



OST

Eastern Switzerland
University of Applied Sciences

Blockchain (BlCh)

Admin

Thomas Bocek

16.09.2024

About Me

- General interests: distributed systems, blockchain, startups
- OST, Lecturer
 - Distributed systems [\[link\]](#) and blockchains [\[link\]](#)
 - Since Corona, also on youtube [\[link\]](#)
 - Focus: practical implementation – Challenge Task
 - Winner last year: implemented a dual deposit system with ICP and canisters (~smart contracts).
- Co-founder & CTO **Axelra AG**
 - Tech Venture Building, Digitalization / Blockchain



BlCh Administration

- Module Description
- Website: <https://dsl.i.ost.ch>
- Exercises onsite **and** remote: **Teams**
 - Team code: 82yh8gm
- Lectures: pre-recorded, videos available on <https://dsl.i.ost.ch/lect> and **Youtube**
 - Videos and PDFs will be uploaded before the lecture starts on Tuesday 08:10
 - Youtube will only have the lectures videos, admin related videos & PDFs only via (VPN) <https://dsl.i.ost.ch/lect/hs24/>
 - Same as in previous semester **HS23**

Blockchain

Kürzel:

M_BlCh

Durchführungszeitraum:

HS/21-HS/24

ECTS-Punkte:

4

Lernziele:

Verteilte Systeme sind allgegenwärtig in beruflichem und privatem Alltag; sie führen Konzepte und Technologien aus unterschiedlichen Bereichen der Informatik zusammen. Die Themengebiete in diesem Modul umfassen:

- Synchronization in Distributed Systems (Causality, Lamports Clock, Vector Clocks)
- Blockchain Security Considerations and Cryptography
- DHTs (Chord, Kademlia)
- Distributed Systems with WebRTC
- Distributed Batch Processing with Apache Spark
- Ethereum, IOTA, NEO
- Consensus Mechanisms, Atomic Swaps

Verantwortliche Person:

Dr. Bocek Thomas

Standort (angeboten):

Rapperswil-Jona

Empfohlene Module:

Distributed Systems (M_DSv ES/22-ES/25)

Zusätzlich vorausgesetzte Kenntnisse:

Englisch

(Dieses Modul wird teilweise in Englisch gehalten.)

BlCh Administration

Kurzzeichen:

BlCh

Lernziele:

Plan und Lerninhalt:

Die Themengebiete in diesem Modul können variieren und werden in der ersten Vorlesung bekanntgegeben.

- If there is interest in further topics (blockchain and distributed systems related), please talk to me.

BlCh 2024: Plan

Nr	Date	Lecture*	Lecturer
01	17.09.2024	Admin (lecture and challenge task), Repetition DSy (part 1) - no exercises	Bocek
02	24.09.2024	Repetition DSy (part 2), Introduction Blockchain	Bocek
03	01.10.2024	Ethereum Components / Architecture	Bocek
04	08.10.2024	1st hand-in, Solidity	Bocek
05	15.10.2024	DeFi	Bocek
06	22.10.2024	DAO, POAP, Stablecoins	Bocek
07	29.10.2024	2nd hand-in, Wallets and Seed Phrases	Bocek
08	05.11.2024	HTLCs, Cross-chain Atomic Swaps, Payment Channels	Bocek
09	12.11.2024	Security Considerations, Layer 2 Use Cases	Bocek
10	19.11.2024	3rd hand-in, Sui	Bocek
11	26.11.2024	Interview, Exam Preparation	Bocek
12	03.12.2024	Final hand-in, Challenge Task Presentations, part 1	you
13	10.12.2024	Challenge Task Presentations, part 2	you
14	17.12.2024	Q&A and Challenge Task Award Winner Announcement - no exercises	Bocek

* topics may change

BlCh Exercises

- Challenge Task
 - Starts 24.09.2024 (lecture 2)
 - **No exercises on 17.09.2024!**
- Goal: practical application of distributed systems concepts and tools
- Onsite and remote (on request): via MS Teams
 - Tuesday exercise: 10:10 – 11:50, 13:10 – 14:50

Plan und Lerninhalt:

Die Themengebiete in diesem Modul können variieren und werden in der ersten Vorlesung bekanntgegeben.

In den Übungen entwickeln Studentengruppen eine verteilte Applikation (Challenge Task II), welche diverse Requirements erfüllen muss. Das Erfüllen dieser Requirements ist Voraussetzung für das Bestehen der Übungen und für die Zulassung zur Prüfung. Ein Beispiel eines Challenge Tasks aus dem HS18 war es, eine vollständige verteilte P2P Applikation zu erstellen, welche mithilfe einer Blockchain Nachrichten notariell beglaubigen kann.

BlCh Challenge Task

- Leistungsbewertung

Während der Prüfungssession:

Schriftliche Prüfung, 60 Minuten

Zulassungsbedingungen zur Prüfung:

Nach Ankündigung, Abgabe erfolgreich gelöste Übungsaufgaben.

- Must include a simple frontend (e.g., HTML, Vue, React, Svelte, Angular)
 - Issue and redeem stablecoin
- Must include a public blockchain (e.g., Ethereum, Solana)
 - Trading can be done with existing DEXes

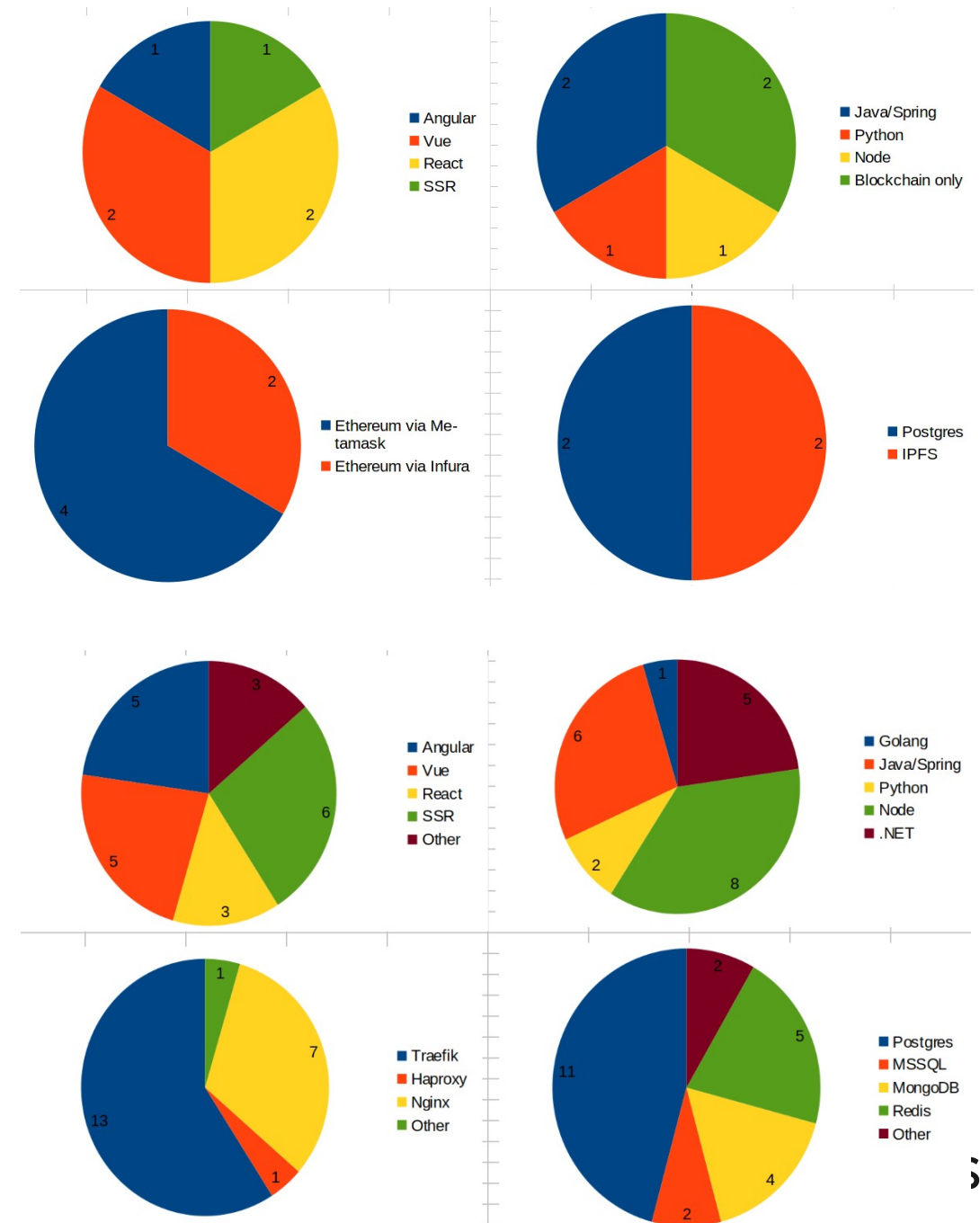
- Challenge Task HS 2024
 - Stablecoin with rebalancing on decentralized exchange (DEX)
 - Ideally, the application is a decentralized application (DApp).
- Requirements
 - A working prototype with your stablecoin.
 - Use latest stable releases of chosen libraries and frameworks.
 - Interaction with a public blockchain (can be testnet).
 - Must be tradable on a decentralized exchange (DEX)
 - Stablecoin needs to rebalance on DEX to remain stable
 - Status and process need to be shown in the frontend.

BlCh 2024: Plan / Challenge Task

Nr	Date	Lecture*	Milestone
01	17.09.2024	Admin (lecture and challenge task), Repetition DSy (part 1) - no exercises	Group forming, idea for (d)app
02	24.09.2024	Repetition DSy (part 2), Introduction Blockchain	Group forming done, setup dev environment
03	01.10.2024	Ethereum Components / Architecture	
04	08.10.2024	Solidity	Hand-in 1 , initial plan
05	15.10.2024	DeFi	
06	22.10.2024	DAO, POAP, Stablecoins	
07	29.10.2024	Wallets and Seed Phrases	Hand-in 2 , first version (initial commit)
08	05.11.2024	HTLCs, Cross-chain Atomic Swaps, Payment Channels	
09	12.11.2024	Security Considerations, Layer 2 Use Cases	
10	19.11.2024	Sui	Hand-in 3 , current progress
11	26.11.2024	Interview, Exam Preparation	Testing, testing, testing
12	03.12.2024	Final hand-in, Challenge Task Presentations, part 1	Final Hand-in (02.12.2024, 23:59 CET)
13	10.12.2024	Challenge Task Presentations, part 2	
14	17.12.2024	Q&A and Challenge Task Award Winner Announcement - no exercises	

BlCh Challenge Task

- Final deliverables, 02.12.2024, 23:59 (CET)
 - Well documented code and infrastructure
 - Presentation (slides) and demo of the application, also showing the architecture and design decisions
- Libraries and tools
 - Allowed to use any language, framework, and platforms. However, the supervisors are familiar with those: Java, Golang, JavaScript, Linux (see FS24, HS23)
- If you **fail** the CT, you fail this course



DSA Challenge Task 2018

- Design and implementation of a fully-distributed, P2P messaging application with an integrated, blockchain-based notary service
- Requirements
 - Full decentralization and P2P
 - Send messages between peers
 - Quickly and easily verify messages
- Each winner: 0.01311 BTC (50CHF)
 - They used the IOTA blockchain as a signaling layer for WebRTC.
 - Everything decentralized



DSA Challenge Task 2019

- Design and implementation of a fully-distributed, P2P gambling game
- Requirements:
 - Fully decentralization and P2P communication
 - Waiting room with chat
 - Fully decentralized gambling
- Each winner: 0.0075 BTC (~50CHF)
 - Simple yet efficient design
 - Blockchain-based four-in-a-row
 - Technology: Ethereum with web3.js and WebRTC



DS1/VSS Challenge Task FS 2020

- Free choice project
- Requirements
 - Use at least one text protocol, at least one binary protocol
 - Load balancing
 - Scalable service with authentication
- Each winner: 5.27mBTC (0.00527BTC)
 - They gathered weather data from multiple locations, and they used many components: ActiveMQ, Eureka discovery services, Kibana, Docker compose, running on self-hosted gitlab.



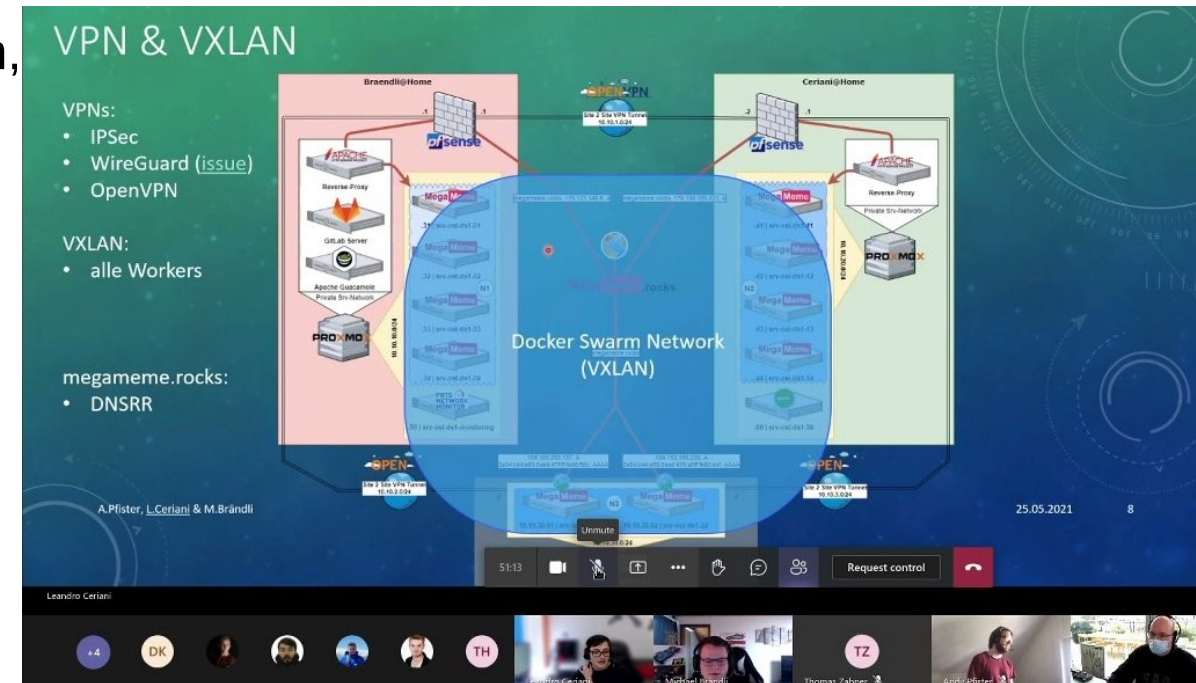
ADSB Challenge Task HS 2020

- Design and implementation of a decentralized financial application
- Requirements
 - Full decentralization and P2P mechanisms for the financial product (e.g., WebRTC, TomP2P, libp2p) or use scalable mechanisms ready to be deployed on the cloud
 - Graphical (GUI/Web-based) frontend
 - Public blockchain based
- Each winner: 2.625 mBTC (0.002625 BTC)
 - Donation platform and used the blockchain to keep track of donations



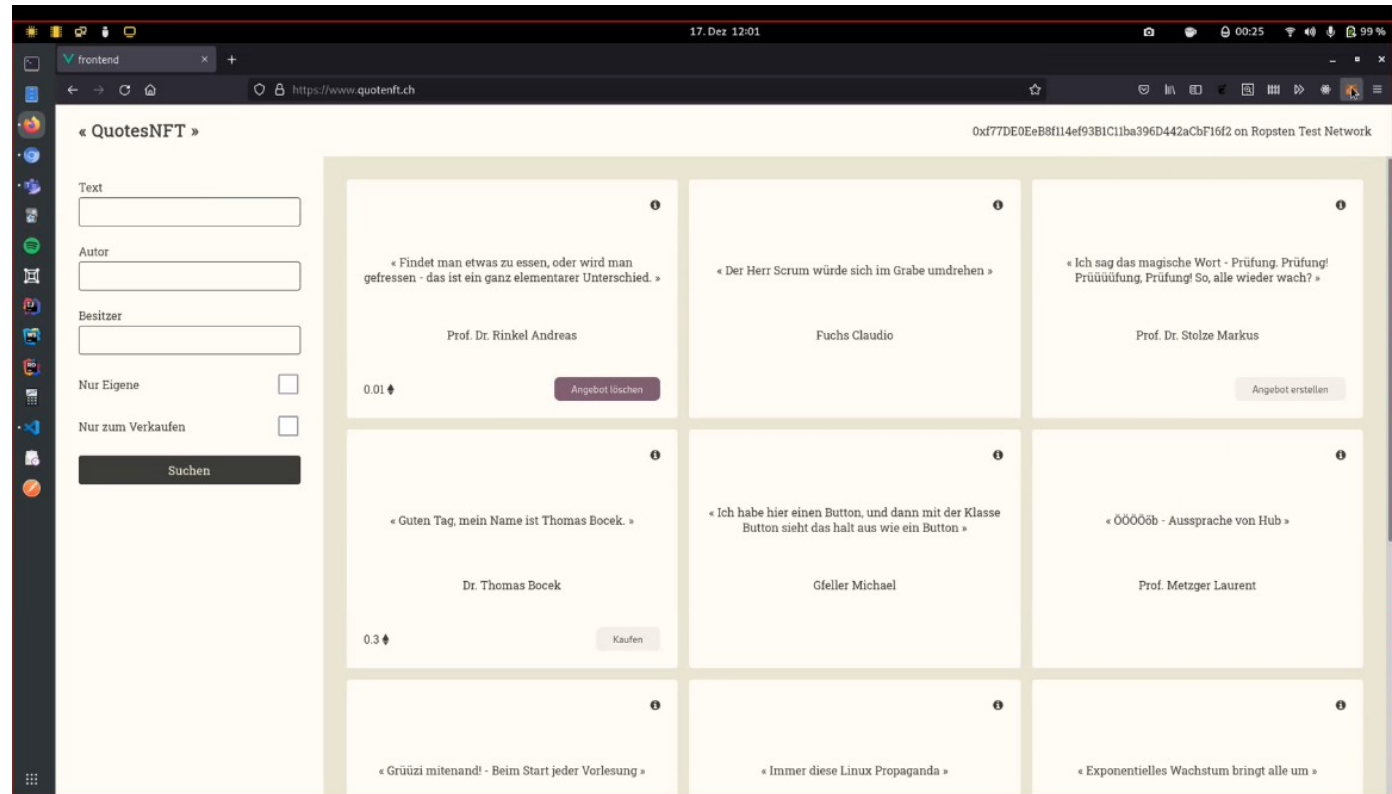
DS1 Challenge Task FS 2021

- This semester's challenge task (CT) is the design and implementation of a simple distributed system, with the following components:
 - Simple Frontend (e.g., HTML, Vue, React, Svelte)
 - Loadbalancer(e.g., traefik, nginx, HAproxy, Caddy)
 - Two instances of a service (your choice)
 - One storage backend (Postgres, simple KV memory storage)
 - JWT Authentication
- Each winner: 1.35 mBTC (0.00135 BTC)
 - Voting meme platform with Svelte and Ruby on Rails with docker swarm, GlusterFS, and CockroachDB



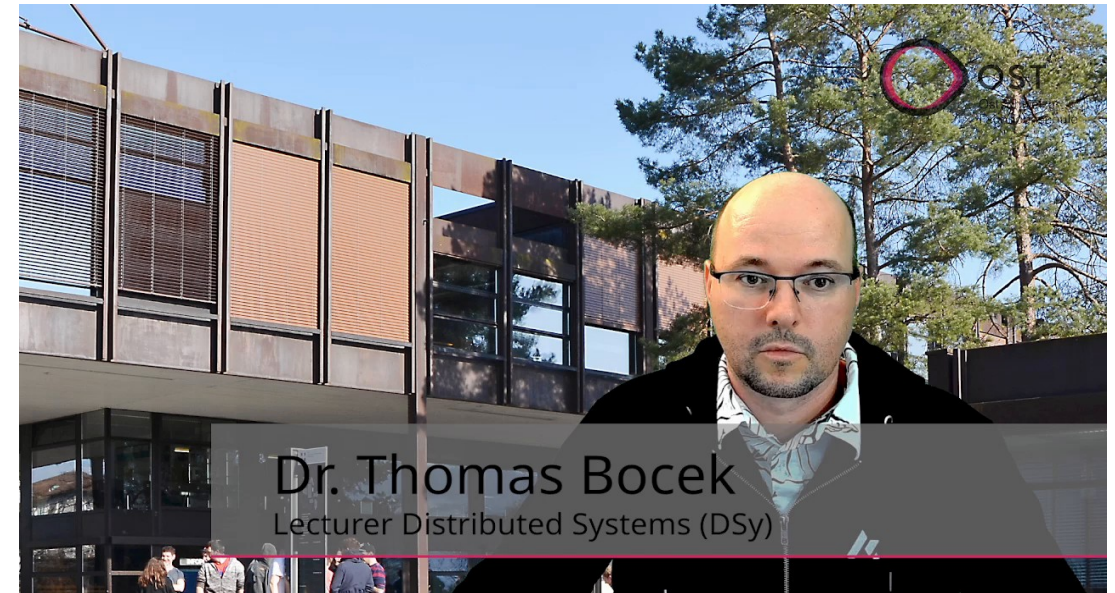
BlCh Challenge Task HS 2021

- This semester's challenge task (CT) is the design and implementation of an application including NFTs. Ideally, the application is a decentralized application (Dapp). Requirements:
 - A working prototype for your use-case
 - Use latest stable releases of chosen libraries and frameworks
 - An NFT stored on a public blockchain (can be testnet)
 - Transfer of an NFT triggered directly or indirectly via the frontend/backend (can be testnet)
- Each winner: 1 mBTC (0.001 BTC)
- QuoteNFT is a platform to trade NFT quotes. The trading happens on a smart contract and is fully decentralized. Their project uses Vue.js for the frontend, node and express with TypeScript for the backend, and MetaMask to connect to Ethereum. Their QuoteNFT platform uses Traefik as a reverse proxy and docker-compose to orchestrate the services



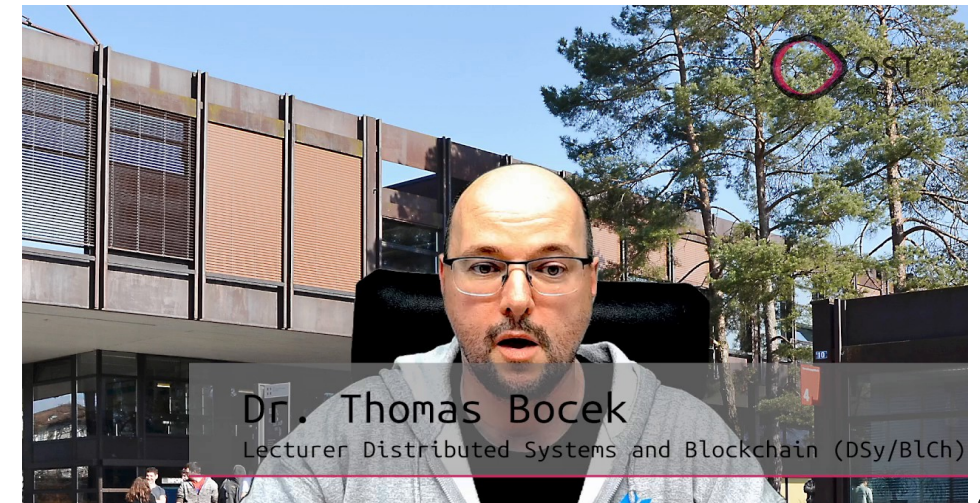
DSy Challenge Task FS 2022

- This semester's challenge task (CT) is the design and implementation of a simple distributed system (of your choice), with at least one service with a websocket, and where a service instance can fail.
- Requirements
 - Load balancing with scalable service
 - Failover of a service instance
 - A websocket needs to send data from a service to the frontend. You need to implement (consume) a websocket (using e.g., Blazor that integrates websockets does not fulfill this requirement). You can produce websocket data in your backend or use 3rd party websocket services (e.g., crypto market data)
 - Dockerized
 - Persistent storage (storage does not need to be scalable, but you can build it scalable if you want)
 - Use latest stable releases of chosen libraries and frameworks
- Amy Gdala, a web application to memorize information by talking about your day (writing a diary) and to search for all your stored information with natural language queries. Their techstack included GPT-3, Kibana/Elastic Search, Coqui-STT/TTS, Python for micro-services, Kubernetes, and Istio for gRPC load balancing.



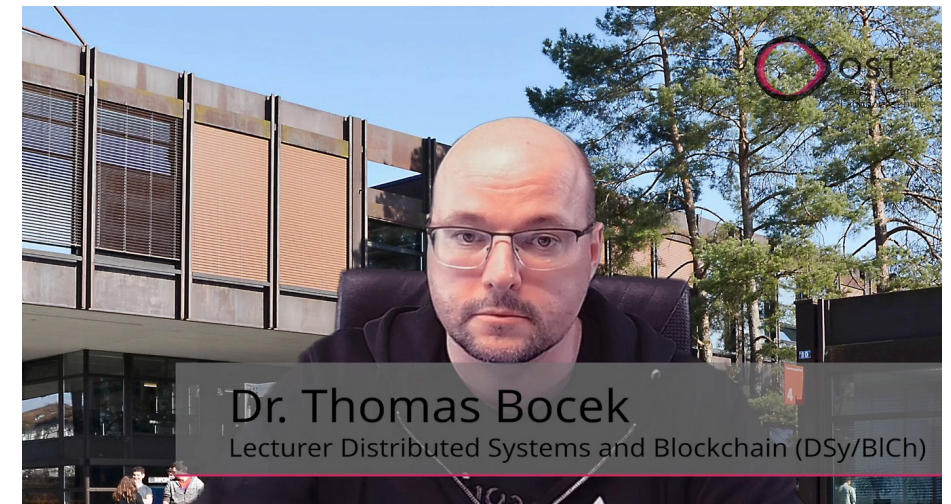
BlCh Challenge Task HS 2022

- This semester's challenge task (CT) is the design and implementation of an onchain voting application. Ideally, the application is a decentralized application (Dapp).
- Requirements
 - A working prototype for your use-case
 - Use latest stable releases of chosen libraries and frameworks
 - Submission of a voting proposal, with previously known consequences and recipients (can be testnet)
 - Onchain voting on proposal with at least 2 participants / identities (can be testnet)
 - Successful vote needs to trigger something onchain. Can be an ERC20 or an NFT transfer (can be testnet)
 - Voting status and process need to be shown in the frontend
 - The solution may use existing libraries and code, but those must open source software
- Winners built a decentralized autonomous organization (DAO), using soul-bound tokens (SBT) to vote on documents and its changes. They used Solidity with the OpenZeppelin Governor, for the backend next.js, PostgreSQL to store metadata, and to connect to the Ethereum, they used ethers.js.



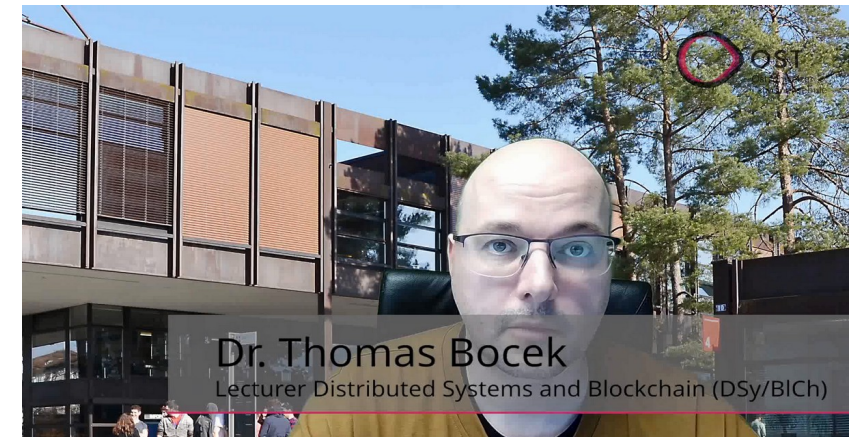
DSy Challenge Task FS 2023

- This semester's challenge task (CT) is the design and implementation of a simple distributed system (of your choice) where a service instance can fail.
 - 1) Load balancing with scalable service
 - 2) Failover of a service instance
 - 3) Dockerized and Frontend connects via HTTP/3
 - 4) Persistent storage (storage does not need to be scalable, but you can build it scalable if you want)
 - 5) Use latest stable releases of chosen libraries and frameworks
- A web application, designed to share collections of pictures, featured automated tagging through PhotoPrism. For storage, they used ScyllaDB, a high-performance, fault-tolerant database compatible with Cassandra. Everything is self-hosted with their own Kubernetes cluster using MetalLB.



BlCh Challenge Task HS 2023

- This semester's challenge task (CT) is the design and implementation of a blockchain-based solution to a specific problem that you have identified in your own life or community. Ideally, the application is a decentralized application (Dapp).
 - 1) A working prototype
 - 2) Use latest stable releases of chosen libraries and frameworks
 - 3) Interaction with a public blockchain (can be testnet)
 - 4) At least 2 participants need to be involved.
 - 5) Transparent Audit Trail
 - 6) Status and process need to be shown in the frontend
- Winners built a dual deposit system that has a mutually assured destruction mechanism that discourages fraudulent activity from both buyers and sellers. For the backend they used Golang, in the frontend they used Rust that was compiled to WebAssembly. For the blockchain environment they used ICP where canisters (~smart contracts) were written in Motoko.



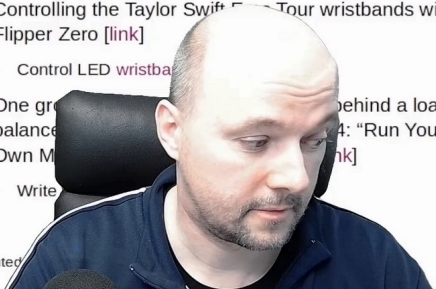
DSy Challenge Task FS 2024

- This semester's challenge task (CT) is the design and implementation of a simple distributed system (of your choice) where a service instance can fail.
 - Load balancing with multiple instances with failover of a service instance
 - Dockerized
 - Simple frontend
 - Scheduled task
 - Persistent storage
 - Use latest stable releases of chosen libraries and frameworks
- Winners built Co-Puzzle Web App, which is a collaborative puzzle using websockets. For the load balancer they used Traefik, everything dockerized of course, for the frontend/backend they used React with next, and for the database, they used MongoDB.

Distributed Systems & Blockchain in the News



- Challenge Task
 - One group with CRDT / OT → [braid.org](#)
 - Braid.org is an open working group focused on creating interoperable state synchronization protocols, algorithms, tools, and standards. → Add state synchronization methods in HTTP
 - One group with Taylor Swift → 27.05.2024 - Controlling the Taylor Swift Eras Tour wristbands with Flipper Zero [\[link\]](#)
 - Control LED wristbands
 - One group with a load balancer → 24.05.2024: "Run Your Own M..." [\[link\]](#)
 - Write
- 26.05.2024: Should I Use JWTs For Authentication Tokens? [\[link\]](#)
 - Author argues No
 - I argue HELL, YES!
- 03.06.2024: FS24 Distributed Systems Challenge Task Winner



BlCh Exercises

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BlCh Recommendation

- Follow the lecture closely
 - Lecture slides contain relevant
 - Reading further literature is recommended
 - Link are provided in the slides
- Post-processing the lecture
 - If topics or statements from the lecture are not clear, research and resolve them
- Actively participate in the challenge task
 - Trying to understand it theoretically is not enough
 - hands-on is key!
 - If its not working, read logs, try to figure it out by yourself. If its still not working, ask
 - Do not miss the opportunity of discussing details with your supervisor
- 10 lectures
 - (25h = 20h + 5h; ca. 2.5h / week)
 - ~1-1.5h frontal teaching
 - ~2 h post-processing
- 12 exercises / challenge task
 - (72h = 60h + 12h ca. 6h / week)
 - ~5h challenge task
 - ~1h post-processing
- Exam
 - ~23h exam preparation
- 4 ECTS = 120h
- Prüfung:
 - Closed book 60min, no coding, Hilfsmittel: none

Summary

- Lectures videos online before Tuesday – 08:10
- Challenge task, group members: send to thomas.bocek@ost.ch until next week
 - Work on challenge task during exercise hours and/or at home
- 6 requirements to be met
 - A working prototype with your stablecoin.
 - Use latest stable releases of chosen libraries and frameworks.
 - Interaction with a public blockchain (can be testnet).
 - Must be tradable on a decentralized exchange (DEX)
 - Stablecoin needs to rebalance on DEX to remain stable
 - Status and process need to be shown in the frontend.
- All 6 requirements must be fulfilled to pass this course
- 4 Deliverables
 - 08.10.2024, initial plan
 - 29.10.2024, first version (initial commit)
 - 19.11.2024, current progress
 - 02.12.2024, **23:59 (CET)** - documented infrastructure, source code, and presentation
- Presentations on the 03.12.2024 and 10.12.2024 onsite (1.209)
- OST BIC Challenge Task Winner HS 2024
 - 17.12.2024

