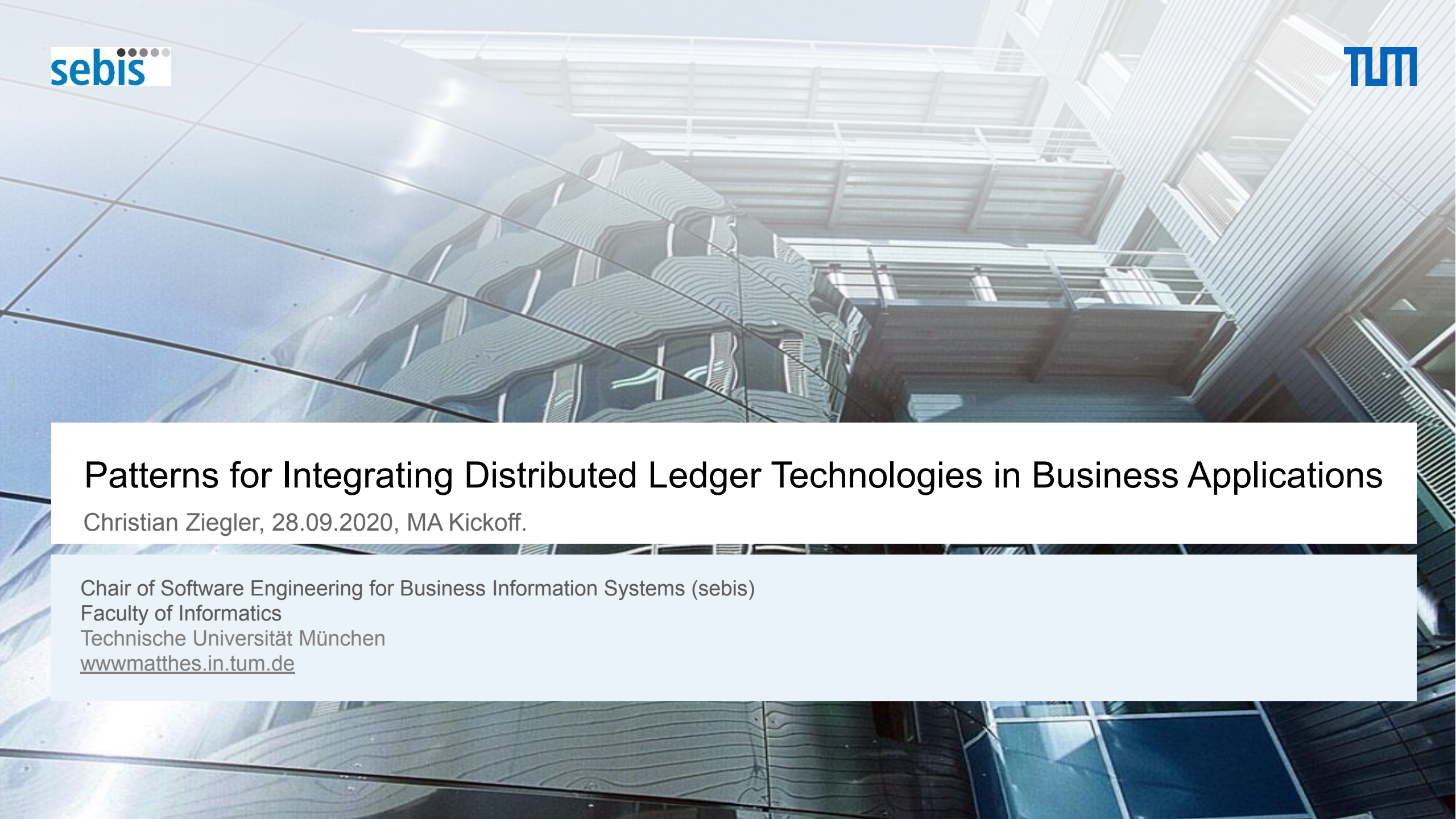

Patterns for Integrating Distributed Ledger Technologies in Business Applications

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Outline

Motivation
- A Brief History of DLT
- Why we need Patterns

Research Approach
- Overview
- Finding Projects
- Related Work
- Research Questions

Patterns
- Possible Pattern Categories
- Possible Pattern inside the Categories

Motivation - A Brief (and extremely simplified) History of DLT

Bitcoin

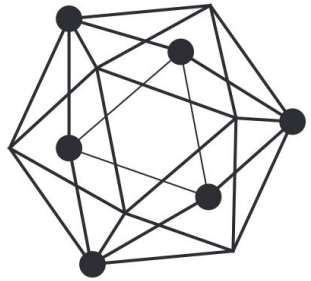
“Transfer money without a third party”

7187 Cryptocurrencies are active today [1]

Ethereum

“Execute code on a global virtual machine”

More than 2 million Smart Contracts deployed on Ethereum [2]



Hyperledger

“Build your own private blockchain for your enterprise system with all its benefits (and downsides...)”

Hyperledger collaborates with more than 250 companies [3]

[1] https://coinmarketcap.com/all/views/all/
[2] https://etherscan.io/accounts/c/2
[3] https://www.hyperledger.org/

Motivation - Why we need Patterns

Blockchain is new technology that struggles finding its way into the market

Companies have many pilot applications that contain blockchain-technology

Very few pattern catalogues have been published on DLT

developer teams tend to “re-invent the wheel” regarding to blockchain-technology due the immaturity of the technology

Flaticon.com: Pixel perfect, Freepik, mynamepong, Good Ware

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Overview

- Look at the market and the trends and find projects
- Find related work such as existing published DLT pattern catalogues

Mostly finished

- Look at the technology that the projects use
- Find out which technologies are used most and extract implementations
- Convert the extracted implementations into the (adapted) GoF pattern description

TODO

Research Approach - Finding Projects

Google Scholar

Searches for “DLT”, “Distributed Ledger Technology”, “Blockchain” sorted by newest -> Mostly “hard to argue blockchain projects”

Scopus

Searches for published pattern catalogs: Resulted in one big pattern catalogue

Checked out top 10 projects: They deliver the base technology most DLT projects use

Everest.link

Newest hype projects and very small projects with extremely niche ideas

Research Approach - Related Work

(Just one Paper?!)

A Pattern Collection for Blockchain-based Applications [1]

- Interactions with external world patterns
  - **Oracle**: Introducing the state of external systems into the closed blockchain execution environment
  - **Reverse Oracle**: The off-chain components of an existing system rely on smart contracts running on a blockchain to supply requested data and check required conditions.
  - **Legal and smart contract pair**: A bidirectional binding is established between a legal agreement and a corresponding smart contract.
- Data Management
  - **Encrypting on-chain data**: Ensure confidentiality of the data stored on blockchain by encrypting it.
  - **Tokenization**: Using tokens on blockchain to represent transferable digital or physical assets or services
  - **Off-chain data storage**: Use hashing to ensure the integrity of arbitrarily large datasets which may not fit directly on the blockchain
  - **State channel**: Transactions that are too small in value relative to a blockchain transaction fee or that require much shorter latency than can be provided by a blockchain, are performed off-chain with periodic recording of net transaction settlements on- chain.
- Security
  - **Multiple authorization**: A set of blockchain addresses which can authorise a transaction is predefined. Only a subset of the addresses is required to authorize transactions.
  - **Off-chain secret enabled dynamic authorization**: Using a hash created off-chain to dynamically bind authority for a transaction.
  - **X-confirmation**: Waiting for enough number of blocks as confirmations to ensure that a transaction added into blockchain is immutable with high probability
- Structural Patterns of Contract
  - **Contract registry**: Before invoking a smart contract, the address of the latest version of the smart contract is located by looking up its name on a contract registry
  - **Embedded permission**: Smart contracts use embedded permission control to restrict access to the invocation of the functions defined in the smart contracts.
  - **Data contract**: Store data in a separate smart contract.
  - **Factory contract**: An on-chain template contract is used as a factory that generates con- tract instances from the template.
  - **Incentive execution**: A reward is provided to the caller of a contract function for invoking it

Most are interesting for my research but with different categories

[1] XU, Xiwei, et al. A pattern collection for blockchain-based applications. In: *Proceedings of the 23rd European Conference on Pattern Languages of Programs*. 2018. S. 1-20.

Research Approach - Research Questions

RQ1 What are common features that Distributed Ledger Applications share?

RQ2 How can these features be put in a formal pattern definition?

RQ3 From the defined patterns, which are the most important ones?

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Possible Pattern Categories

Unique Asset Storing	Unique Asset Transfer	On-Chain Code Execution	Identity Management
Information Broadcasting	Off-Chain Data Storage	On-Chain Data Storage	Decentralized Exchange
Governance	Cryptocurrency Minting	Cryptocurrency Storing	Cryptocurrency Transfer

Possible Patterns inside the Categories

Identity Management	Decentralized Exchange	Cryptocurrency Minting	Cryptocurrency Storing
• Asymmetric security keys (Bitcoin, Ethereum, …) • Certificate based authentication (Hyperledger MSP, …)	• Atomic swaps (Bitcoin, Bitcoin Cash, Decred, Litecoin, …) • Flash Swaps & Liquidity (Uniswap)	• Pre-Mine • Mining (PoW, PoS, …) • Minting (Stablecoins) • Elastic Supply (AMPL)	• UTXO based (Bitcoin, Litecoin, …) • Account based (Ethereum, BnB, …) • Hybrid approach (Accounting systems on top of UTXO based coins. e.g. Bitcoin)

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Discussion

- Are there other important sources for projects and pattern catalogues that I have missed?
- Are the research questions conclusive and expedient?
- Do you think that my pattern categorisation makes sense?
- Do you think that the example patterns I listed for four categories would make good patterns?
- In general would you agree that the direction I am aiming regarding the categories and pattern is productive?