses on anticipating the needs of industry and society, and offers forward-thinking programs with real world application and produces research that is helping to shape our present and future. The Department of Systems and Computer Engineering is a recognized world-class institution in software engineering, computer systems engineering, communications engineering, and biomedical engineering. Together with the Department of Electronics, the Department of Systems and Computer Engineering constitutes one of the largest and most research-intensive centres for Electrical and Computer Engineering and Software Engineering education and research in Canada. The Cyber Security Evaluation and Assurance (CyberSEA) Research Lab conducts advanced academic research to develop systematic and rigorous approaches for evaluating and assuring the cyber security of software-dependent systems.

The Institut de Recherche en Informatique de Toulouse (IRIT), created in 1990, is a Joint Research Unit (UMR) of the Centre National de la Recherche Scientifique (CNRS), the Institut National Polytechnique de Toulouse (INP), the Université Paul Sabatier Toulouse3 (UT3), the Université Toulouse1 Capitole (UT1) and the Université de Toulouse Jean Jaurès (UT2J). IRIT is one of the largest UMR at the national level, is one of the pillars of research in Occitanie with its 700 members, permanent and non-permanent. Due to its multi-tutorial nature (CNRS, Toulouse Universities), its scientific impact and its interactions with other fields, the laboratory constitutes one of the structuring forces of the IT landscape and its applications in the digital world, both at regional and national level. The Advancing Rigorous Software and System Engineering (ARGOS) team's main research topics are rigorous system and software engineering processes, security and resilience at both the foundations and application level, particularly for cyber-physical systems. They develop design frameworks using formal methods, model-driven-engineering practices, analysis, and experimental evaluation to help in the development of well-designed, properly modelled, accurately documented, and well-understood systems. The Argumentation, Décision, Raisonnement, Incertitude et Apprentissage (ADRIA) team contributes to the development of new approaches to knowledge representation, reasoning. and decision in Artificial Intelligence. They develop formal models of argumentation and their applications to reasoning, explaining decisions, or modeling dialogues (for negotiation purposes especially).

Supervision

Jason Jaskolka (Carleton); Brahim Hamid (IRIT);
(jason.jaskolka@carleton.ca; brahim.hamid@irit.fr)

Application Instructions and Further Information

To apply, please send your CV to: jason.jaskolka@carleton.ca and brahim.hamid@irit.fr

For more information about Graduate Studies at Carleton University and the Department of Systems and Computer Engineering, please visit: https://carleton.ca/sce/graduate-studies/. For more information about applying for Graduate Studies at Carleton University, please visit: https://graduate.carleton.ca/apply-online/. For more information about funding for Graduate Studies, please visit: https://graduate.carleton.ca/financial-assistance/admissions-funding/.

Administrative Process

2 to 3 months after the acceptance.