Technische Universität Braunschweig

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High-Performance Consensus Mechanisms for Blockchains

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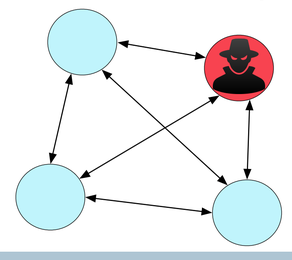
Problem Statement

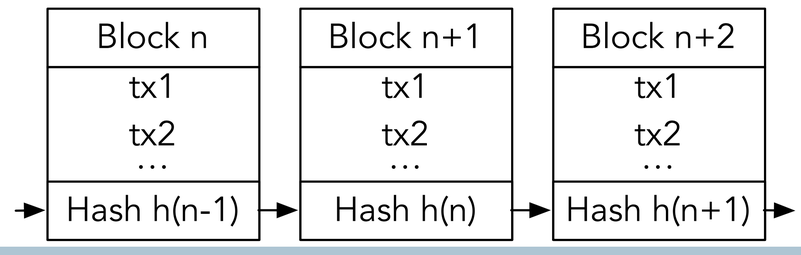
- Transaction ordering based on **Proof-of-Work** wastes **computational power** and **energy**
- Expensive and **ecologically harmful**: Bitcoin has higher energy demand than Israel!
- BFT protocols considered the solution, but only **limited scalability** for number of participants

↪ **Overcome today's BFT scalability restrictions!**

Basics: Blockchains & BFT

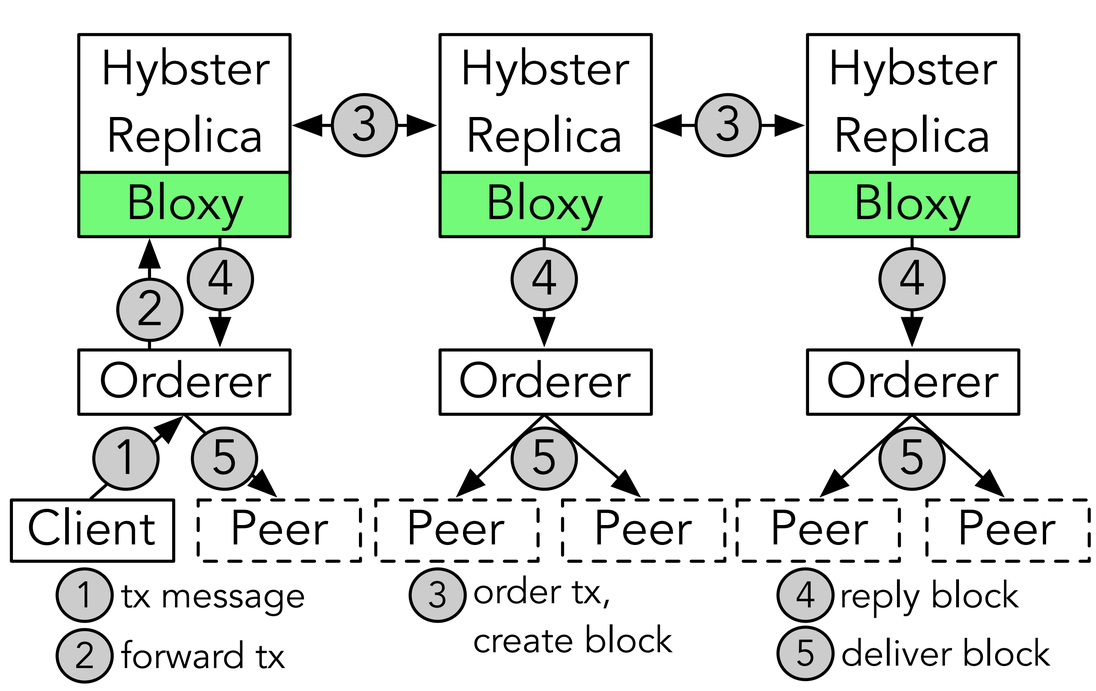
- **Permissioned** blockchains: authenticated participants, e. g. Hyperledger Fabric
- **Permissionless** blockchains: no regulation on participants, e. g. Bitcoin
- **Byzantine Fault Tolerance (BFT)**: reach consensus with $3f + 1$ nodes even if f nodes behave arbitrarily faulty





Scalable BFT Ordering for Permissioned Blockchains

- Hyperledger Fabric: **permissioned** blockchain with modular consensus
- BFT ordering service based on **Hybster** [Behl et al., EuroSys'17]
  - Hybrid BFT protocol: only $2f + 1$ nodes to tolerate f faults
  - Trusted subsystem based on **Intel SGX**
  - Designed for high scalability
- **Blockchain-aware Trusted Proxy (Bloxy)**
  - Based on **Troxy** [Li et al., DSN'18]
  - Transparent access to BFT cluster
  - Shift BFT reply voting to SGX enclaves on replicas
  - Disseminate created blocks to all connected peers
- **Advantages**:
  - Drastically reduced message complexity
  - Smooth integration: no modification to Fabric
  - SGX-based voting: offloading to replicas, no trust in orderer needed

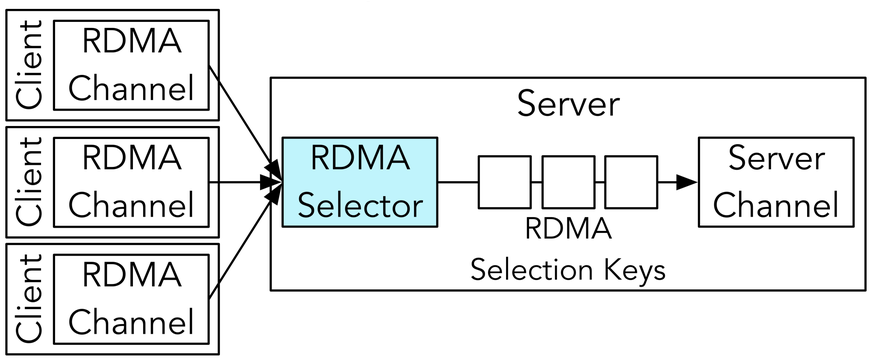


Remote Direct Memory Access (RDMA)

- BFT protocols incur higher **latencies** than crash-tolerant protocols
  → Limits adoption of BFT
- **RDMA**: hardware-based protocol offloading technology in data centers
  - Direct data movement between memory of remote hosts
  - No OS and CPU involvement or intermediate copies as with TCP
  → Low latency

↪ **Low latency and high throughput for BFT communication**

- **RDMA Selector**: handle multiple channels with one thread



Future Work

- Scalable BFT for **permissionless** blockchains
- Often thousands of participants → BFT protocol scalability not well-explored for such numbers
- Investigate mechanisms such as threshold cryptography, ring communication, choosing random committees, …

Related Work

- Bessani et al., "A **Byzantine Fault-tolerant Ordering** Service for the Hyperledger Fabric Blockchain Platform", SERIAL'17
- Gilad et al., "**Algorand**: Scaling Byzantine Agreements for Cryptocurrencies", SOSP'17
- Miller et al., "The **Honey Badger of BFT** Protocols", CCS'16
- Mazières, "The **Stellar** Consensus Protocol: A Federated Model for Internet-level Consensus", 2015