Challenging Anti-fragile Blockchain systems

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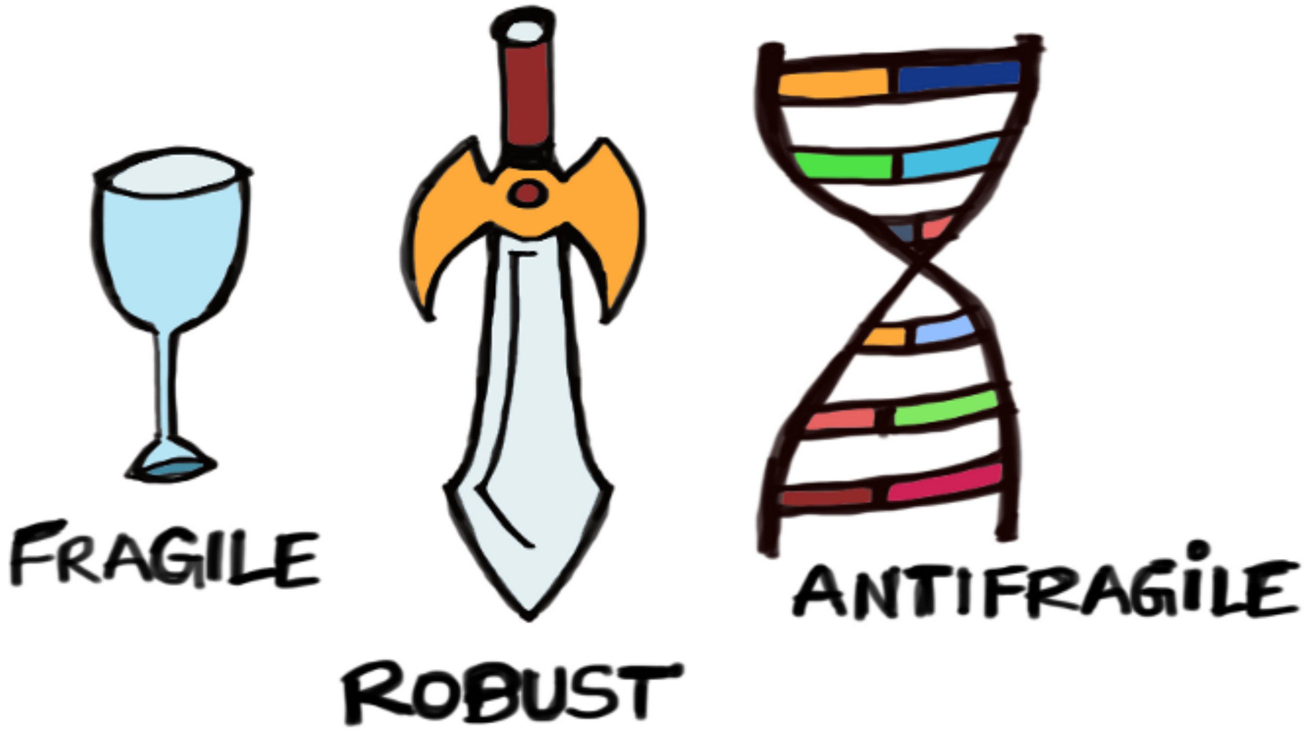
What is Anti-fragile?



Harmed by disorder

Resilient to disorder

Benefits and Learns from disorder

Systems considered anti-fragile

- Financial system
- Human Body
- Restaurant system
- Healthcare system
- Netflix as a company and its architecture
- **Bitcoin**

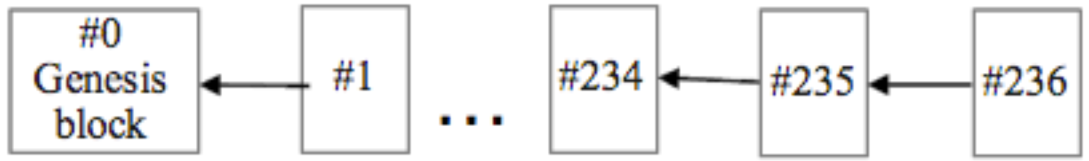
Industries are in interested in Bitcoin

- Banks
- Music
- Retail
- Supply Chain
- Manufacturing

- But they see **issues** with the Bitcoin protocol, so they are investing in **Blockchain**

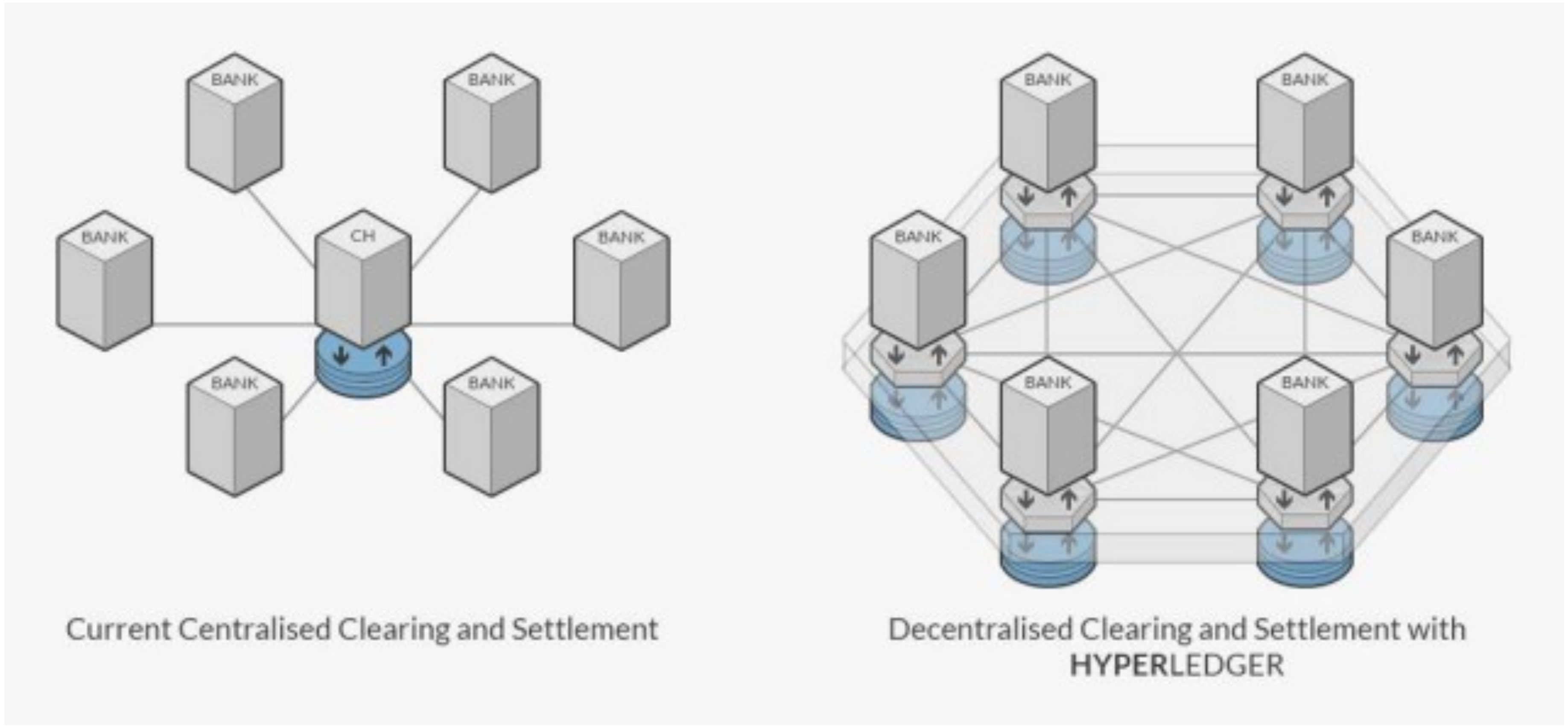
What is a Blockchain ?

- **A chain (sequence) of <u>blocks</u> of transactions**
  - Each block consists of a number of transactions



- **A Blockchain is just a Distributed Database with:**
  - Added security
  - Consensus
  - Data immutability
  - Smart Contracts (chaincode)
  - Authorization & Authentication
  - Record keeping

Traditional vs. Blockchain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Current Centralised Clearing and Settlement
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Decentralised Clearing and Settlement with
HYPERLEDGER

	Proof of Work (Bitcoin, Ethereum)	State machine replication (Hyperledger, Corda)
Membership	Permissionless	Permissioned
User IDs	Decentralized, Anonymous (Decentralized protection by PoW compute/hash power)	Centralized, all Nodes know all other Nodes (Centralized IDM protects against Sybil attacks)
Scalability (no. of Nodes)	Excellent, >100k Nodes	Verified up to few tens (or so) Nodes
Throughput	7 tx /sec upper bound (Bitcoin)	>10k tx /sec with existing implementations in software
Power efficiency	>1 GW (Bitcoin)	Good (commodity hardware)
Forks in blockchain	Possible (leads to double spending attacks)	Not possible
Consensus	No	Yes, with BFT protocols
Cryptocurrency	Yes	No
Anti-Fragile	Yes	???

Problem

- Important institutions are rushing to implement Blockchain.
- Most implementations are untested and will likely have bugs.
- Hypothesis: Removing key elements from anti-fragile system like Bitcoin will make it more fragile
- What can I use to test Distributed Systems like Blockchains?
  - Formal methods
  - **Failure injection**
  - Instrumentation

Related Work

- Random fault injection (Basiri et al., 2016)
- Byzantine fault injection (Martins et al., 2013)
- Lineage-driven fault injection (Alvaro et al., 2015)

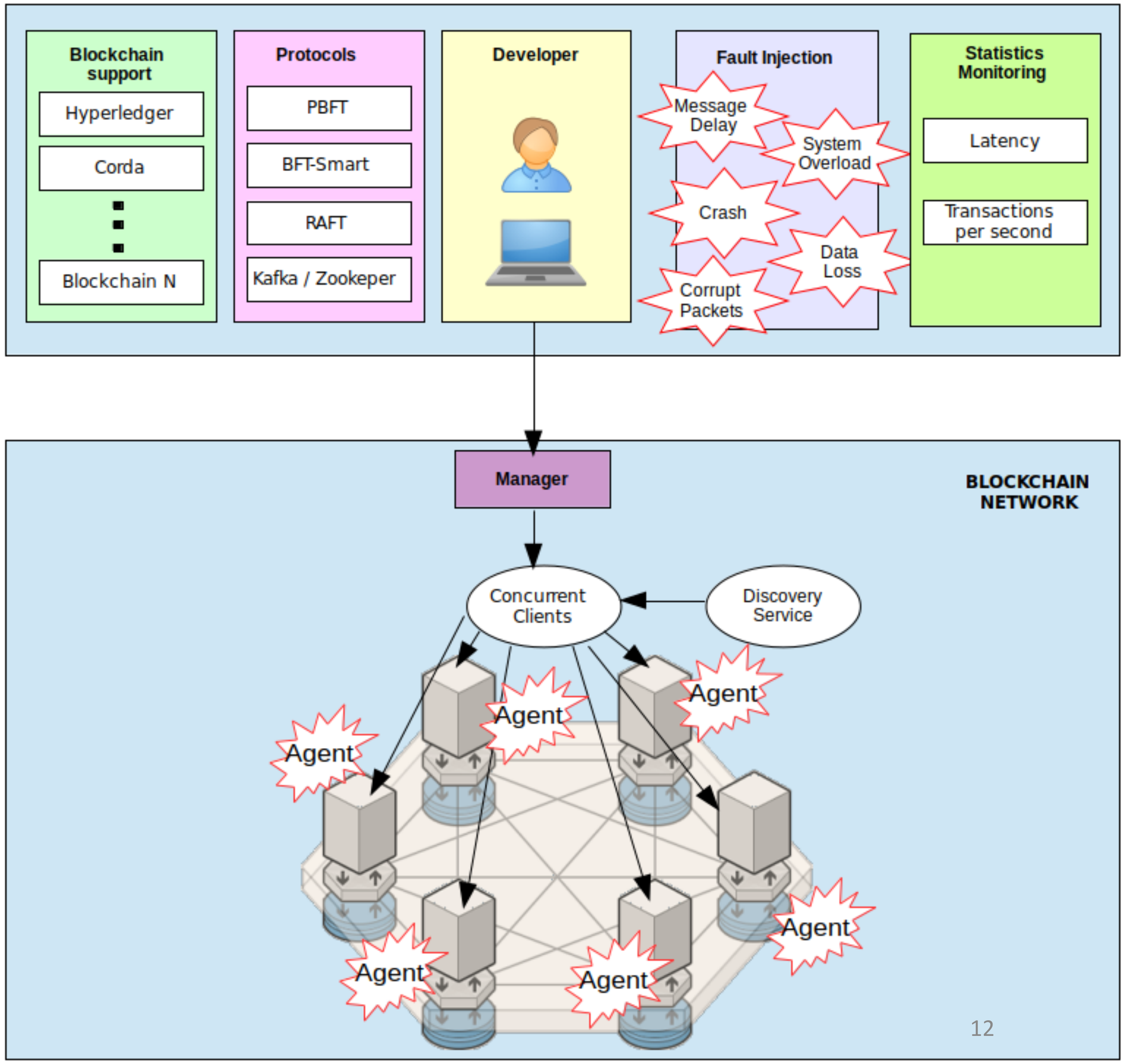
Motivation

- Blockchain technologies do not have any fault injection frameworks
- Blockchain tech hasn’t been formally verified
- Available fault-injection solutions do not cover Byzantine failures

My proposal

- Systematic Byzantine Failure Injection for Blockchain technology.
- Byzantine faults in consideration
  - Crash
  - Message Delay
  - Corrupt Packets
  - System Overloading
- Systematic and recoverable injection
  - Fault Type
  - Fault Parameters (fault duration, delay time, # clients)
- Blockchain and protocols in consideration
  - Hyperledger Fabric - PBFT & Kafka
  - Corda - BFT-Smart & RAFT

Architecture for Failure Injection



Challenge

- Create a general solution to inject Byzantine failures into Blockchains despite their differences:
    - Language
    - Architecture
    - Protocol

Next Steps

- Complete implementation of the Failure injector
- Perform large scale experiments with Hyperledger Fabric and Corda
- Introduce Smart failure injection like LDFI
- Start the base line for a Benchmark for permissioned Blockchain

END

- Problem: Recent interest in Blockchain technologies that remain untested. They lack good testing framework to verify and compare them. We don’t know if they are anti-fragile.

- Contribution: Systematic Byzantine Failure Injection for Blockchain technology. Aims to help benchmark Blockchain technologies and endow them with anti-fragility if used in production.

Example of Failure

- http POST http://injector:8080 cmd="WAIT" period=500 type="DELAY"

- http POST http://injector:8080 cmd="START" type="DELETE" path="/var/lib/hyperledger/data"

- http POST http://injector:8080 cmd="WAIT" type="DOWN" iface="eth0"