RESEARCH CENTRE

Nancy - Grand Est

IN PARTNERSHIP WITH:

Université de Lorraine, CNRS

2021 ACTIVITY REPORT

Project-Team COAST

Web Scale Trustworthy Collaborative Service Systems

IN COLLABORATION WITH: Laboratoire lorrain de recherche en informatique et ses applications (LORIA)

DOMAIN

Networks, Systems and Services, Distributed Computing

THEME

Distributed Systems and middleware

Contents

Project-Team COAST

Creation of the Project-Team: 2015 July 01

Keywords

Computer sciences and digital sciences

A1.3. – Distributed Systems

A1.3.3. – Blockchain

A1.3.4. – Peer to peer

A1.3.5. – Cloud

A1.3.6. – Fog, Edge

A2.5.1. – Software Architecture & Design

A2.6.2. – Middleware

A3.1.3. – Distributed data

A3.1.5. – Control access, privacy

A5.1.1. – Engineering of interactive systems

A5.1.2. – Evaluation of interactive systems

Other research topics and application domains

B6.1.1. – Software engineering

B6.3.1. – Web

B6.5. – Information systems

B8.4. – Security and personal assistance

B8.4.1. – Crisis management

B9.1.1. – E-learning, MOOC

B9.6.1. – Psychology

B9.8. – Reproducibility

B9.10. – Privacy

1 Team members, visitors, external collaborators

Research Scientist

- Claudia-Lavinia Ignat [Inria, Researcher, HDR]

Faculty Members

- François Charoy [Team leader, Univ de Lorraine, Professor, HDR]
- Khalid Benali [Univ de Lorraine, Associate Professor, HDR]
- Gérôme Canals [Univ de Lorraine, Associate Professor]
- Claude Godart [Univ de Lorraine, Professor]
- Thomas Lambert [Univ de Lorraine, Associate Professor, from Sep 2021]
- Gérald Oster [Univ de Lorraine, Associate Professor]
- Olivier Perrin [Univ de Lorraine, Professor, HDR]
- Samir Youcef [Univ de Lorraine, Associate Professor]

PhD Students

- Anis Ahmed Nacer [Univ de Lorraine, ATER, until Nov 2021]
- Clélie Amiot [CNRS]
- Alexandre Bourbeillon [Inria]
- Victorien Elvinger [Univ de Lorraine, until Jun 2021]
- Abir Ismaili-Alaoui [Univ de Lorraine]
- Quentin Laporte Chabasse [Univ de Lorraine, until Jun 2021]
- Hoai Le Nguyen [Univ de Lorraine, Jan 2021]
- Matthieu Nicolas [Univ de Lorraine, ATER]
- Pierre Antoine Rault [Inria]

Technical Staff

- Victorien Elvinger [Inria, Engineer, from Jul 2021]

Interns and Apprentices

- Oscar Leclerc [Inria, Jan 2021]
- Carla Souyri [Inria, from Jun 2021 until Jul 2021]

Administrative Assistant

- Sophie Drouot [Inria]

Visiting Scientist

- Linda Ouchaou [Univ de Lorraine, until Aug 2021]

2 Overall objectives

The advent of the Cloud, smart mobile devices and service-based architecture has opened a field of possibilities as wide as the invention of the Web 25 years ago. Software companies now deliver applications and services using the Web as a platform. From text to video editing, from data analytic to process management, they distribute business applications to users within their web browser or on some mobile appliance [1]. These services are deployed on sophisticated infrastructures that can cope with very demanding loads. The Software as a Service approach (SaaS) highlights their cooperative nature, by enabling the storage of data in cloud infrastructures that can be easily shared among users.

Clients consume applications through service API (web services), available on delivery platforms, called stores or markets. This approach of software distribution outstrips the traditional software distribution channels, in scale and opportunity. Scale has different dimensions: the number of users (communities rather than groups), the size of data produced and managed (billions of documents), the number of services and of organizations (tens of thousands). Opportunity refers to the infinite number of combinations between these services and the many ways to consume and use them.

This fast-paced evolution challenges research because the creation of applications from the composition of services must incorporate new content and context based constraints. From a socio-technical perspective, the behaviour of users is evolving constantly as they get acculturated to new services and ways to cooperate. Mere enhancement of current existing solutions to cope with these challenges is insufficient.

We conduct a dedicated research effort to tackle the problems arising from the evolution of contemporary technologies and of those we can anticipate. We explore three directions: large scale collaborative data management, data centred service composition and above all, a foundation for the construction of trustworthy collaborative systems.

Large scale collaborative data management concerns mostly the problem of allowing people to collaborate on shared data, synchronously or not, on a central server or on a peer to peer network. This research has a long history referring back to a paper by Ellis [21]. Users acculturation to online collaboration triggers new challenges. These refer to the number of participants to a collaboration (a crowd), to the number of different organizations and to the nature of documents that are shared and produced. The problem is to design new algorithms and to evaluate them under different usage conditions and constraints and for different kinds of data.

Data centred service composition deals with the challenge of creating applications by composing services from different providers. Service composition has been studied for some time now but the technical evolution and the growing availability of public API oblige us to reconsider the problem [18]. Our goal here is, taking into account this evolution, like the advent of the Cloud, the availability at a large scale of public API based on the REST [2] architectural style, to design models, methods and tools to help developers to compose these services in a safe and effective way.

Based on the work that we do in the two first topics, our main research direction aims at providing support to build **trustworthy collaborative applications.** We base it on the knowledge that we can gather from the underlying algorithms, the composition of services and the quality of services that we can deduce and monitor. The complexity of the context in which applications are executed does not allow to provide proven guarantees. Our goal is to base our work on a contractual and monitored approach to provide users with confidence in the service they use. Surprisingly, people rely today on services with very little knowledge about the amount of confidence they can put in these services. They are based on composition of other unknown services. Thus, it becomes very difficult to understand the consequences of the failure of a component of the composition. We follow a path that portrays a ruptured continuum, to underscore both the endurance of the common questions along with the challenge of accommodating a new scale. We regard collaborative systems as a combination of supportive services, encompassing safe data management and data sharing. Trustworthy data centred services are an essential support for collaboration at the scale of communities and organizations. We will combine our results and expertise to achieve a new leap forward toward the design of methods and techniques to enable the construction of usable large scale collaborative systems.

[1] See "Open API Growth: a Visualization" (ProgrammableWeb 2011)
[2] representational state transfer

3 Research program

3.1 Introduction

Our scientific foundations are grounded on distributed collaborative systems supported by sophisticated data sharing mechanisms and on service oriented computing with an emphasis on orchestration and on non-functional properties. Distributed collaborative systems enable distributed group work supported by computer technologies. Designing such systems requires an expertise in Distributed Systems and in Computer-supported collaborative Work research area. Besides theoretical and technical aspects of distributed systems, the design of distributed collaborative systems must take into account the human factor to offer solutions suitable for users and groups. The Coast team vision is to move away from a centralized authority based collaboration toward a decentralized collaboration. Users will have full control over their data. They can store them locally and decide with whom to share them. The Coast team investigates the issues related to the management of distributed shared data and coordination between users and groups. Service oriented Computing [30] is an established domain on which the ECOO, Score and now the Coast teams have been contributing for a long time. It refers to the general discipline that studies the development of computer applications on the web. A service is an independent software program with a specific functional context and capabilities published as a service contract (or more traditionally an API). A service composition aggregates a set of services and coordinates their interactions. The scale, the autonomy of services, the heterogeneity and some design principles underlying Service Oriented Computing open new research questions that are at the basis of our research. They span the disciplines of **distributed computing**, **software engineering** and **computer supported collaborative work** (CSCW). Our approach to contribute to the general vision of Service Oriented Computing is to focus on the issue of the efficient and flexible construction of reliable and secure high-level services. We aim to achieve it through the coordination/orchestration/composition of other services provided by distributed organizations or people.

3.2 Consistency Models for Distributed Collaborative Systems

Collaborative systems are distributed systems that allow users to share data. One important issue is to manage consistency of shared data according to concurrent access. Traditional consistency criteria such as serializability, linearizability are not adequate for collaborative systems. Causality, Convergence and Intention preservation (CCI) [34] are more suitable for developing middleware for collaborative applications. We develop algorithms for ensuring CCI properties on collaborative distributed systems. Constraints on the algorithms are different according to the kind of distributed system and to the data structure. The distributed system can be centralized, decentralized or peer-to-peer. The type of data can include strings, growable arrays, ordered trees, semantic graphs and multimedia data.

3.3 Optimistic Replication

Replication of data among different nodes of a network promotes reliability, fault tolerance, and availability. When data are mutable, consistency among the different replicas must be ensured. Pessimistic replication is based on the principle of single-copy consistency while optimistic replication allows the replicas to diverge during a short time period. The consistency model for optimistic replication [32] is called eventual consistency, meaning that replicas are guaranteed to converge to the same value when the system is idle. Our research focuses on the two most promising families of optimistic replication algorithms for ensuring CCI:

- operational transformation (OT) algorithms [21]
- algorithms based on commutative replicated data types (CRDT) [31].

Operational transformation algorithms are based on the application of a transformation function when a remote modification is integrated into the local document. Integration algorithms are generic, being parametrised by operational transformation functions which depend on replicated document types. The advantage of these algorithms is their genericity. These algorithms can be applied to any data type and they can merge heterogeneous data in a uniform manner. Commutative replicated data types is

a new class of algorithms initiated by WooT [29], the first algorithm designed WithOut Operational Transformations. They ensure consistency of highly dynamic content on peer-to-peer networks. Unlike traditional optimistic replication algorithms, they can ensure consistency without concurrency control. CRDT algorithms rely on natively commutative operations defined on abstract data types such as lists or ordered trees. Thus, they do not require a merge algorithm or an integration procedure.

3.4 Process Orchestration and Management

Process Orchestration and Management is considered as a core discipline behind Service Management and Computing. It includes the analysis, the modelling, the execution, the monitoring and the continuous improvement of enterprise processes and is for us a central domain of studies. Many efforts have been devoted establishing standard business process models founded on well-grounded theories (e.g. Petri Nets) that meet the needs of business analysts, software engineers and software integrator. This led to heated debate in the Business Process Management (BPM) community as the two points of view are very difficult to reconcile. On one side, business people in general require models that are easy to use and understand and that can be quickly adapted to exceptional situations. On the other side, IT people need models with an operational semantic in order to be able transform them into executable artifacts. Part of our work has been an attempt to reconcile these points of view. This resulted in the development of the Bonita BPM system. It resulted also more recently on our work in crisis management where the same people are designing, executing and monitoring the process as it executes. More generally, and at a larger scale, we have been considering the problem of processes spanning the barriers of organizations. This leads to the more general problem of service composition as a way to coordinate inter organizational construction of applications. These applications provide value, based on the composition of lower level services [17].

3.5 Service Composition

Recently, we started a study on service composition for software architects where services are coming from different providers with different plans (capacity, degree of resilience...). The objective is to support the architects to select the most accurate services (w.r.t. to their requirements, both functional and non-functional) and plans for building their software. We also compute the properties that we enforce for the composition of these services.

4 Application domains

4.1 Crisis Management

Crisis management research investigates all the dimensions regarding the management of unexpected catastrophic events like floods, earthquake, terrorist attacks or pandemics. All the phases of a crisis, from preparedness to recovery require collaboration between people from many organizations. This provides opportunities to study inter-organizational collaboration at a large scale and to propose and evaluate mechanisms that ensure secure and safe collaboration. The work of Béatrice Linot[14] provided us with a deep understanding of the factors that encourage collaboration and help to maintain trustworthy collaboration between stakeholders. This work is continued by Clélie Amiot who studies the effects of human chat-bot collaboration in this kind of setting.

4.2 Collaborative Editing

Collaborative editing is a common application of optimistic replication in distributed settings. The goal of collaborative editors, irrespective of the kind of document, is to allow a group of users to update a document concurrently while ensuring that they eventually get all the same copy at the end. Our algorithm allows to implement collaborative editor in a peer to peer way. It avoids the need for a central server ensuring a higher level of privacy among collaborators. In this context, it requires to consider the problem of authentication and authorization of participants[16] and of trust between them[23].

5 Highlights of the year

In 2021, despite all the troubles caused by the pandemic, five PhDs and one HDR have been defended in the team. They all took more time than expected mostly due to difficult work condition and slower supervision in 2020 but it was an achievement for us to be able to have all our doctoral students to defend successfully their thesis.

6 New results

6.1 Users trust assessment based on their past behavior in large scale collaboration

Participants: Claudia-Lavinia Ignat.

In a large scale peer-to-peer collaboration where control over data is given to users who can decide with whom to share their data, a main challenge is how to compute trust in the collaborators. We showed how to automatically compute users trust according to their past behavior during the collaboration in order to be able to predict their future behavior. We focused on two use cases: contract-based multi-synchronous collaboration and trust game from game theory [11]. In a multi-synchronous collaboration users can work independently with different streams of activity on the shared data that can diverge and then synchronize at a later time. In a contract-based multi-synchronous model, contracts are specified by data owners when they share the data and the adherence to or violation of contracts can be checked after users gained access to data. Audit of user compliance to the given contracts in the contract-based multi-synchronous collaboration allows the computation of trust scores associated to users. The trust game is a money exchange game that has been widely used in behavioral economics for studying trust and collaboration between humans. In this game, exchange of money is entirely attributable to the existence of trust between users. User trust can be computed in terms of the sum of money exchanged.

A general methodology was proposed for both use cases for aggregating trust during the successive interactions between two users. However, computing trust from a single interaction between two users depends on the application domain and the associated semantics and we proposed trust functions for each of the use cases [7].

6.2 Mitigating the Cost of Identifiers in Sequence CRDT

Participants: Matthieu Nicolas, Gérald Oster, Olivier Perrin.

To achieve high availability, large-scale distributed systems have to replicate data and to minimize coordination between nodes. The literature and industry increasingly adopt Conflict-free Replicated Data Types (CRDTs) to design such systems. CRDTs are data types which behave as traditional ones, e.g. the Set or the Sequence. However, compared to traditional data types, they are designed to support natively concurrent modifications. To this end, they embed in their specification a conflict-resolution mechanism.

To resolve conflicts in a deterministic manner, CRDTs usually attach identifiers to elements stored in the data structure. Identifiers have to comply with several constraints such as uniqueness or being densely ordered according to the kind of CRDT. These constraints may prevent the identifiers' size from being bounded. As the number of the updates increases, the size of identifiers grows. This leads to performance issues, since the efficiency of the replicated data structure decreases over time.

To address this issue, we propose a new CRDT for Sequence which embeds a renaming mechanism. It enables nodes to reassign shorter identifiers to elements in an uncoordinated manner. Obtained experiment results demonstrate that this mechanism decreases the overhead of the replicated data structure and eventually limits it.

To validate the proposed renaming mechanism, we performed an experimental evaluation to measure its performances on several aspects: (i) the size of the data structure ; (ii) the integration time of the rename operation ; (iii) the integration time of insert and remove operations. In cases (i) and (iii), we use LogootSplit as the baseline data structure to compare results. The results we obtained are very encouraging, as the integration time is far shorter with the renaming mechanism, even with the time spent to apply the rename operation.

6.3 Social Networks as Collaboration Support

Participants: Quentin Laporte Chabasse, Gérald Oster, François Charoy.

Safe peer to peer collaborative services requires a trusted peer to peer network in order to be effective. We investigated how to leverage social networks underlying inter organizational collaboration to support such collaboration. To reach this goal, we need to analyze collaborative graphs. They are a relevant sources of information to understand behavioural tendencies of groups of individuals. Exponential Random Graph Models (ERGMs) are commonly used to analyze such social processes including dependencies between members of the group. Our approach considers a modified version of ERGMs, modeling the problem as an edge labelling one. The main difficulty is inference since the normalizing constant involved in classical Markov Chain Monte Carlo approaches is not available in an analytic closed form.

The main contribution is to use the recent ABC Shadow algorithm [33]. This algorithm is built to sample from posterior distributions while avoiding the previously mentioned drawback. The proposed method is illustrated on real data sets provided by the HAL platform and provides new insights on self-organized collaborations among researchers [24]. In 2021, we applied this method in a longitudinal way to identify patterns regarding the evaluation of collaboration on several years for the same teams. We also applied it to dataset from a social study in a French primary school. These results are described in the PhD thesis of Quentin Laporte Chabasse [12] and in a research paper that is in minor revision in a journal.

6.4 Trust and Data Sharing in Crisis Management

Participants: François Charoy, Béatrice Linot.

Sharing information between responders is important during crisis management response. Tools and platforms are eagerly developed for that purpose. They are supposed to support people and help them to build a shared situation awareness. However as the scale of crisis increases and as more and more organizations are involved, people get reluctant to use them to share their data. They prefer to rely on one to one communication tools like phones or text. This is why we have studied how these collaborative platforms impact the work of responders positively or negatively. It shows that participants have problems sharing written information for different kind of reason including its persistence, the time taken to produce the message and the lack of knowledge regarding who may access this information. It also shows that different dimensions of trust have to be taken into account, in partners, in the platform and in the data that are shared. This informs us on the requirements for future collaborative platforms. These results are described in the PhD thesis of Béatrice Linot [14].

6.5 Composition of Services from Cloud Providers

Participants: Anis Ahmed Nacer, François Charoy, Olivier Perrin.

We continued our work on providing a framework to compare plans for services from cloud providers in order to help architects to select the best composition given the required criteria (both functional and non-functional requirements) for a micro service architecture. This year we have developed and experimented an algorithm to select the best composition of services in order to deploy an entire micro-service architecture with non functional requirements and cost constraints based on the comparison method that we proposed previously [25]. This has been described in Anis Ahmed Nacer thesis that he defended in November 2021 [15].

6.6 Combining data analysis and event processing for a proactive business process management

Participants: Khalid Benali, Abir Ismaili-Alaoui.

With the digitized era and the rise of technologies such as big data, Internet of Things, Cloud computing, etc, organizations are faced with many factors and challenges that generate real changes in the traditional Business Process Management (BPM). Among these challenges, we have the huge amount of data and event data that are continuously gathered within the organization. Actually IoT invokes significant opportunities for private data exchange enabling new business models across heterogeneous networks [26]. From a business process perspective, the widespread of these IoT devices led to a new Business process interactions within the organizations such as Person-to-Thing, Thing-to-person, and Thing-to-Thing due to the advent of Internet of things Technologies [36]. These new process interactions come complete the existing ones like Person-to-Person (P2P), Person-to-Application (P2A), and Application-to-Application (A2A) processes [35] [20] [22]. So as we can see, the omnipresence of these "things" is both a challenge and an opportunity for process improvement.

Learning from data and event data that are gathered from IoT sensors and past process execution is an effective approach to improve the performance of business processes, especially those that perform repetitive tasks and activities. In fact, insights that are obtained from these data represents a valuable support for business process improvement and for decision making. This raw data must be processed using data science techniques and event-based systems in order to transform these raw data and raw event data into a high-level knowledge. This high-level knowledge can be exploited thereafter, for business process improvement purposes.

7 Bilateral contracts and grants with industry

7.1 Bilateral contracts with industry

Fair & Smart

Company: Fair & Smart

Dates: 2020-2024

Participants: Claudia-Lavinia Ignat *(contact)*, Gérald Oster, Olivier Perrin, François Charoy.

The goal of this project is the development of a platform for the management of personal data according to General Data Protection Regulation (GDPR). Other partners of this project are CryptoExperts and team READ from LORIA. The computational personal trust model that we proposed for repeated trust game [19] and its validation methodology [23] will be adapted for the Fair&Smart personal data management platform for computing trust between the different users of this platform. Our decentralised mechanism for identity certification relying on a blockchain [27, 28] will be transfered to Fair& Smart for user identification for their personal data management platform.

8 Dissemination

Participants: Claudia-Lavinia Ignat, Gérald Oster, Olivier Perrin, François Charoy, Thomas Lambert, Khalid Benali.

8.1 Promoting scientific activities

8.1.1 Scientific events: organisation

General chair, scientific chair

- Claudia-Lavinia Ignat was Co-chair of Workshops and Masterclasses at ECSCW 2021 (The European Conference on Computer-Supported Cooperative Work: The International venue on Practice-centred computing and the Design of cooperation technologies).

Member of the organizing committees

- Claudia-Lavinia Ignat was member of the Steering Committee of International Conference on Intelligent Computer Communication and Processing (ICCP) in 2021.
- Thomas Lambert was Publicity Chair of the 6th International Parallel Data Workshop (PDSW) in 2021. This workshop was hosted by SuperComputing 2021.

Member of the conference program committees

- Claudia-Lavinia Ignat was or is associate chair at ACM CHI Conference on Human Factors in Computing Systems (CHI) in 2021 and 2022. In 2021 she was PC member of International Conference on Cooperative Design, Visualization and Engineering (CDVE), International Conference on Collaboration Technologies and Social Computing (CollabTech), International Conference on Intelligent Computer Communication and Processing (ICCP).
- François Charoy was PC member of ICSOC 2021, ICWS 2021, BSCT 2021 (Workshop on Blockchain and Smart Contract Technologies), AI-PLE 2021.
- Khalid Benali was PC member of WorldCIST'21 (9th World Conference on Information Systems and Technologies), I3E 2021 (IFIP Conference on e-Business, e-Services and e-Society), INFORSID 2021, ICCCI 2021 (13th International Conference on Computational Collective Intelligence), and MEDES 2021 (13th International Conference on Management of Digital EcoSystems).
- Thomas Lambert was PC member of HPCC'21 (23rd International Conferences on High Performance Computing and Communications) and IEEE BigData'21 (2021 IEEE International Conference on Big Data).
- Gérald Oster was PC member of ICCP 2021 (International Conference on Intelligent Computer Communication and Processing).

8.1.2 Journal

Member of the editorial boards

- Claudia-Lavinia Ignat is associate editor of Computer Supported Cooperative Work (CSCW): The Journal of Collaborative Computing and Work Practices.
- François Charoy is at the editorial board of the Springer Service Oriented Computing and Applications Journal.

Reviewer - reviewing activities

- In 2021 Claudia-Lavinia Ignat was a reviewer for ANR projects. She also reviewed articles for Automated Software Engineering, Transactions on Cloud Computing, Information and Software Technology journals.
- François Charoy reviewed papers for IEEE Internet of Things.

8.1.3 Invited talks

- Claudia-Lavinia Ignat was invited to present her work on user trust assessment in collaborative systems ("Évaluation de la confiance entre les utilisateurs dans les systèmes collaboratifs") in the context of Journées Scientifiques Fédération Charles Hermite on the topic of Network Science, in Nancy, on November 2021.

8.1.4 Scientific expertise

- Gérald Oster was reviewer for the ANRT (National Association of Research and Technology) to review a CIFRE (Industrial agreements on training through research) PhD project.

8.1.5 Research administration

- François Charoy is an elected member of the CNU 27. He is a member of the board as assessor. He is also co-head of the Computer Science mention of the IAEM Doctoral School.
- Claudia-Lavinia Ignat is member of the Inria Evaluation Commission. She is a member of the Inria Nancy-Grand Est COMIPERS committee. She is a member of the organisation committee of the Security Seminar at LORIA. In 2021, she was a member of the CRCN recruitment jury at Inria Rennes and at Inria Grenoble and of the selection committee in charge of recruiting an assistant professor at LORIA-Faculté des Sciences de Nancy, University of Lorraine.
- Gérald Oster is an elected member at AM2I scientist council of University of Lorraine.
- Khalid Benali was member of the selection committee in charge of recruiting an associate professor for LORIA-IDMC, University of Lorraine in 2021.

8.2 Teaching - Supervision - Juries

8.2.1 Teaching

Permanent members of the Coast project-team are leading teachers in their respective institutions. They are responsible of lectures in disciplines like software engineering, database systems, object oriented programming and design, distributed systems, service computing and more advanced topics at all levels and in different departments in the University. Most PhD Students have also teaching duties in the same institutions. Claudia-Lavinia Ignat teaches a course on data replication and consistency at Master level (M2 SIRAV) at University of Lorraine. As a whole, the Coast team accounts for more than 2500 hours of teaching. Members of the Coast team are also deeply involved in the pedagogical and administrative life of their departments.

- Claude Godart is responsible for the Computer Science Department of the Polytech Nancy engineering school.
- Khalid Benali is responsible for the professional Master degree speciality “Distributed Information Systems” of MIAGE and of its international branch in Morocco.
- François Charoy is responsible for the Software Engineering specialisation at the TELECOM Nancy Engineering School of University de Lorraine.
- Gérald Oster is responsible for the 3rd (last) year of study at the TELECOM Nancy Engineering School of University de Lorraine. He is also President of the jury of the Diploma at TELECOM Nancy.

8.2.2 Supervision

- PhD defended: Hoai Le Nguyen, Study of group performance and behaviour in collaborative editing, defended on January 2021, Claudia-Lavinia Ignat and François Charoy
- PhD defended: Victorien Elvinger, Secured Replication for Peer-to-Peer Collaborative Infrastructures, defended on June 2021, François Charoy and Gérald Oster
- PhD defended: Quentin Laporte-Chabasse, Federation of Organisations over Peer to Peer Collaborative Network, defended in January 2021, François Charoy and Gérald Oster
- PhD defended: Béatrice Linot, Trust in cooperative systems, defended in February 2021, Jérome Dinet and François Charoy
- PhD defended: Anis Ahmed Nacer, Safe Service Composition, defended on November 2021, Olivier Perrin and François Charoy
- PhD in progress: Abir Ismaïli-Alaoui, started in September 2016, Khalid Benali and Karim Baïna (Université Mohammed V, Rabat, Morocco)
- PhD in progress: Matthieu Nicolas, Optimisation of Replication Algorithms, started in October 2017, Olivier Perrin and Gérald Oster
- PhD in progress: Jean Philippe Eisenbarth, Securing the future blockchain-based security services, started in May 2019, Olivier Perrin and Thibault Cholez.
- PhD in progress: Clélie Amiot, Trust and Human/Chatbot collaboration, started in October 2019, Jérome Dinet and François Charoy
- PhD in progress: Alexandre Bourbeillon, Trust among users in collaborative systems, started in November 2020, Claudia-Lavinia Ignat
- PhD in progress: Pierre-Antoine Rault, Security mechanisms for decentralised collaborative systems, started in October 2020, Claudia-Lavinia Ignat and Olivier Perrin
- Claudia-Lavinia Ignat is member of the PhD committee of William Aboucaya, PhD student in Inria project-team MiMove (Inria Paris) since October 2019
- Claudia-Lavinia Ignat is member of the PhD committee of Ikram Garfatta, "Towards Correct Blockchain-based Business Processes", supervised by Kaïs Klai and Mohamed Graïet, LIPN

8.2.3 Juries

- Claudia-Lavinia Ignat was examiner of the PhD thesis of Mozhdeh Farhadi "Automated application privacy compliance checking in distributed Fog environments", Université de Rennes, November 2021
- François Charoy was reviewer of the PhD thesis of Robin Batard, Telecom Paris et IMT Mines d'Albi
- François Charoy was reviewer of the PhD thesis of Hossain Kordestani, HESAM Université, CNAM
- François Charoy was reviewer of the PhD thesis of Hanane Ariouat, Université de Toulouse, avril 2021
- François Charoy was reviewer of the HDR of Nicolas Figay, Université de Lyon 1, July 2021
- François Charoy was reviewer of the PhD of Léo Besançon, Université de Lyon 1, December 2021
- Khalid Benali was reviewer of the PhD thesis of Mrs YUAN Jingya, INSA-Lyon (Institut National des Sciences Appliquées de Lyon), Université de Lyon, July 2021.

8.3 Popularization

8.3.1 Articles and contents

- In July 2021 Claudia-Lavinia Ignat gave an interview for Inria where she briefly presented her research work (Claudia Ignat presentation on data protection).

8.3.2 Interventions

- In March 2021 Claudia-Lavinia Ignat was interviewed by Ville de Villers-lès-Nancy - Officiel for Women International Day event (Claudia Ignat at Women International Day event)

9 Scientific production

9.1 Major publications

[1] V. Elvinger. 'Secured replication in collaborative P2P environment'. Université de Lorraine, 14th June 2021. URL: https://hal.univ-lorraine.fr/tel-03284806.

[2] C.-L. Ignat. 'Large-scale trustworthy distributed collaboration'. Université de Lorraine, 23rd Apr. 2021. URL: https://hal.inria.fr/tel-03229173.

[3] Q. Laporte-Chabasse. 'Morpho-statistical study of social networks. Application to inter-organisational collaborations'. Université de Lorraine, 12th Jan. 2021. URL: https://hal.univ-lorraine.fr/tel-03229726.

[4] H. Le Nguyen. 'Study of Conflicts in Collaborative Editing'. Université de Lorraine, 14th Jan. 2021. URL: https://hal.univ-lorraine.fr/tel-03203102.

9.2 Publications of the year

International peer-reviewed conferences

[5] J.-P. Eisenbarth, T. Cholez and O. Perrin. 'A Comprehensive Study of the Bitcoin P2P Network'. In: BRAINS 2021 - 3rd Conference on Blockchain Research & Applications for Innovative Networks and Services. Paris/ Virtuel, France: IEEE, 27th Sept. 2021, p. 8. URL: https://hal.inria.fr/hal-03380595.

[6] J.-P. Eisenbarth, T. Cholez and O. Perrin. 'An open measurement dataset on the Bitcoin P2P Network'. In: IM 2021 - 17th IFIP/IEEE International Symposium on Integrated Network Management. Bordeaux / Virtual, France, 17th May 2021, p. 5. URL: https://hal.inria.fr/hal-03244771.

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