Integration of 5G and Blockchains

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BME, 5G Technológia Workshop

Budapest University of Technology and Economics
Fault Tolerant Systems Research Group
Prof. András Pataricza: IBM Faculty Award 2016, cooperation with Duke University

L. Gönczy: Summer internship at the Linux Foundation – mentor
On-chain Business Process Management

Course: “Blockchain technologies and applications” (coming next spring)

Linux Foundation Hyperledger fabric: performance characterization and modelling

Cooperation: Prof. Miklós Telek
Dept. of Networked Systems and Services (HIT)
A new approach to business transactions

Centralized

Blockchain-based ledger

Trusted 3rd party

Shared, distributed ledger
Blockchain, smart contracts

Properties

- **Ledger**: immutable Tx log; not (just) cryptocurrency!
- **Smart contracts**: programmed Tx logic over ledger state
- **Shared**: across participants
- **Distributed**: replication
- **Cryptographically authentic**: non-repudiable (secure identities), tokenization, signed Txs
- **Trust**: fault/attack tolerant group consensus
Basic transaction logic

Client request

Order, contract exec result, acceptance: consensus

All ledgers updated

Batch processing < Blockchain latency < hard real-time
An emerging sector

Enterprise, permissioned

Hyperledger
The Linux Foundation

Chain
Corda

Open/permissionless, cryptocurrency

Bitcoin
IOTA
Ethereum

Estimated Capital Markets Spending On Blockchain Technology, 2014 to 2019 (In $ millions)

Source: Aite Group

Harvard Business Review
The Promise of Blockchain Is a World Without Middlemen

by Vineet Gupta
March 14, 2017
M2M, D2D, automation, edge

Ubiquitous connectivity, IoT, identity, A&A

Software updates, calibration (latency!)

Core

5G

Transactions and events

System of record

BOL shipping records

Receipts (POD, ASN) Inspection documents

Installation documents

Serial. number mismatch
Asset condition
View asset life cycle

Guaranteed latency, reliability; edge, NFV

5G: Enabler VAS!
(5G Enablement)

Figure: [2] IBM: Adopting Blockchain for enterprise asset management (EAM)
Multiple ledgers

Figure: [2] IBM: Adopting Blockchain for enterprise asset management (EAM)
Blockchains in Cyber-Physical Systems

**Cyber-Physical Systems**

- Distributed sensing and control
- Cloud-attached, fog computing
- Systems of systems
- Critical services

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**5G use cases**

1. Mechanization, water power, steam power
2. Mass production, assembly line, electricity
3. Computer and automation
4. Cyber Physical Systems
Blockchain as the “control plane”

- Emergency poweroffs
- Maintenance notifications
- Overheat alarms
- Liveness, temperature aggregates
- Notification acceptance

Algorithm as a Service, Weather forecast, ...
DC monitoring, Monitoring as a Service, Tenant self-service page
MQ, PubSub/DDS, ...

“Local” peers
BCaaS
Consortium
Ethereum, Bitcoin, ...

DC sensors

DC network
## Attaching Blockchains to CPS

### Cloud environments

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<tr>
<th>Function group</th>
<th>Function</th>
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<td>Diagnostic image</td>
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Figure: [3] CSA: Examining the Use of BlockChain Technology for a Secure Internet of Things
In-field Blockchains for CPS (ICACON '17)

- **NW slicing**
- **Mobile edge**
- **mature NFV**

**Ubiquitous**

**Low power**

**D2D**

**Latency guarantees**

**5G?**

Blockchains for CPS-B

- **Cognitive services**
- **Big Data**
- **Orchestration & control**

**“Cyber” Blockchains**

**5G?**

**5G!**

**RT Blockchains?**

**Edge & gateway**

**Distributed Ledger**

**INVOKE SMART CONTRACTS:**
- Readings
- Actuation decisions
- State transitions

**RECEIVE:**
- Commands
- Behavior definitions

**CARRIED BY**
- Clients or peers

**Signals, objects, situations**

**Actions**
- Sensor
- Field device
- Actuator

**Blockchain for CPS-B**
References

