Integration of 5G and Blockchains

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BME, 5G Technológia Workshop

Budapest University of Technology and Economics
Fault Tolerant Systems Research Group

Blockchain@BME MIT

- **Prof. András Pataricza: IBM Faculty Award 2016,** cooperation with Duke University

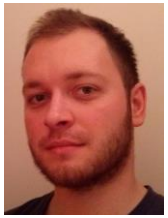

- **L. Gönczy: Summer internship at the Linux Foundation – mentor**

  On-chain Business Process Management

- **Course: "Blockchain technologies and applications"** (coming next spring)

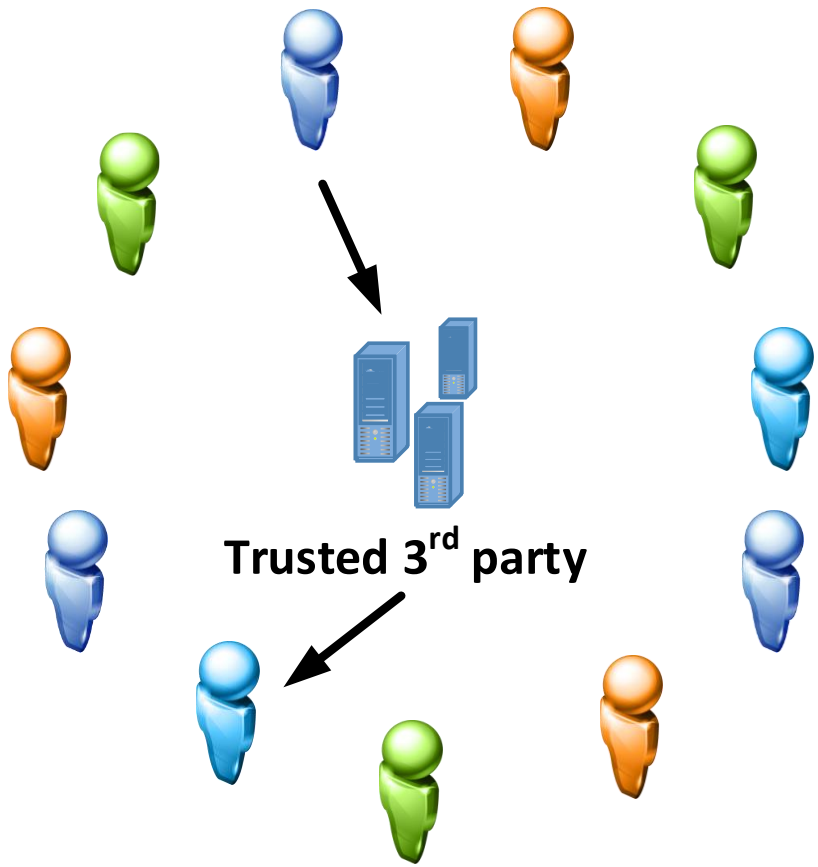

- **Linux Foundation Hyperledger fabric**: performance characterization and modelling
- **Cooperation: Prof. Miklós Telek**

  Dept. of Networked Systems and Services (HIT)

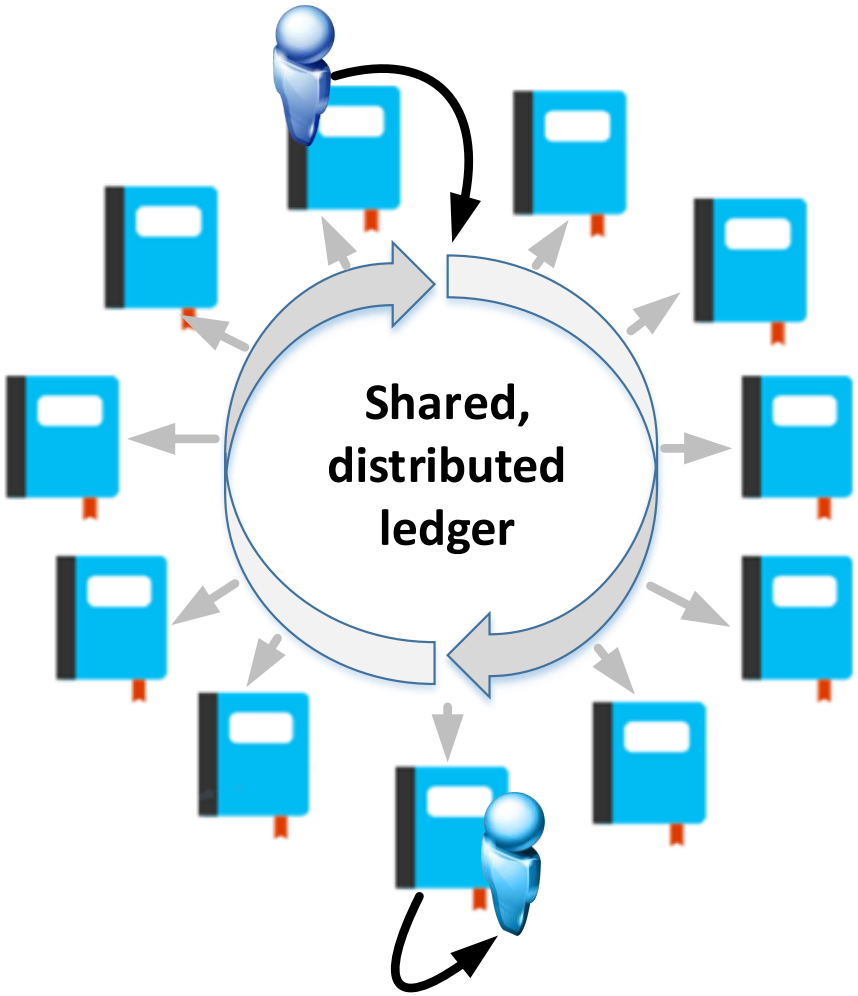



A new approach to business transactions

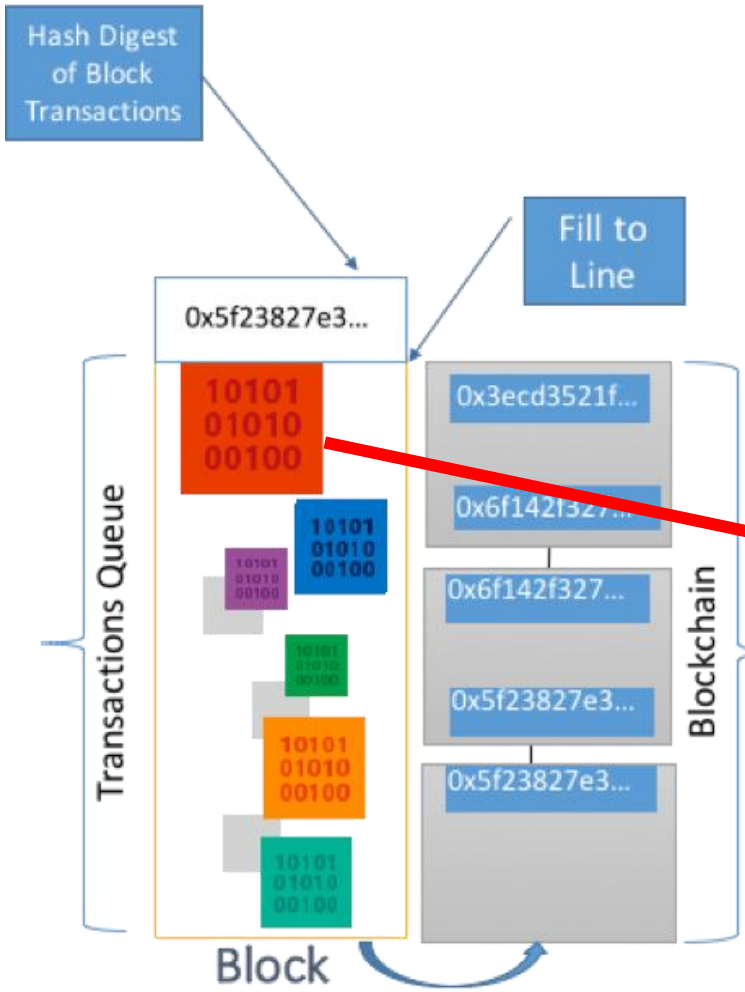
Centralized

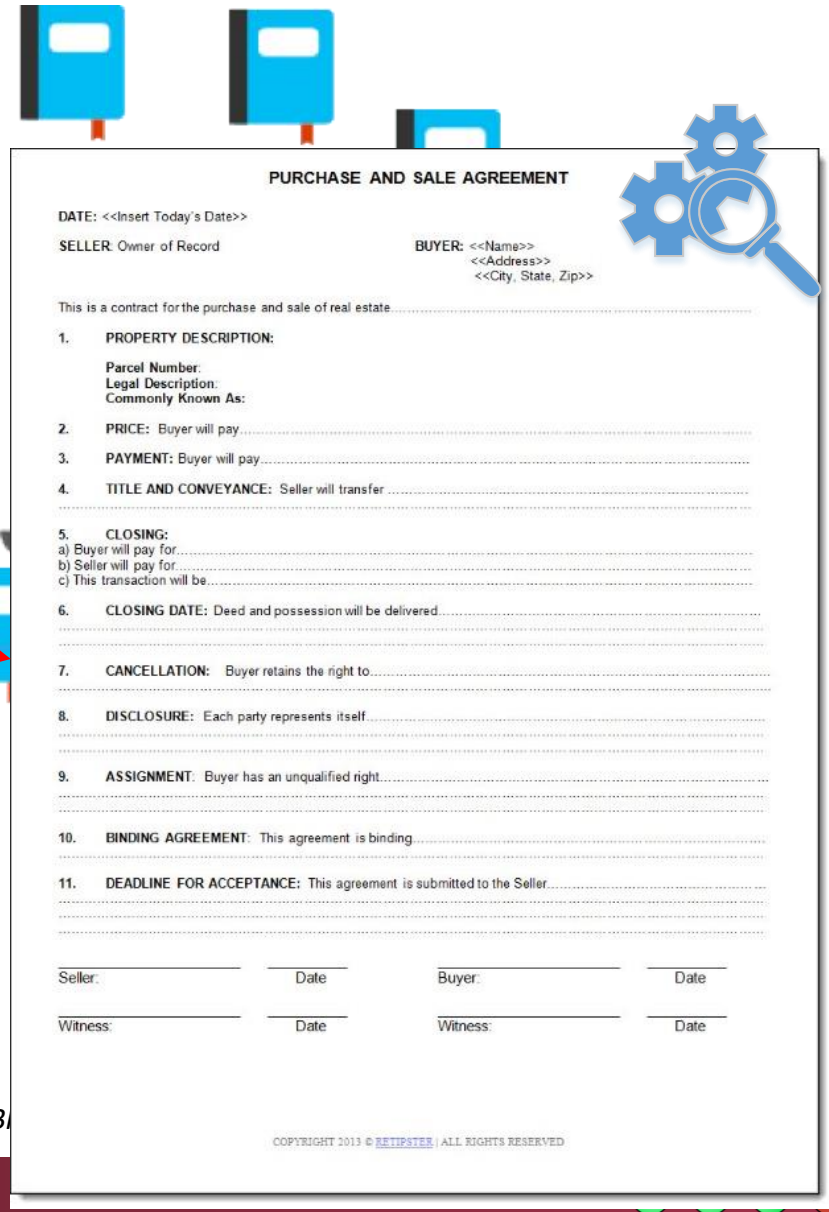


Blockchain-based ledger



Blockchain, smart contracts





PURCHASE AND SALE AGREEMENT

DATE: <<Insert Today's Date>>

SELLER: Owner of Record

BUYER: <<Name>>
<<Address>>
<<City, State, Zip>>

This is a contract for the purchase and sale of real estate.....

1. PROPERTY DESCRIPTION:

Parcel Number:
Legal Description:
Commonly Known As:

2. PRICE: Buyer will pay.....

3. PAYMENT: Buyer will pay.....

4. TITLE AND CONVEYANCE: Seller will transfer.....

5. CLOSING:
a) Buyer will pay for.....
b) Seller will pay for.....
c) This transaction will be.....

6. CLOSING DATE: Deed and possession will be delivered.....

7. CANCELLATION: Buyer retains the right to.....

8. DISCLOSURE: Each party represents itself.....

9. ASSIGNMENT: Buyer has an unqualified right.....

10. BINDING AGREEMENT: This agreement is binding.....

11. DEADLINE FOR ACCEPTANCE: This agreement is submitted to the Seller.....

Seller: Date Buyer: Date

Witness: Date Witness: Date

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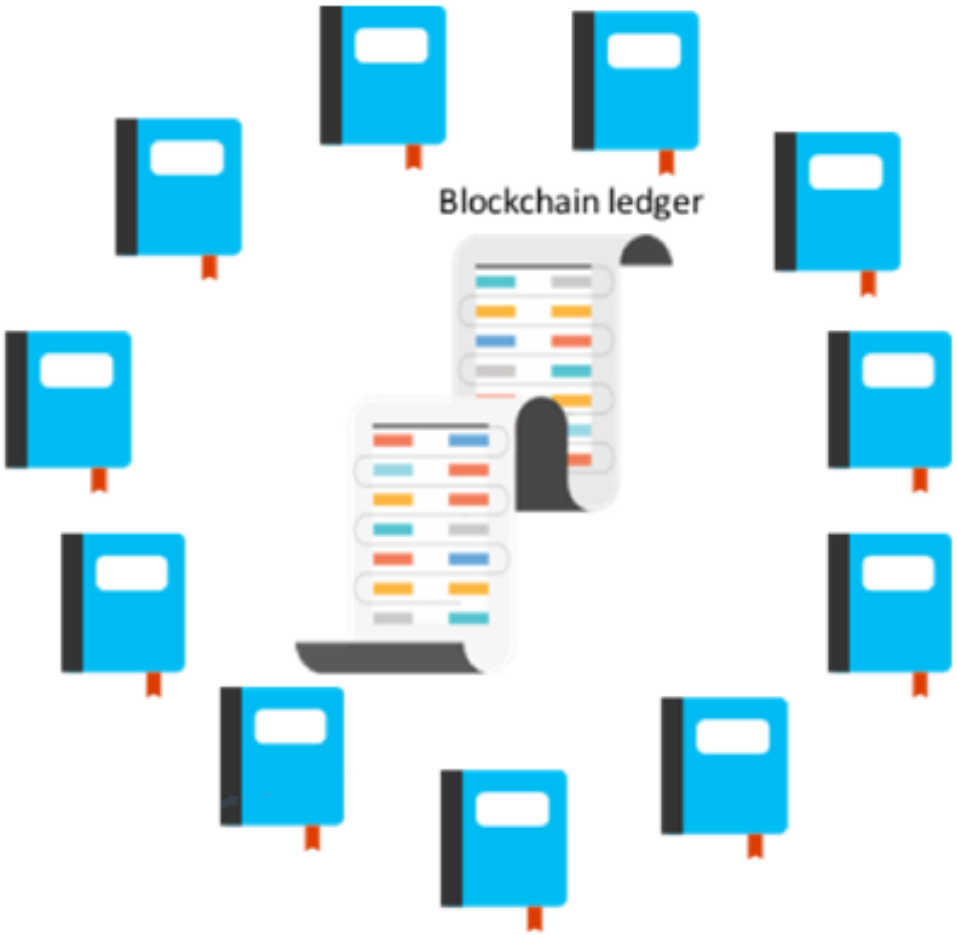
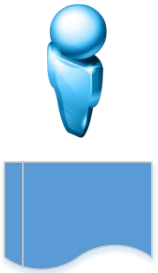
[1] Source: Marley Gray, Principle Architect PM – Microsoft: Introducing Project Bl

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

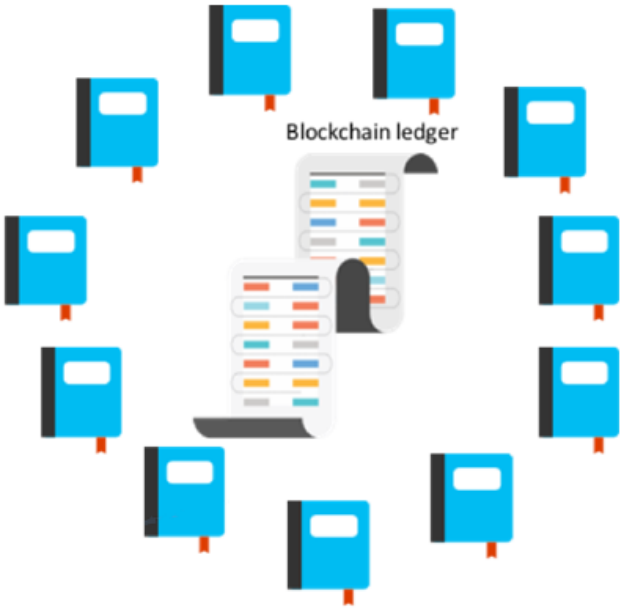


Basic transaction logic



Client **request**

Order, contract exec result, acceptance: **consensus**



All **ledgers updated**

Batch processing < Blockchain latency < hard real-time

An emerging sector

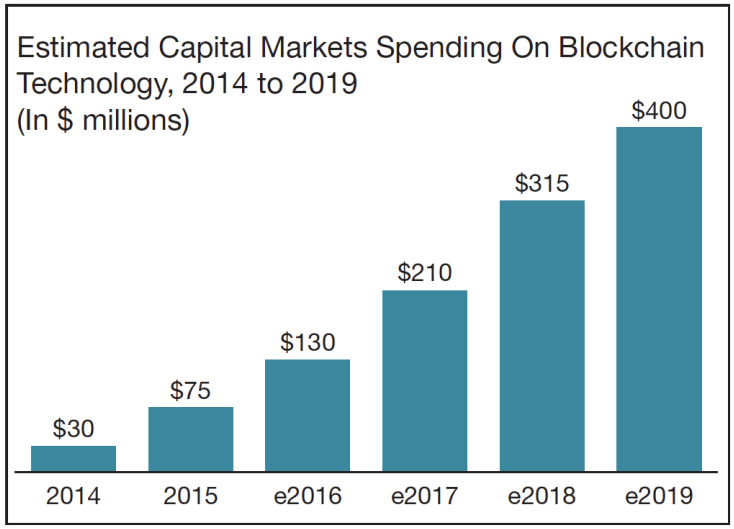
Enterprise, permissioned

HYPERLEDGER

THE LINUX FOUNDATION

Chain

corda



Source: Aite Group

e: estimate

Open/permissionless, cryptocurrency

bitcoin

IOTA

ethereum


Harvard Business Review

INFORMATION & TECHNOLOGY

The Promise of Blockchain Is a World Without Middlemen

by Vinay Gupta

MARCH 08, 2017

M2M, D2D, automation, edge

Ubiquitous connectivity, IoT, identity, A&A

Software updates, calibration (latency!)

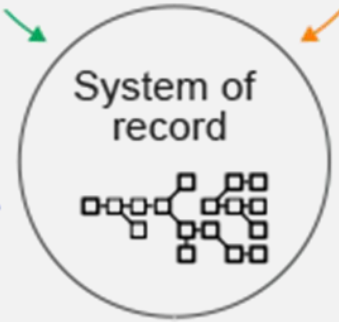
Core 5G

BOL shipping records

Receipts (POD, ASN) Inspection documents

Plant order serialized asset

Installation documents



Guaranteed latency, reliability; edge, NFV

5G: Enabler VAS! (5G Enablement)

Serial. number mismatch
Asset condition
View asset life cycle

VAS

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

Multiple ledgers

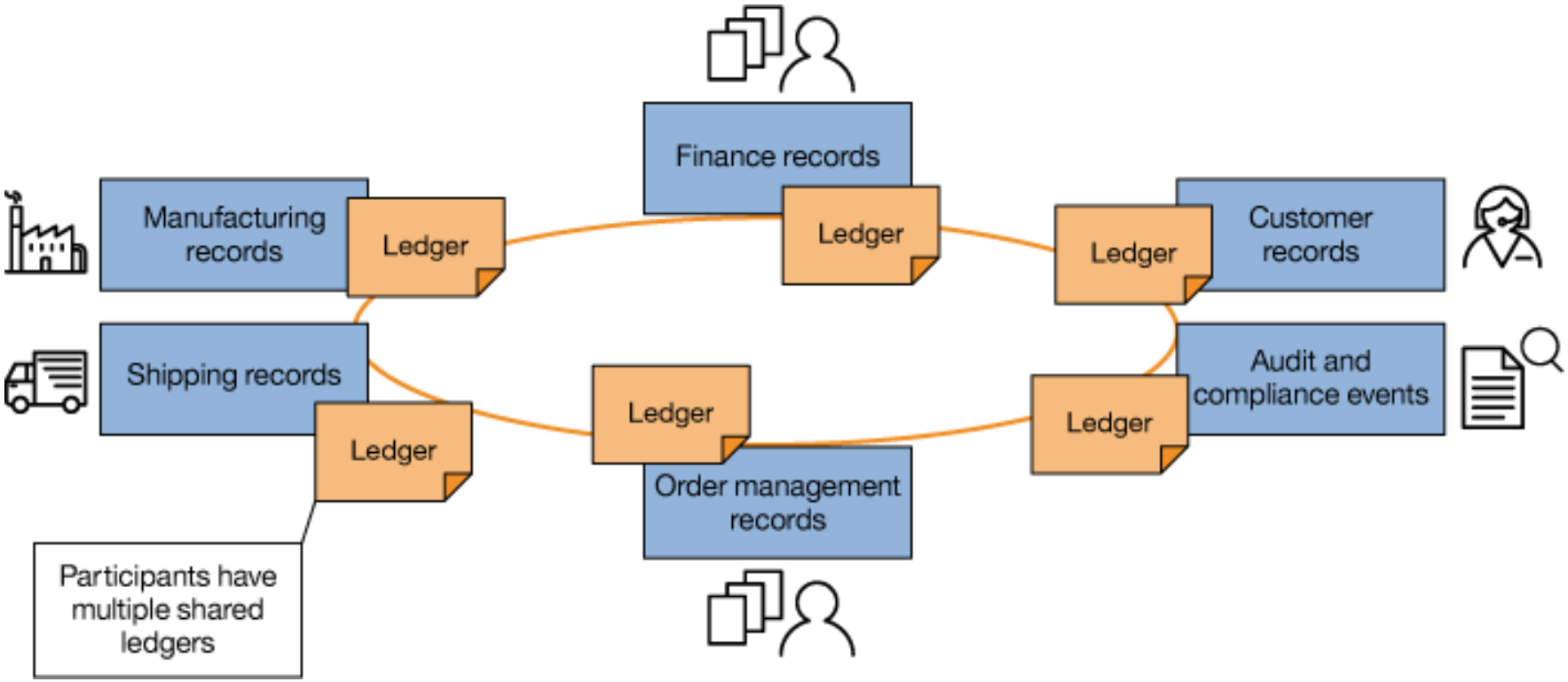
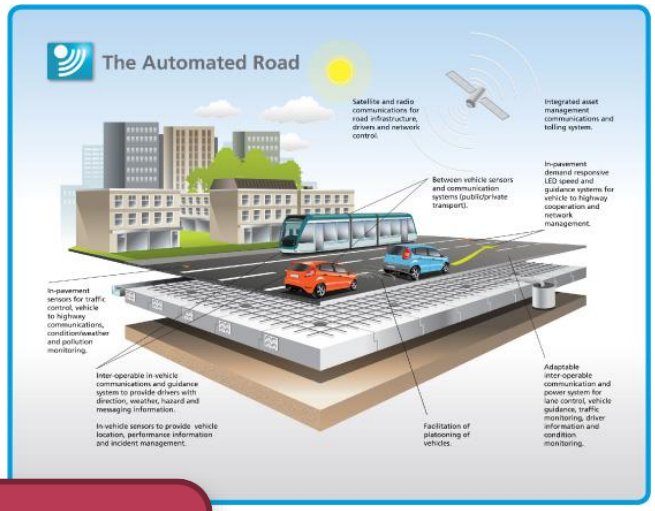


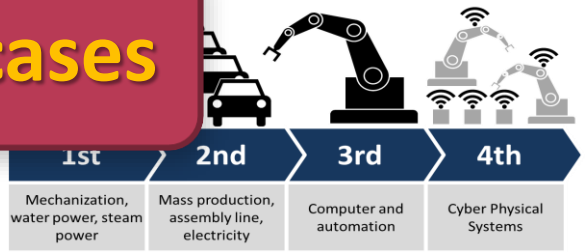
Figure: [2] IBM: Adopting Blockchain for enterprise asset management (EAM)

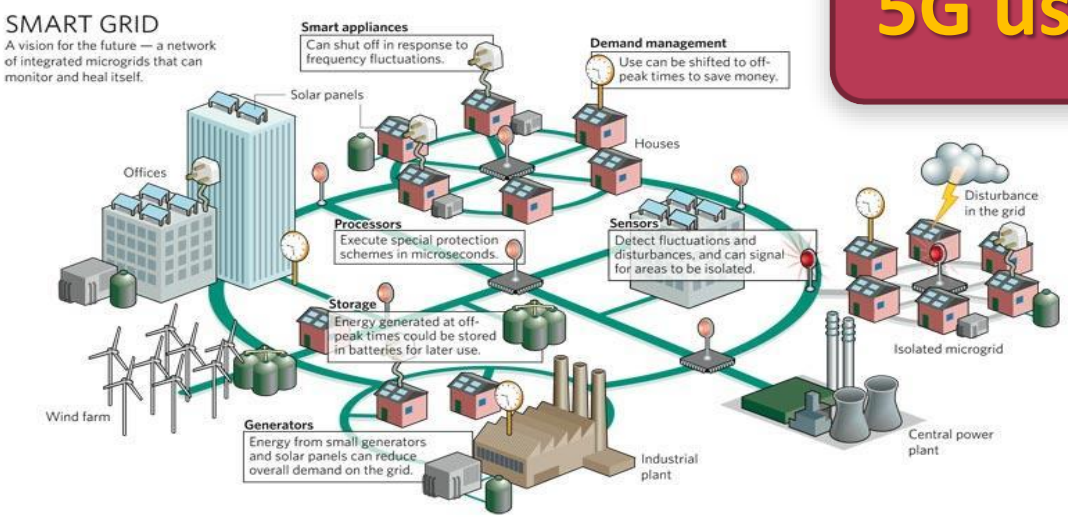
Blockchains in Cyber-Physical Systems

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

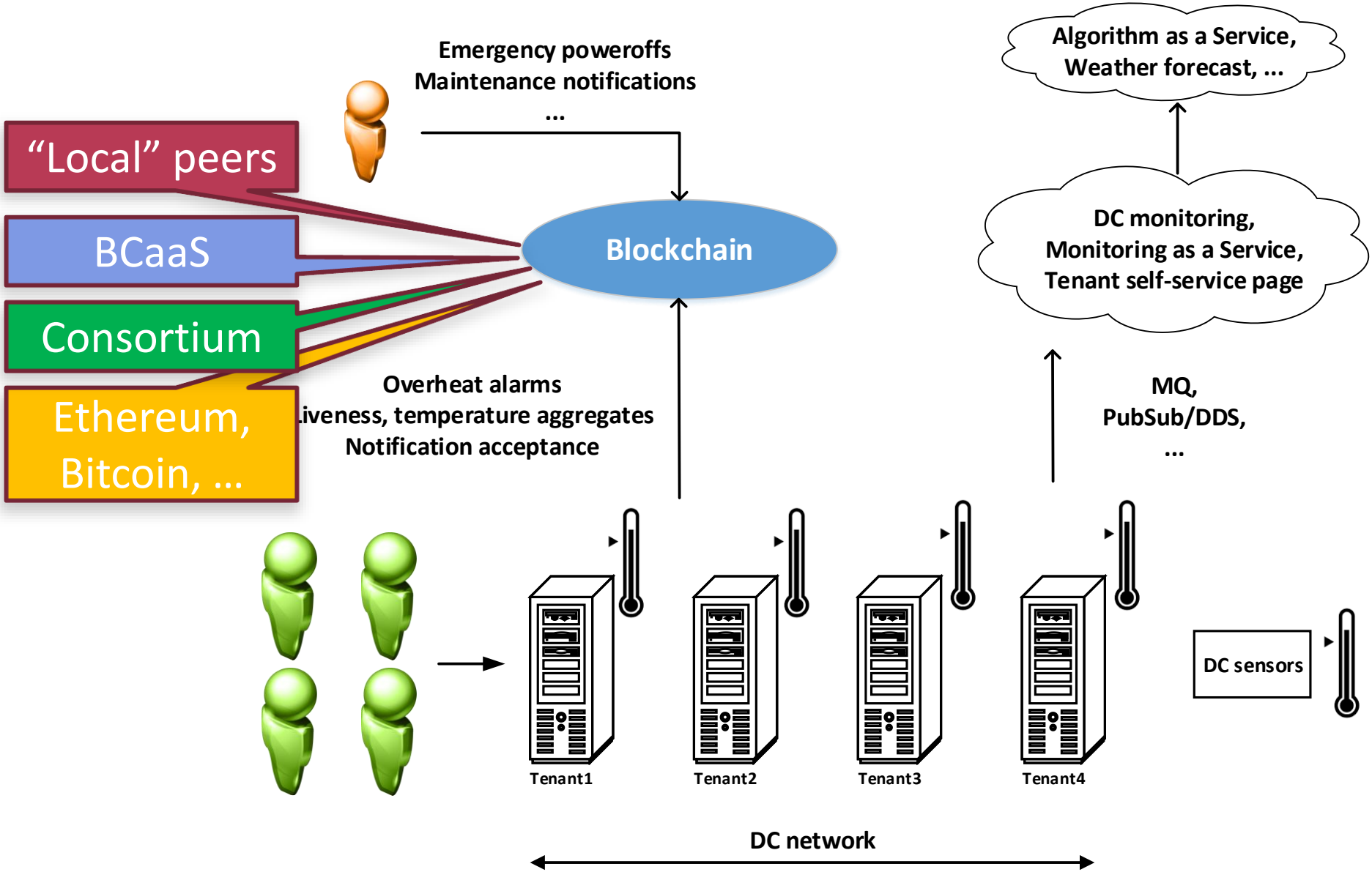


5G use cases



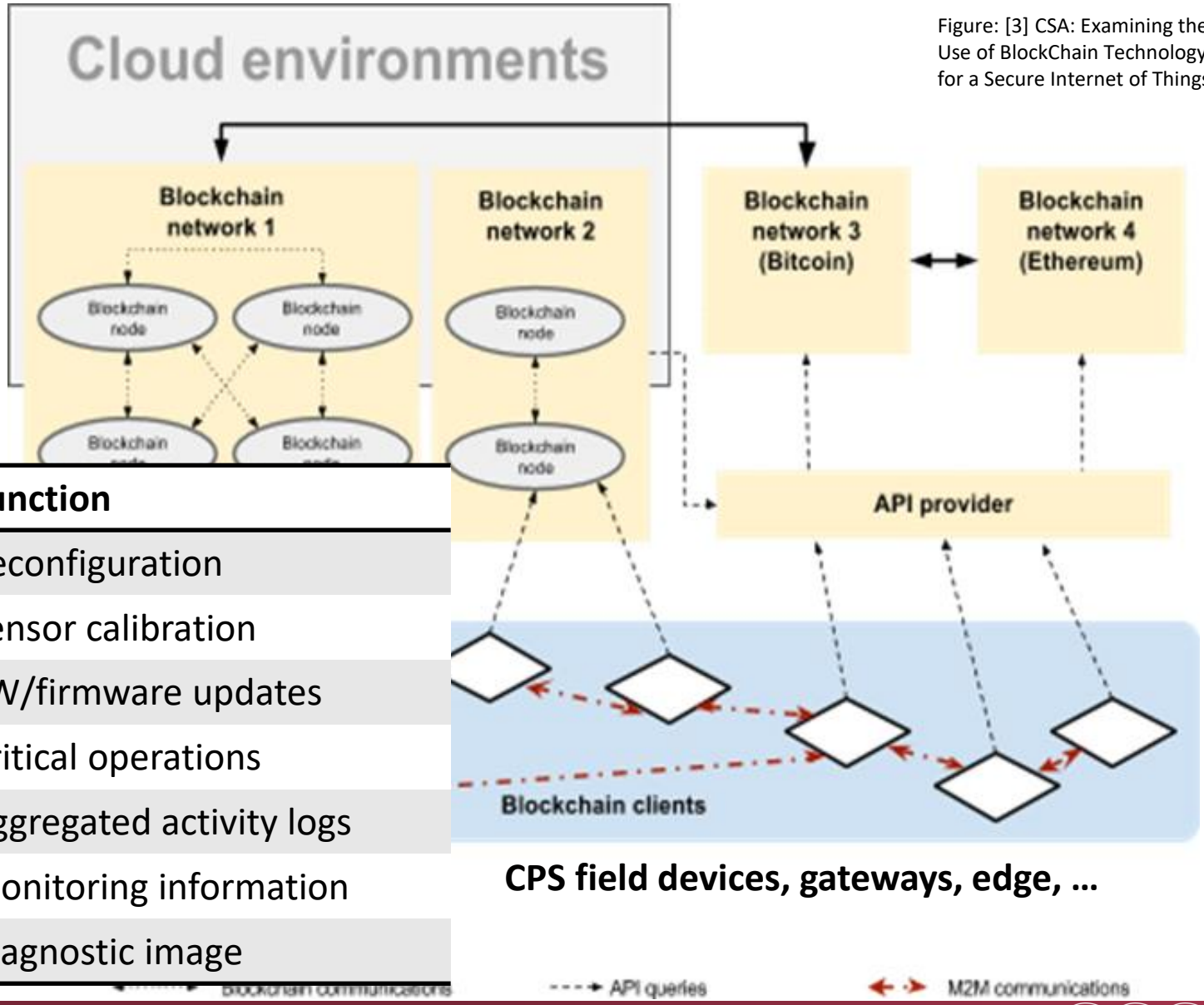


Blockchain as the "control plane"



Attaching Blockchains to CPS

Figure: [3] CSA: Examining the Use of BlockChain Technology for a Secure Internet of Things



Function group	Function
Configuration management	Reconfiguration
	Sensor calibration
	SW/firmware updates
Process execution	Critical operations
	Aggregated activity logs
Diagnosis	Monitoring information
	Diagnostic image

In-field Blockchains for CPS (ICACON '17)

NW slicing

Mobile edge

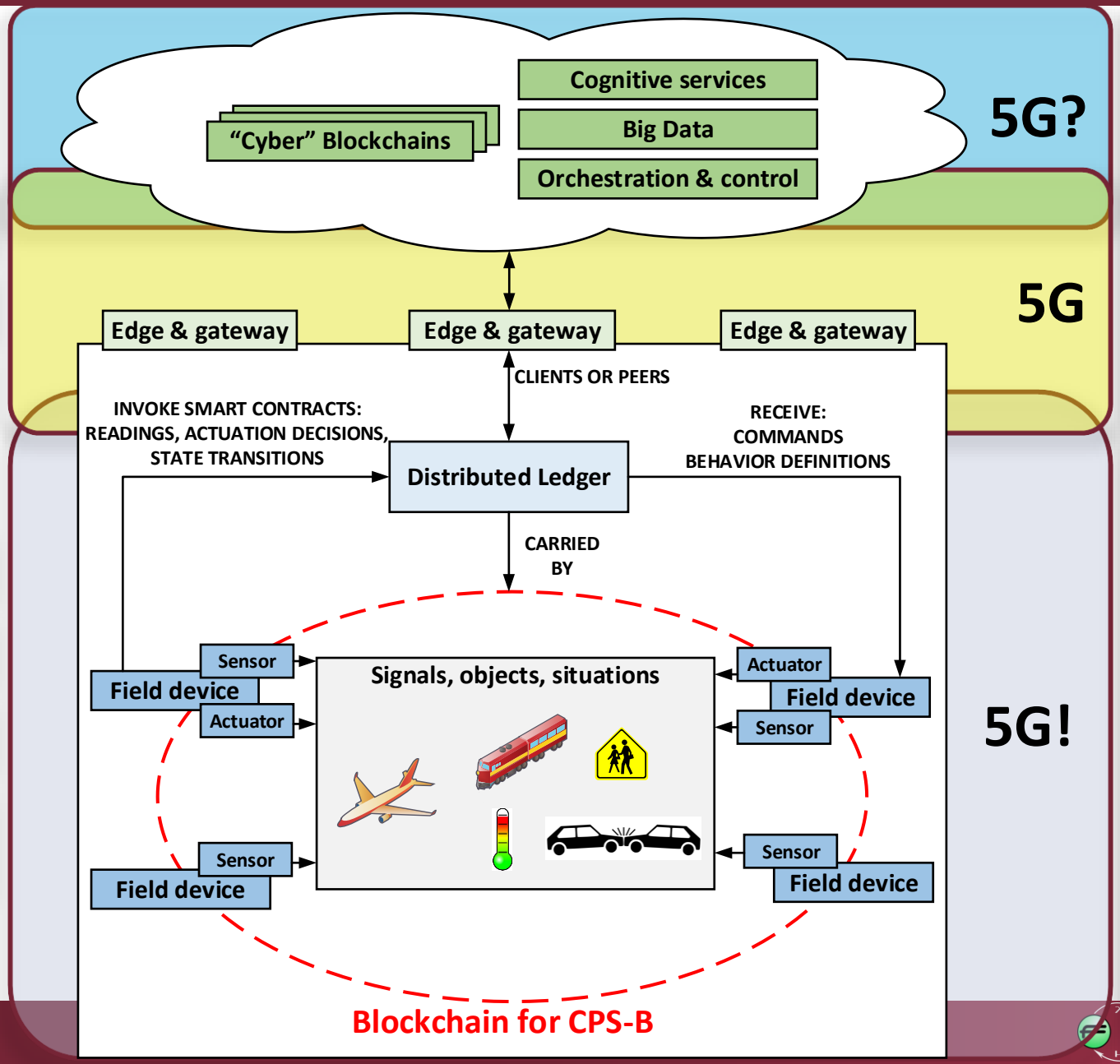
mature NFV

Ubiquitous

Low power

D2D

Latency guarantees



RT Blockchains?

References

1. https://github.com/Azure/azure-blockchain-projects/blob/master/bletchley/bletchley-whitepaper.md
2. https://www.ibm.com/developerworks/cloud/library/cl-adopting-blockchain-for-enterprise-asset-management-eam/index.html
3. https://cloudsecurityalliance.org/document/examining-the-use-of-blockchain-technology-for-a-secure-iot/