UNIVERSITÉ PARIS 1
PANTHÉON SORBONNE

Ecole Doctorale de Management
Panthéon-Sorbonne ED559

Centre de Recherche en Informatique

PhD subject 2021-2024

Titre : Coping with trust issues in collaborative inter-organisational business processes : a blockchain approach

Advisor : Pr. Carine Souveyet (carine.souveyet@univ-paris1.fr)
Co-Advisor : Dr. Irina RYCHKOVA (irina.rychkova@univ-paris1.fr)
Co-Advisor : Dr. Nicolas HERBAUT (nicolas.herbaut@univ-paris1.fr)

Funding : ☑ 3 yers Doctoral Contract funded by the Management Doctoral School ED554.
Keywords : Blockchain, Business Processes, Model-driven Engineering

1 Context

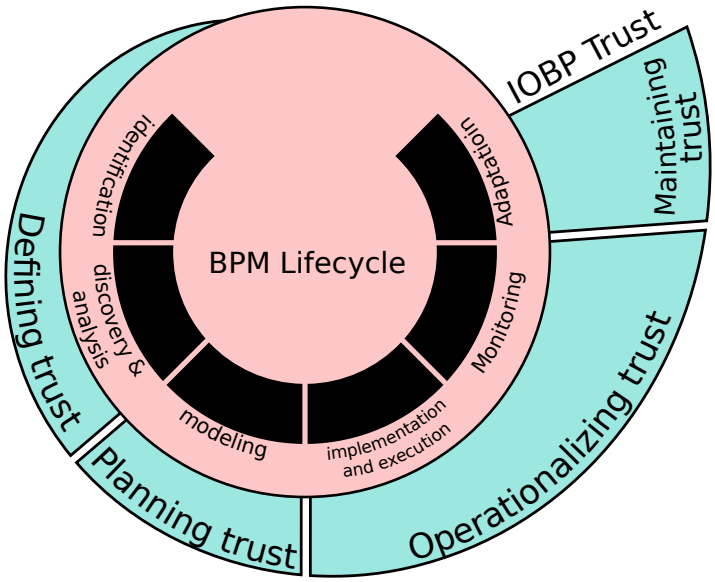
This thesis proposal is at the junction of Business Process Management and Blockchain. It builds up from previous work by the same team in the fields of Enterprise System Engineering and Distributed Ledger Technologies, with several recent publications from CRI lab e.g., [Six et al., 2020] (IEEE Trustcom), [Six et al., 2021], [Ribalta et al., 2021].

These topics are also covered by recently updated MIAGE Graduate-level courses (M1/ISI3 Models and tools for processes, M2/IT4 Blockchain, M2/ISI7-SOA2 Enterprise and Service-Oriented Architecture, M2/ISI2 Advanced process modeling) and are frequently chosen by graduate students for their Master Thesis (5 M2 Thesis, 5 M1 Thesis, 1 submitted paper co-authored by a student) and PhD Thesis (2 PhD students working on blockchain).

Outline

Trust is a keystone for interorganizational relationships. Driven by the growing complexity of their environment, businesses are required to operate within an ecosystem to thrive, moving away from rigid formal coordination and control to a more opportunistic "on-demand" trust. Yet, little is known on how to define, plane, operationalize and maintain such a dynamic trust at the information systems level.

BPM (Business Process Management) is the current trend for business process identification, Modeling, Analysis, Redesign, Implementation and Adaptation [Dumas et al., 2013]. The most important goals are ensuring control and conformance while being grounded on MDE principles : separation of concerns. BPM allows obtaining different advantages (e.g., higher productivity, competitiveness, efficiency and reduced cost, among others). The business process definition, according to BPM, is traditionally oriented to be executed centrally for a single company. Existing technology allows assigning



specific tasks of the process to external actors, all those tasks are orchestrated in a centralized way at process level. This centralized architecture is appropriate for single companies, but it is not efficient when it is necessary to collaboratively involve multiple entities or companies into the same process (e.g., supply chain, logistics, distribution)[Garcia-Garcia et al., 2020].

Partners in heterogeneous business environments typically follow different business rules, have to comply with different policies and regulations ; at the same time, their internal processes are implemented through various software systems, with a set of different underlying security mechanisms. Besides business and technical constraints, reputation and trust play an important role in collaborative business processes [Viriyasitavat and Martin, 2011]. Over the last decade, the Blockchain technology has been developed and considered as a solution to execute and manage collaborative business processes (CBP) [Garcia-Garcia et al., 2020]. This technology enables transactions to be run in a peer-to-peer (P2P) way directly between entities or individual users. Thus, a CBP execution can be carried out without requiring mutual trust between parties.

Several challenges related to collaborative business process management and its support based on blockchain technologies were presented in [Dumas et al., 2013] [Garcia-Garcia et al., 2020] throughout the traditional BPM life cycle. We cite some areas where this thesis can potentially contribute.

Defining Trust

According to the BPM life cycle, during the identification phase, an existing process architecture of an organization is analyzed in response to some business problem. Processes relevant to this business problem, relationships between them, and their execution environments are identified. We are interested in trust issues that occur in the distributed collaborative environments, and analyzing the impact these issues can have on the organizations, their processes and technical infrastructure and the (enterprise) architectures that can efficiently deal with these issues.

Whereas design of a new collaborative process by an organization is a challenging endeavor, the majority of organizations are interested in evolution or redesigning of their existing processes in order to increase their efficiency and to benefit from the emerging blockchain technology. Identification of characteristics for collaborative processes, depending on their functionalities and execution context and specification of the trust properties that these processes must exhibit can substantially contribute to BPM practices of the organizations.

Planning Trust

Mainstream specification languages for business processes such as BPMN, CMMN or DM are well adapted by academia an industry for classical business processes. However, they assume a central party (i.e., an orchestrator) and a single point of trust (and failure), which are not valid assumptions when processes span across organizational boundaries.

Inter-organizational business processes modeling is a growing concern for businesses embarking in digital transformation. Such organization poses several open challenges such as trust, transparency, traceability, security, privacy.

Currently, preoccupations like trust between process participants are not explicitly addressed in process models. Collaboration patterns supporting "trust by design" can be integrated in the process models.

Operationalizing Trust

Blockchain-enabled architecture brings the unique value proposition of "offering a way to execute processes in a trustworthy manner even in a network without any mutual trust between nodes." [Mendling, 2018]. However, there is a lack of understanding on how blockchain can be successfully integrated within enterprise architecture and BPM.

This is caused by the fact that Blockchain is still in its infancy, and there are solutions galore in implementing them in the enterprise. Even if several solutions have been proposed in the literature (see Section 4), they are very often linked to a particular underlying technology and fail to generalize for upcoming new proposals. Another issue in blockchain operationalization of business processes is that current solutions fail capture structuring features of the process that may have outstanding consequence at the implementation layer.

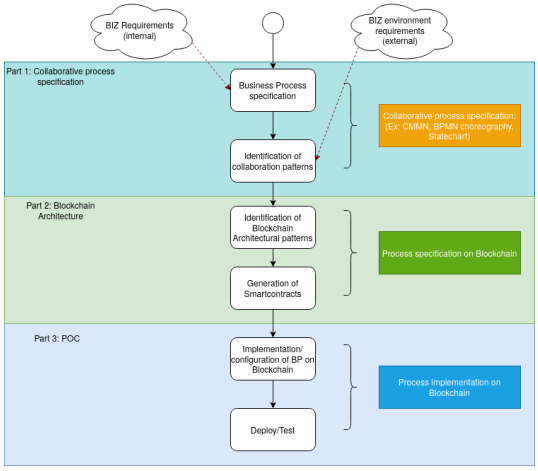
Maintaining Trust

Due to its immutable nature, careful blockchain design must be put at play to circumvent ossification issues of the business process. Governance update, data migration and code upgrade for example, are not well studied and supported in the literature.

2 Thesis Project Organization

Here's a list of tasks to carry-out during the project.

1. Survey existing scientific literature on related topics (blockchain, smart contract, MDE, EA, BPM) and position wrt the thesis contributions
2. Propose a framework to support BCT-based collaborative processes.
3. Implement a demonstrator to design execute BC-based collaborative process.
4. Disseminate research results through scientific articles, patents, publicly accessible open-source tools and technological transfer.



3 Proposal

This thesis aims at proposing solutions to accomodate BCT over the complete BPM lifecycle within the larger domain of Entreprise Architecture.

Major contributions are expected based on the team's current focus : (1) Process Modeling (2) and Process implementation, but other BPM activities may be considered as well.

Research questions raised by the previous issues are numerous :

— How to characterize trust at an inter-organizational level, and what are its impact on Enterprise Architecture ?

— What are the design principles that guide blockchain-capable distributed collaborative process management ?

— What are the best architectural patterns to support in such processes ?

— How can we narrow down the gap beteween entreprise strategy, modelers and developers for BTC collaborative processes ?

— How to support dynamic trust models to maintain operations ?

4 Related work

Very recent work in the literature advocated for the necessity to support the specificities of blockchain for business process modeling and enterprise architecture modeling.

4.1 Business Process modeling and Blockchain

The trustless architecture of blockchain systems allow redesigning the collaborative processes involved in distrustful entities exchanges across organization boundaries. Automation and innovation in inter-organizational processes are made possible through the blockchain runtime with arbitrarily complex operation (through the use of Turing-complete languages in Smart Contracts) and powerful privacy scheme (through privacy patterns and Blockchain-specific constructs e.g., Channels)

Several proposals have been made to add support for blockchain technologies throughout the traditional BPM lifecycle [Dumas et al., 2013], especially in the "Discovery and modeling" and the "implementation and execution" activities [Garcia-Garcia et al., 2020].

For modeling activities, several existing work proposes BPMN or BPMN extensions to support BCT, even if other paradigms are also studies (State machines, metamodel-based notations and Petri-nets). For implementation and execution, notable efforts have been carried out on the leading Caterpillar engine [López-Pintado et al., 2019], Lorikeet [Tran et al., 2018] or ad hoc execution platforms. Two clear trends are emerging, that is (i) developing an ad hoc tool to support BTC in BPM or (ii) integrating with commercial BPMS. In anycase, existing modeling tools only partially support BCT core elements, like tokenization, performance

Other BPM activities are not as well studied in the literature [Garcia-Garcia et al., 2020], since the efforts of the scientific community in integrating BCT into BPM are at a very early stage. The "Resign" and "Monitoring" activities are the most challenging and the least studied activity, but pose great challenges due to the immutability of blockchain design and its distributed nature.

4.2 Enterprise Architecture and Blockchain

A new "School of thoughts" of Entreprise architecture claims that the discipline should also include the "Enterprise Ecological Adaptation" problem into account and not being a mere tool of building a foundation for execution [Korhonen and Halén, 2017]. In this perspective, the digital transformation efforts of many businesses aim at creating more collaboration and building complex business ecosystems which brings resilience, economies of scopes and new adaptive capabilities. The Platform

Economy is the ultimate form of the Ecological Adaptation, where each additional stakeholder brings value to the system [Bonchek and Choudary, 2013]. Several organizational and technical challenges are still to be addressed by the literature for such platforms, from governance to litigation management, interoperability and legal aspects.

In this context, Blockchain Technologies are perceived as key enablers for platforms, since their promise is to bring transparency and trust. The Enterprise architecture is scarce at best, covering distributed control of assets and liabilities [Ilin et al., 2019], and business processing mapping from ArchiMate models [Babkin and Komleva, 2019].

Our team started working on this topic from the requirements angle, and proposed an automated decision model for the selection of blockchain technology [Six et al., 2021].

5 Candidate Requirements

Candidate should own a Master degree in Computer Science, be fluent in written and spoken English. French is a plus, especially for teaching duties, but by no mean an obligation. Good devOps skills (software development + operations) are expected. Previous knowledge of topics related to Blockchain, Model driven engineering , Process engineering and a previous professional experience in R&D is an advantage.

6 Application procedure

Please submit your application by email to Irina Rychkova and Nicolas Herbaut (firstname.lastname@univ-paris1.fr) including :

— CV + cover letter + list of references

— copies of the relevant diplomas with grades and ranking of the last two years.

— Any resource supporting your application (publications, code repository...)

Practical Informations

This PhD thesis will take place in Paris 1 Panthéon-Sorbonne University

Address :	Centre Pierre Mendes France, 90 rue de Tolbiac 75013 Paris
Duration :	3 years
Salary :	about 1980 EUR gross monthly including teaching duties.
Application deadline :	30^{th} June
Start date :	October 2021

Références

[Babkin and Komleva, 2019] Babkin, E. and Komleva, N. (2019). Model-driven liaison of organization modeling approaches and blockchain platforms. In *Enterprise Engineering Working Conference*, pages 167–186. Springer.

[Bonchek and Choudary, 2013] Bonchek, M. and Choudary, S. P. (2013). Three elements of a successful platform strategy. *Harvard Business Review*, 92(1-2).

[Dumas et al., 2013] Dumas, M., La Rosa, M., Mendling, J., Reijers, H. A., et al. (2013). *Fundamentals of business process management*, volume 1. Springer.

[Garcia-Garcia et al., 2020] Garcia-Garcia, J. A., Sánchez-Gómez, N., Lizcano, D., Escalona, M., and Wojdyński, T. (2020). Using blockchain to improve collaborative business process management : Systematic literature review. *IEEE Access*, 8 :142312–142336.

[Ilin et al., 2019] Ilin, I., Levina, A., Borremans, A., and Kalyazina, S. (2019). Enterprise architecture modeling in digital transformation era. In *Energy Management of Municipal Transportation Facilities and Transport*, pages 124–142. Springer.

[Korhonen and Halén, 2017] Korhonen, J. J. and Halén, M. (2017). Enterprise architecture for digital transformation. In *2017 IEEE 19th Conference on Business Informatics (CBI)*, volume 1, pages 349–358. IEEE.

[López-Pintado et al., 2019] López-Pintado, O., García-Bañuelos, L., Dumas, M., Weber, I., and Ponomarev, A. (2019). Caterpillar : A business process execution engine on the ethereum blockchain. *Software : Practice and Experience*, 49(7) :1162–1193.

[Mendling, 2018] Mendling, J. (2018). Towards blockchain support for business processes. In *International Symposium on Business Modeling and Software Design*, pages 243–248. Springer.

[Ribalta et al., 2021] Ribalta, C. N., Lombard-Platet, M., Salinesi, C., and Lafourcade, P. (2021). Blockchain mirage or silver bullet ? a requirements-driven comparative analysis of business and developers' perceptions in the accountancy domain. *Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications (JoWUA)*, 12(1) :85–110.

[Six et al., 2021] Six, N., Herbaut, N., and Salinesi, C. (2021). Blade : Un outil d'aide à la décision automatique pour guider le choix de technologie blockchain. *Revue ouverte d'ingénierie des systèmes d'information*, 2(1).

[Six et al., 2020] Six, N., Ribalta, C. N., Herbaut, N., and Salinesi, C. (2020). A blockchain-based pattern for confidential and pseudo-anonymous contract enforcement. In *2020 IEEE 19th International Conference on Trust, Security and Privacy in Computing and Communications (TrustCom)*, pages 1965–1970. IEEE.

[Tran et al., 2018] Tran, A. B., Lu, Q., and Weber, I. (2018). Lorikeet : A model-driven engineering tool for blockchain-based business process execution and asset management. In *BPM (Dissertation/Demos/Industry)*, pages 56–60.

[Viriyasitavat and Martin, 2011] Viriyasitavat, W. and Martin, A. (2011). A survey of trust in workflows and relevant contexts. *IEEE Communications Surveys & Tutorials*, 14(3) :911–940.