



## Master Thesis: An Analysis of Complex Blockchain-Processes using BPM

### Context:

Blockchain Technology is a new innovative way how to store and processing data. In contrast to current systems (e.g. Java programs working on MySQL databases), the Blockchain promises forgery protection. As an example, in the Bitcoin network, a sender places a transaction to transfer a certain amount of the cryptocurrency to a receiver. If the transaction follows the syntactical rules (a receiver, the amount, etc. was defined), the network will also check the semantical rules. In case of Bitcoin, these are for instance if the sender has enough cryptocurrency available for this transaction. Once the network has considered the transaction valid, it will eventually be included in the blockchain. At this point, the transaction cannot be reverted or challenged. The sender cannot deny being the original sender and also the integrity of the data is ensured using asymmetric cryptography (Public/Private Key Infrastructure).

### Problem Statement:

To guarantee manipulation safety and consensus finding or to prevent double spending, a lot of internal complex processes are involved. Another complexity level constitutes that the processes are intertwined closely, i.e. intersection points between processes are frequent. Hence, many specific textbooks, research papers or tutorials in blogs fail to provide guided, deep and all-embracing learning material.

Business process management is the discipline of modelling, implement, execute and analyse business processes. It provides methodologies to depict complex workflows of businesses in a lucid way using process models. These process models can be implemented in workflow management systems which generate event logs. These event logs are basis of further analysis. Many different modelling notation and execution languages have been proposed serving different application use cases. The multiperspective process model incorporates information on the resource which has to fulfil a specific task or a certain tool to use etc. additionally.

### Task:

An initial step is to fully understand the basic functioning of Blockchain Technology. A good starting point are the two "big" protocols Bitcoin [1, 5] and Ethereum [6]. Depending on the own preferences, some might prefer to start with a taxonomy of Blockchain technologies [4] and read the specific protocols afterwards.

Having a good overview of Blockchain technology, the student can start with digging deep into the specific protocols of the most common solutions Bitcoin and Ethereum. Central to this stage is the technical description (e.g. Ethereum Yellow Paper [2]).

From a BPM perspective, the student must have fully instilled the modelling language “BPMN” [7] which is the de-facto standard in process modelling in science. The student will recognize that BPMN fail to support the multidimensional process model. Therefore, BPMN must be extended, or already published extensions or different solutions must be used (e.g. RALph [8], WRF [9]).

During the analysis of the Blockchain protocols, the student will model the described processes into multidimensional process models. An example is attached to the E-Mail – the file can be loaded in <https://demo.bpmn.io> for instance\*. Thereby, the student must differentiate between common processes of “all” Blockchains, and specific processes (e.g. GAS which is specific to Ethereum). It will be inevitable to choose certain hierarchical levels using connected sub-processes.

Having modelled the finest-grained internal processes, the models can be used to implement them in a WFMS. The student is free to use Camunda or build a WFMS from the scratch using libraries (e.g. jBPM). The master thesis can be evaluated, by comparing the functional scope of common Blockchains and the expressiveness of the models within the WFMS.

### Goal:

The goal of the thesis is a complete and deep overview of Blockchain-internal processes. With the help of the thesis, BPMN- (or process modelling-) aware people must immediately understand what’s going on under the hood of Bitcoin, Ethereum etc.

The thesis is evaluated in terms of the granularity of the internal processes, the chosen hierarchical levels of sub-processes, the clarity of intersection points of processes and the modelling itself. Further on, the multiperspectivity of process models will be rated. On top, the scientific methods will affect the grading and the knowledge gain of the student during the thesis. The chosen evaluation framework for the thesis (cf. Section “Task”), its suitability and implementation will heavily affect the overall rating.

### Hard Requirements:

Hard requirements to successfully pass this master thesis are high conformity of the process models regarding the official specification as well as domain-specific accuracy of the process models\*. Also, the multi-perspectivity of process models must be given. At last, a working implementation of some process models in a WFMS to evaluate the process models must be available. This implementation should simulate the processes known from the blockchain.

In case of deviations or other issues, it is in the response of the student to timely contact the supervisor.

***\*Please note, that the example attached the E-Mail do not meet all specification rules. This should not be used in this form in the thesis!***

### References:

[1] <https://bitcoin.org/bitcoin.pdf>

[2] <https://ethereum.github.io/yellowpaper/paper.pdf>

[4] Paolo Tasca: A Taxonomy of Blockchain Technologies: Principles of Identification and Classification

[5] Andreas Antonopoulos: Mastering Bitcoin

[6] Andreas Antonopoulos: Mastering Ethereum

[7] <https://www.omg.org/spec/BPMN/2.0.2/PDF>

[8] Cristina Cabanillas: RALph: A Graphical Notation for Resource Assignments in Business Processes

[9]

<http://www.workflowpatterns.com/documentation/documents/Resource%20Patterns%20BETA%20TR.pdf>