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Towards an Approach to Organization of Decentralized Business Process Model Repository

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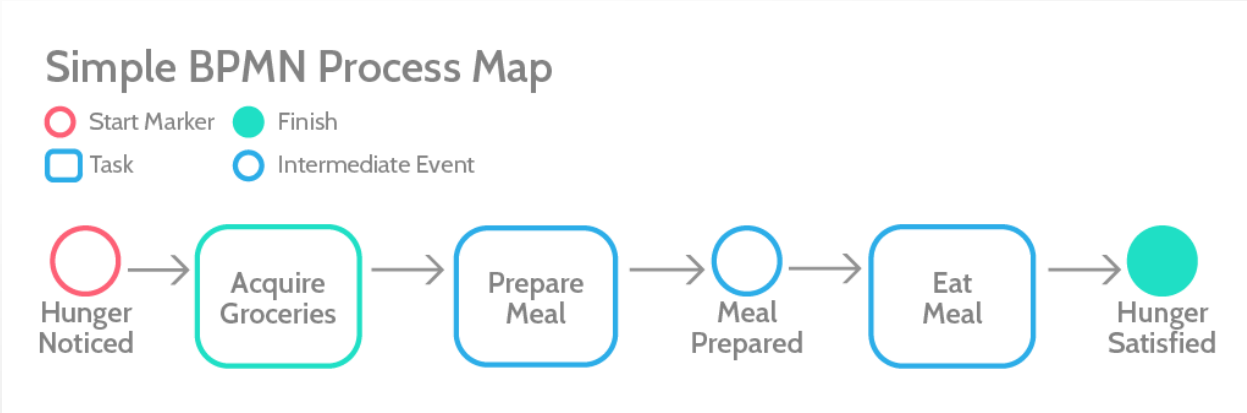
Motivation

- Large companies tend to keep extremely large collections of business process models.
- Availability, integrity, and security are vital for enterprise collections of business process models.
- Blockchain technology can be utilized to keep and manage business process models securely and stably.

Business Process Model Repository

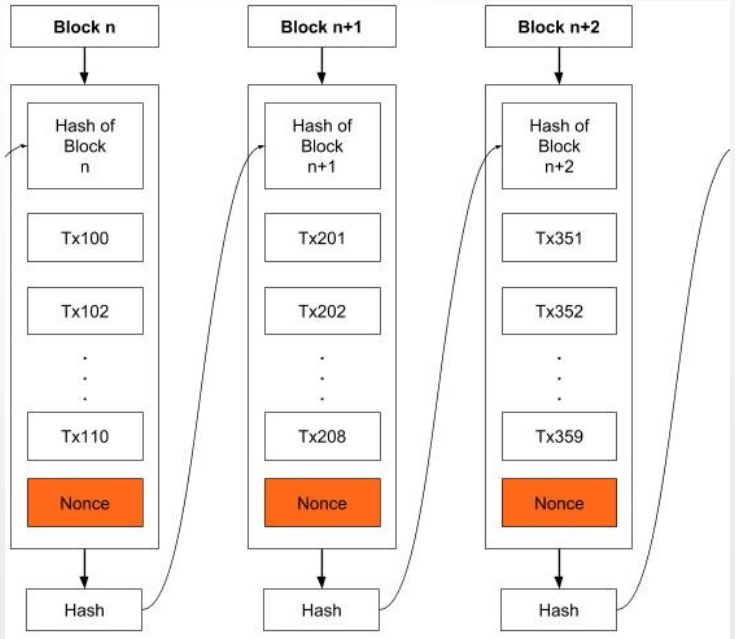
- A "business process model repository" is the software used to store, search, and manage business process models.
- Support of the BPMN – a de-facto standard business process modeling notation, displaying graphical and textual process descriptions.
- Access control and integrity fulfillment are critical for corporate assets.



https://www.process.st/bpmn-tutorial/

Blockchain Technology

- Stored data is consolidated into blocks that contain hash values of blocks generated before, which creates a chain of irreversible and immutable blocks.
- Data authenticity and consistency could be proven by checking the conformity of hash values back to the initial block of the whole blockchain.
- Blockchain transactions do not need a "trusted entity" for processing, they cannot be altered and could be easily traced.

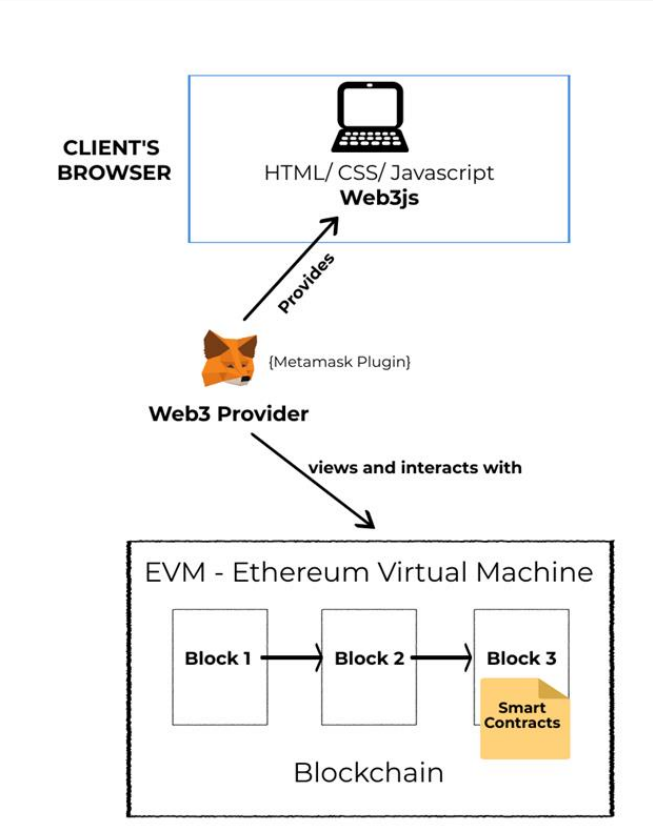


https://www.tutorialspoint.com/blockchain/index.htm

Smart Contracts and Decentralized Applications

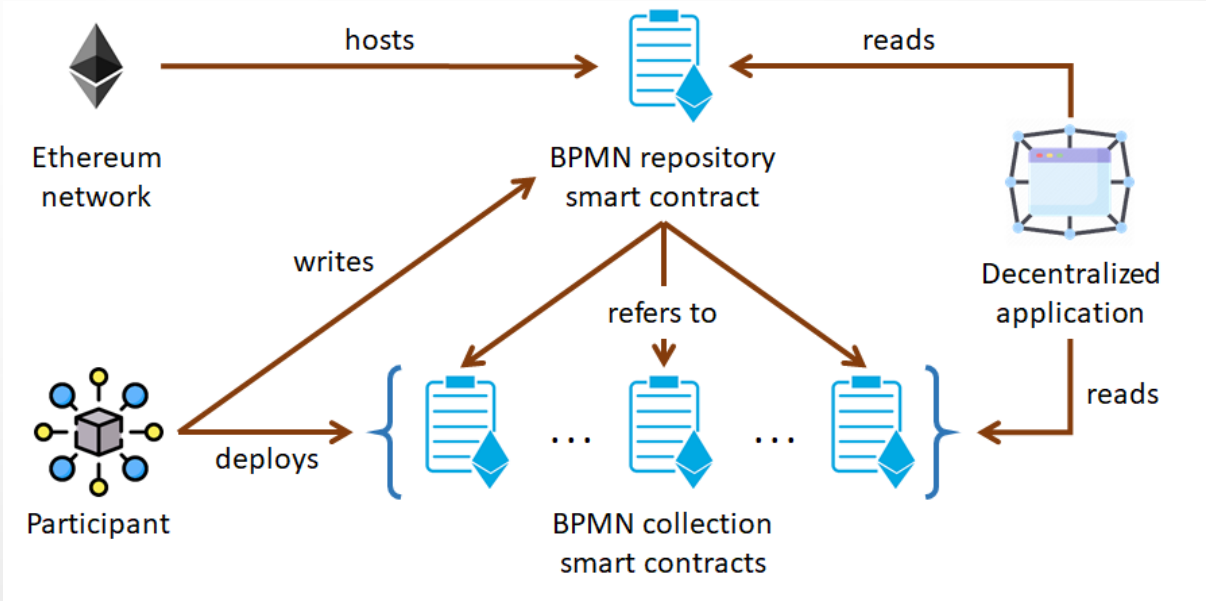
- "Smart contracts" are computer programs that run in the blockchain platform and record immutable transactions into the blockchain.
- Ethereum and other platforms that support smart contracts are called "programmable blockchains", which are used to create decentralized applications or "DApps".
- DApps use smart contracts as back-end code and blockchains as databases in contrast to traditional applications backed by centralized servers.

https://alastria-es.medium.com/comparison-of-dlt-platforms-be84950d339d



Problem Statement

- Using programmable blockchain platforms, such as Ethereum, there could be created a decentralized application to store and manage collections of business process models as part of the inter-organizational repository of corporate knowledge.
- A proof-of-concept smart contract and corresponding DApp should be implemented.



Collection of Business Process Models

- Collection of business process models is the set of documents prepared in BPMN 2.0 format (XML-based files), which represent organizational activities for knowledge gathering and sharing purposes:

$$C = <own, MR, m, P, A>,$$

- own – is the owner of a collection of business process models;
- MR – is the list of records about business process models;
- m – is the number of business process model records;
- P – is the permissions mapping, which defines users allowed to access this collection;
- A – is the set of algorithms used to manage a collection.

Business Process Model Record

- Business process model record is the structure that consists of business process model attributes:

$$MR_i = <t_i, u_i, h_i, desc_i, ind_i, ts_i>,$$

- t_i – is the title of a business process model;
- u_i – is the direct URL used to access a BPMN 2.0 document;
- h_i – is the hash value of a BPMN 2.0 content (SHA256 is used);
- $desc_i$ – is the annotation or brief description of a business process model;
- ind_i – is the industry name to which a business process belongs;
- ts_i – is the timestamp that shows when the record was made.

Permissions Mapping

- Permissions mapping is the function that associates each address of a blockchain network to the binary value, which determines whether such address is allowed to add new business process models into this collection or not:

$$P\colon addr \rightarrow \{0, 1\},\ addr \in Addr,$$

- $addr$ – is the address in a blockchain network;
- values of P determine whether a user with network address $addr$ is allowed to add new business process models to a collection, $P(addr) = 1$, or not $P(addr) = 1$.

Managing a Collection of Business Process Models

- Algorithms to manage a collection of business process models is the set of algorithms used to implement certain operations with the collection of business process models:

$$A = <add, set>,$$

- *add* – is the algorithm of adding new record about a business process model referenced in the collection;
- *set* – is the algorithm of setting access permissions (either granting or revoking) for a given user's address.

Algorithms of a Blockchain-based Business Process Model Collection

Add a new business process model

Step 1. Get the sender's address (i.e. a blockchain address of a user who initiated the execution of this algorithm) $send \in Addr$.

Step 2. Determine the access permission $P(send)$ given to the obtained sender's address $send \in Addr$. Check whether the sender's address is given with the permission (3) to access a collection of business process models, i.e. if $P(send) = 1$, $send \in Addr$, then proceed to Step 3. Otherwise, if $P(send) = 0$, execution of the algorithm should be finished.

Step 3. Create a new record about a business process model that should be added to the blockchain $MR_{new} = \langle t_{new}, u_{new}, h_{new}, desc_{new}, ind_{new}, ts_{new} \rangle$, where $new = m + 1$.

Step 4. Add created record MR_{new} to the end of the list of business model records MR (2).

Step 5. Increase the number of business process model records, $m = m + 1$. Finish the algorithm.

Set access permissions

Step 1. Get the sender's address $send \in Addr$.

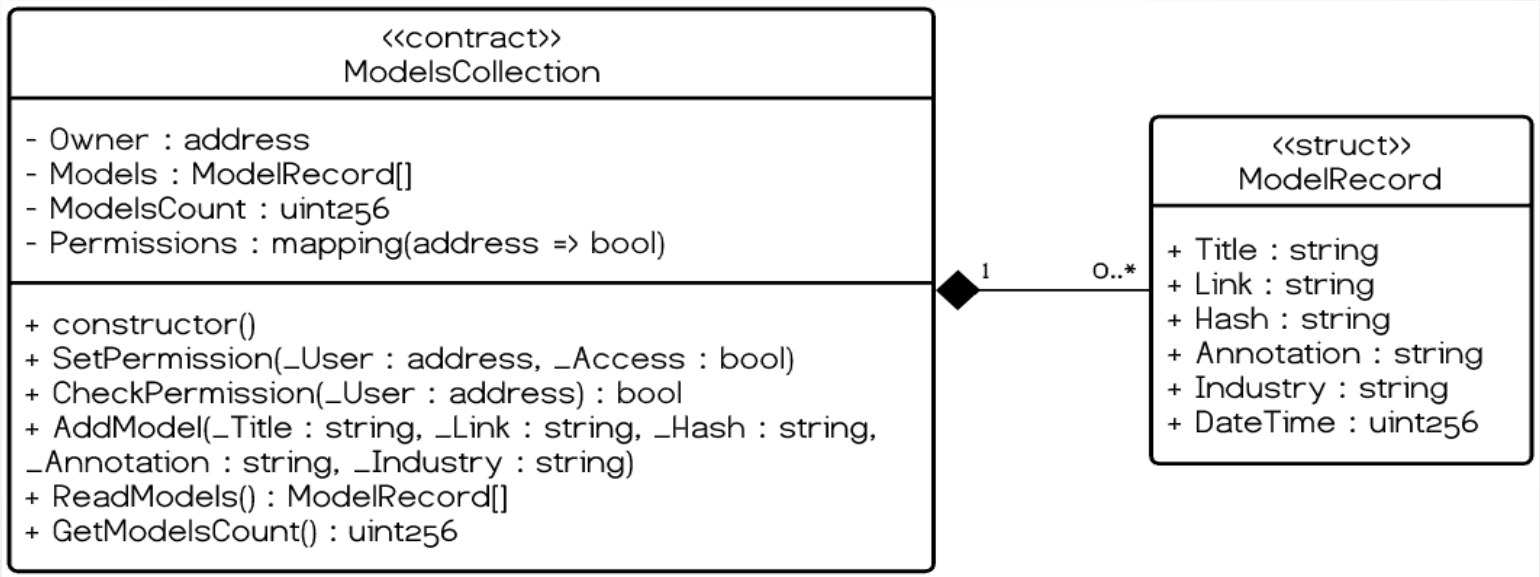
Step 2. Compare obtained sender's address $send \in Addr$ to the collection owner's address $own \in Addr$. If compared addresses are equal, then proceed to Step 3 and finish.

Step 3. Compare the user's address $user \in Addr$ to the collection owner's address $own \in Addr$. If compared addresses are not equal, then proceed to Step 4 and finish.

Step 4. Set access permission for the given user, $P(user) = access$, $user \in Addr$.

Ethereum Smart Contract Prototype

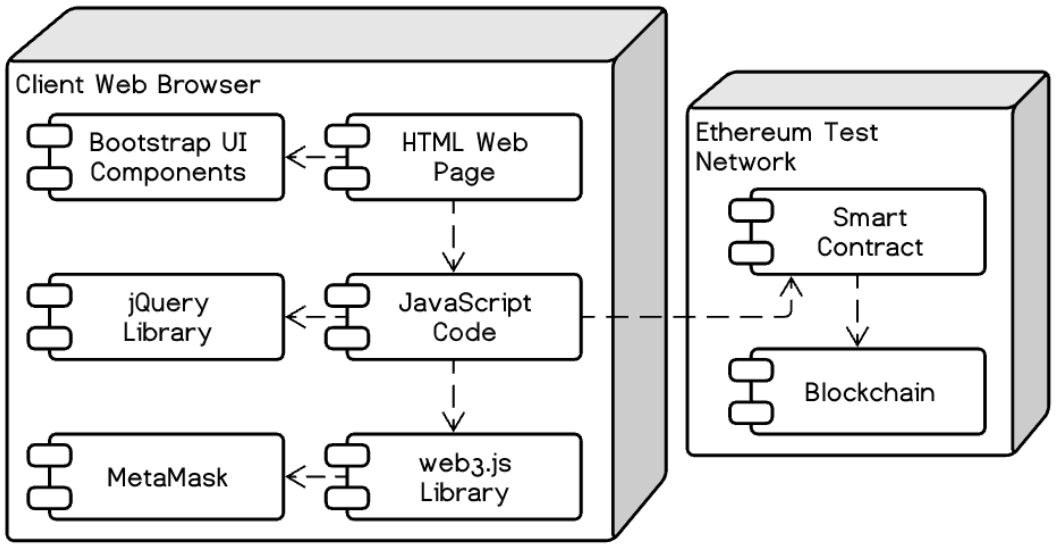
- Solidity
- Remix IDE
- Ropsten (Ethereum test network)
- MetaMask



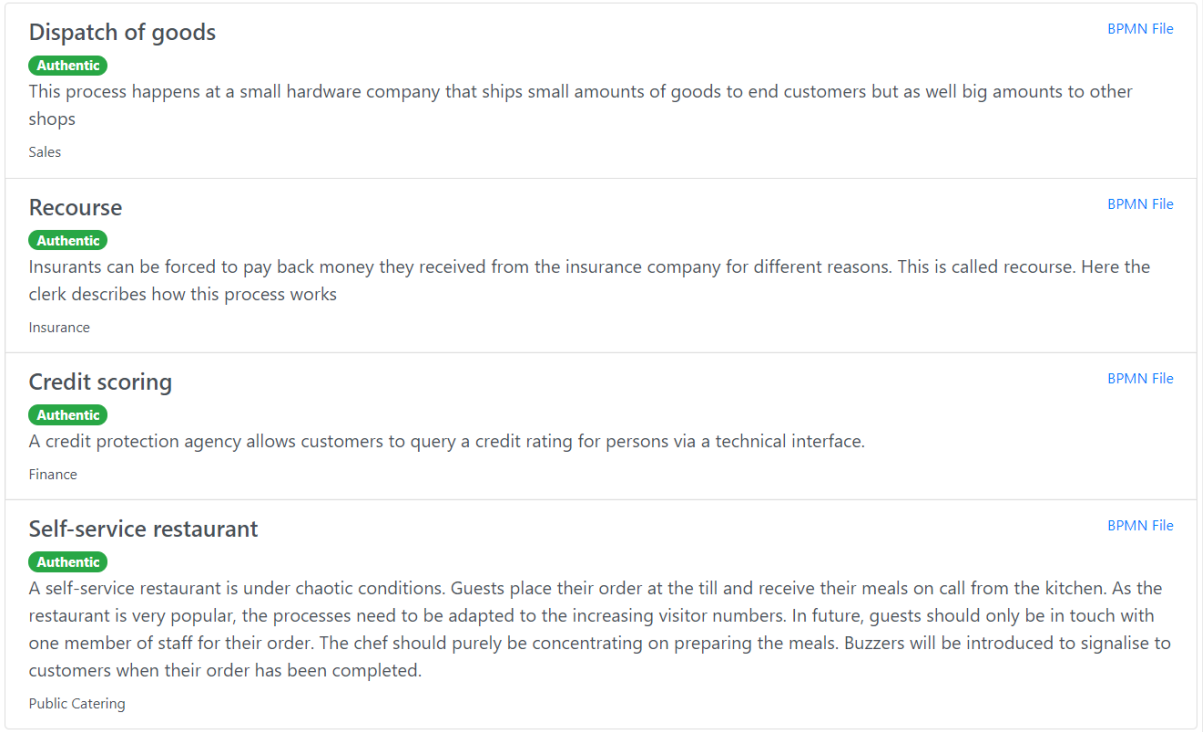
Structure of the smart contract prototype

Web Application Prototype

The system architecture of the web application prototype



Business process models requested from the smart contract

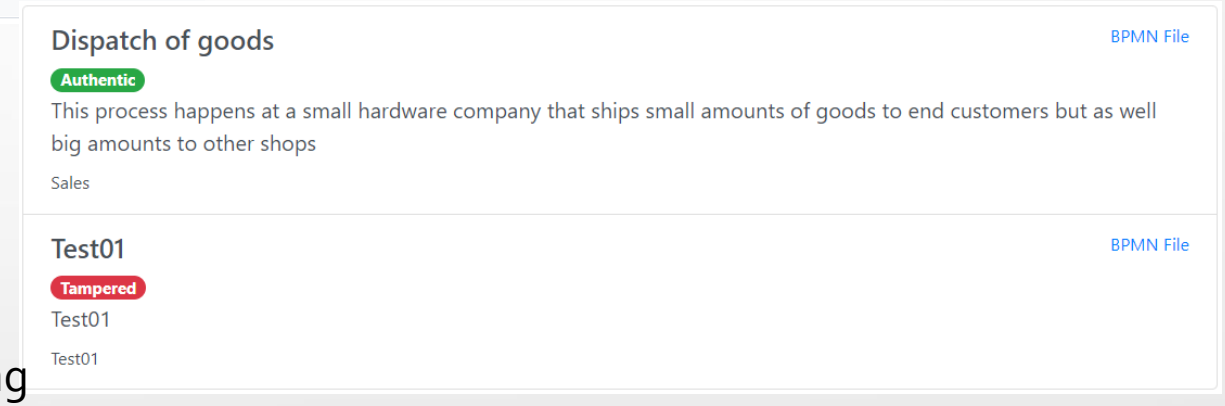


Validation of a Decentralized Application Prototype

Details of a business process model publishing transaction

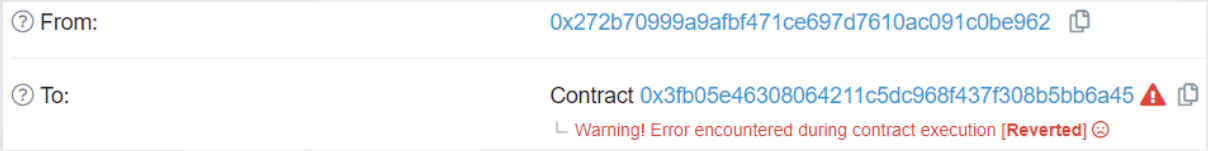
#	Name	Type	Data
0	_Title	string	Test01
1	_Link	string	https://raw.githubusercontent.com/freebpmnquality/bpmn_structuredness/main/input/dispatch.bpmn
2	_Hash	string	bd7ffce0d0b77dc74f8fab0b69c8b10d0956bdbd1901297d2c58bf7404d25400
3	_Annotation	string	Test01
4	_Industry	string	Test01

Example of tampered business process model detection



Smart contract deployed to the testnet:
https://ropsten.etherscan.io/address/0x3fb05e46308064211c5dc968f437f308b5bb6a45

Example of the unpermitted model publishing



Conclusion and Future Work

- We proposed formal definitions of the collection of business process models, the business process model record, the permissions mapping, and the collection management algorithms.
- Suggested algorithms allow to add a new record about a business process model and to configure access permissions.
- Formal definitions and algorithms were implemented as the smart contract prototype deployed to the Ethereum test network Ropsten.
- There was created the prototype of a web application to access the smart contract.
- Future work includes the elaboration of exchanging and trading capabilities of the proposed solution.

Thank you for your attention!