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Blockchain-oriented Software Engineering: Challenges and New Directions

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Source: http://ieeexplore.ieee.org/document/7965292/

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Motivation

A lot of Attention has been paid to the concepts of Blockchain and Smart Contract

"we should think about the blockchain as another class of thing like the Internet"

and

"wide adoption of blockchain technology has the potential of reshaping the current financial services technical infrastructure."

Motivation

12 billions $USD in October 2016, **80%** the capitalization of **Bitcoin**

In 2015 to
$490 million

Venture capital investments in **Blockchain** startups has been increasing from **$93.8 million** in 2013 to **$315 million** in 2014

Bitcoin and **Blockchain** remind of the **Internet in 1993**, venture **capital** started to **flow** internet **startups**

Google, Yahoo Cisco and Amazon

https://coinmarketcap.com/

Motivation

The "exchanges", Web applications allowing to store digital currencies and to trade them against other currencies

- MtGox $600 million in 2014
- Bitfinex $65 million in 2016
- Decentralized autonomous organization (DAO) $50-$60 million in Juni 2016 as Ether digital currency withdrawal of Funds Worth

All of these attacks can be attributed to poor software development practices.

Numerous of software projects rapidly born and quickly developed.

The scenario is a first-come-first-served base

Blockchain-Technology

Blockchain is a Initially key technique
behind Bitcoin

Bitcoin is a Cryptocurrency such as:

**Ethereum,Rippe, BitConnect, NEO,
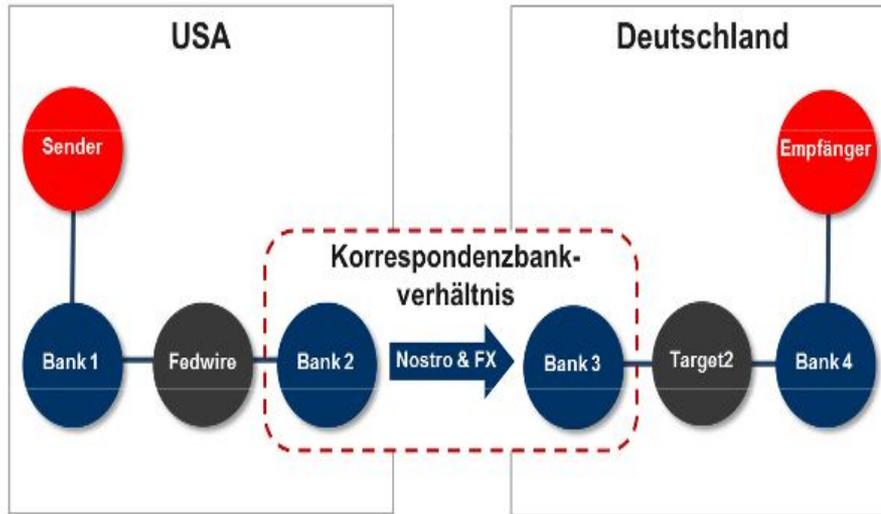LiteCoin,Monero** ect.

Bitcoin was Invented in 2008 as
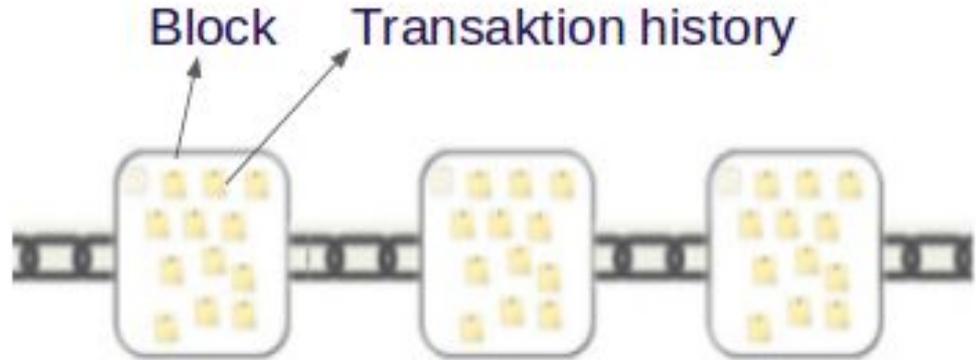"Peer-to-Peer Electronic Cash System"

https://www.bitcoin.com/

Blockchain-Technology

Traditional central Systemarchitektur

http://blog.frankfurt-school.de/wp-content/uploads/2016/01/Blockchain_FSBlog_part1.pdf

Blockchain-Technology

Challenges

New Professional roles:

Due to the business-critical nature of the Blockchain, the Sector will need professional figures with a well-defined skills portfolio comprising finance, law, and technology expertise.

An example of a new role could be that of an intermediary between business-focused contractors with low technology expertise and IT

Challenges

Security and Reliability:

"Software Security Guidelines span every phase of the software development lifecycle" and "Software Reliability Engineered Testing is a testing method encompassing the whole development process"

Ensuring security and reliability in BOS development might require specific methodologies such as Cleanroom Software Engineering or software reviews.

Mathematically analysis techniques could help enforcing reliability and security-related properties in blockchain-oriented applications.

Testing techniques can also enhance system security and reliability.

Challenges

Software architecture:

Specific design notations, macroarchitecture patterns, or meta-models may be defined for BOS development.

Software engineers should define criteria for selecting the most appropriate blockchain implementation, evaluating the adoption of sidechain technology, or the implementation of an ad-hoc blockchain.

Ethereum has adopted simplistic database, a key-value store.

Challenges

Modeling languages:

Blockchain-oriented systems may require specialized graphic models for representation.
More specifically, existing models might also be adapted to BOS.

UML diagrams might be modified or even created anew to account for the BOS specificities

Diagrams such as the Use Case Diagram, Activity Diagram, and State Diagram could not effectively represent the BOS environment.

Challenges

Metrics:

BOSE may benefit from the introduction of specific metrics.

It could be useful to refer to the Goal Question Metric (GQM) method.

Goal Question Metric-was originally intended for establishing measurement activities, but it can also be used to guide analysis and improvement of software processes.

Specific metrics are required to measure complexity, communication capability, resource consumption of the Blockchain

Repositories

Building a Dataset of Blockchain-oriented Software:

Moody's identified more than 120 publicly announced blockchain projects.

Moody's list as a baseline,considered only on the first 17 position most capitalized cryptocurrency and assets at CoinMarketCap

The Software can be easily found by searching for the specified project name.

Study focused on freely accessible,open-source software hosted on GitHub.
GitHub provides homogeneous metadata, which allows to compare projects

Repositories

Dataset Analysis:

From the 1184 repositories after comprise process identified 52 GitHub accounts information extracted on:

- Popularity (Stargazers),
- Programming languages,
- Community involvement (Contributors, Open Issues, Watchers, Forks)
- Age (time elapsed since creation)

Repositories

To focus on the most relevant repositories, considered those that :

   i) are base repositories (not a fork from a previously existing repository),

   ii) had been updated in the previous 30 days

   iii) were created more than 30 days before

 By using these criteria retained 193 repositories out of the initial 1184.
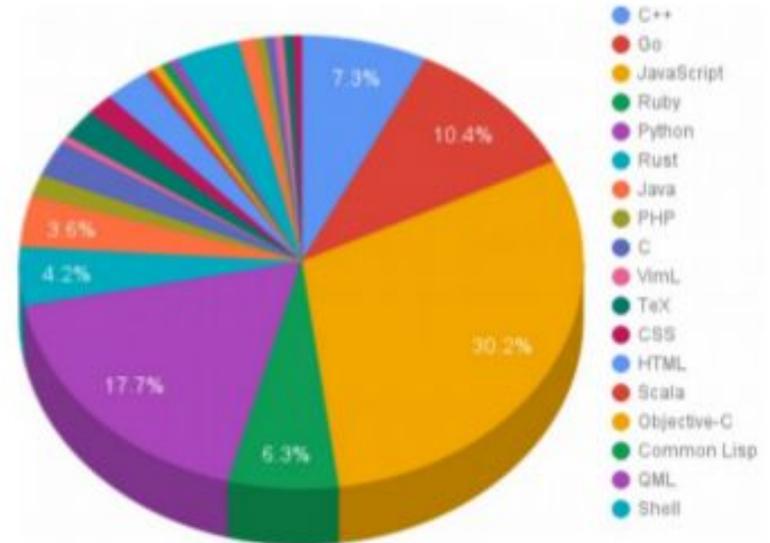
Repositories

Preliminary Results:

Diagram reports the most used programming languages among the 193 repositories.

JavaScript, Python, Go, C++, and Ruby are the top 5 languages

JavaScript repositories accounting for more than 30% of the total.

Python and Go in the podium

Java repositories–not reaching 4% of the total

Legend:
- C++
- Go
- JavaScript
- Ruby
- Python
- Rust
- Java
- PHP
- C
- VimL
- TeX
- CSS
- HTML
- Scala
- Objective-C
- Common Lisp
- QML
- Shell

Pie values visible: 7.3%, 10.4%, 30.2%, 17.7%, 6.3%, 4.2%, 3.6%

Repositories

TABLE I
EXTRACTED STATISTICS ACROSS THE TOP 10 BOS REPOSITORIES

GitHub Repository	stargazers	contributors	open issues	age (days)	watchers	forks	first language
bitcoin/bitcoin	9966	396	547	2105	1211	4266	C++
ethereum/go-ethereum	2160	78	285	1002	367	695	Go
ledger/ledger	1813	108	14	3055	103	255	C++
digitalbazaar/forge	1584	41	137	2260	103	241	JavaScript
ripple/ripple-client	1244	51	21	1437	968	486	JavaScript
ethereum/mist	1168	35	198	471	210	299	JavaScript
dogecoin/dogecoin	1153	300	52	1022	149	505	C++
ripple/rippled	1144	53	118	1782	246	338	C++
coinbase/toshi	839	18	97	749	98	187	Ruby
ethereum/cpp-ethereum	723	89	212	1001	196	270	C++

- The top 10 BOS repositories were created around 4 years ago on average

- Most of them have a considerable number of open issues

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New Research Directions

Testing:

Based on P. S. Kochhar, T. F. Bissyandé, D. Lo, and L. Jiang, "Adoption of software testing in open source projects–a preliminary study on 50,000 projects," study, a bigger team size leads to a higher number of test cases per developer decreases with an increase in the team size

Investigate the same can be said about Blockchain-oriented Software

bitcoin/bitcoin repository has 400 GitHub Contributor as reported in Table I

New Research Directions

Collaboration:

A large contributing members has been shown to be a pivotal success factor in OSS evolution.
The high number of contributors predicate the attractiveness of BOS.

To achieve sustainable development and improve software quality, specific practices to enhance, the synergy between the system and the community would be highly beneficial to BOSE
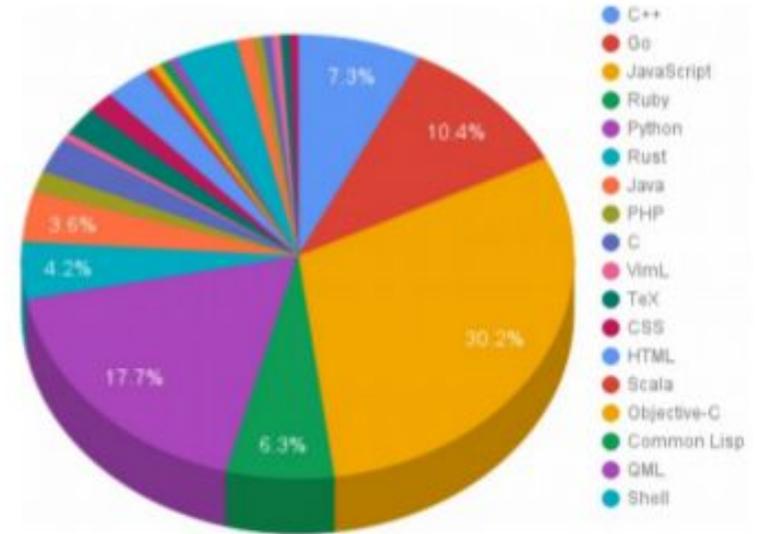
New Research Directions

Enhancement of testing and debugging for specific programming languages:

A programming languages Go, Python, and Ruby are gaining increasing popularity among BOS projects.

This arises the need for enhanced testing and debugging suites, tailored upon the most popular BOS languages.

Java testing suites have undergone much more testing than Go.

- C++
- Go
- JavaScript
- Ruby
- Python
- Rust
- Java
- PHP
- C
- VimL
- TeX
- CSS
- HTML
- Scala
- Objective-C
- Common Lisp
- QML
- Shell

Thank You !