Blockchain for Industry 4.0

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Cyber-Physical Systems and Cloud for Smart Industry

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Problem statement

In commerce, the Supply Chain Management (SCM) consists on the management of the distribution of goods between different actors

- Producers, wholesale distributors, dispenser, repackager, etc…

It is a network of businesses and relationships [3], therefore a good cooperation protocol is important to optimize the supply chain and eventually reduce the risk of frauds [1]

It is a trustless network, i.e. the trust of the entire network does not rely on a single element [4]

Use cases

(Drug) Drug Supply Chain, by the Food and Drugs Administration (FDA) in USA [2]

(Precast) Precast Components Supply Chain, by Z. Wang Et al. [5]

(Soybean) Soybean Supply Chain, by K. Salah Et al. [6]

(Fashion) Fashion and Apparel Industry, by OriginTrail [7]

Requirements of SCM

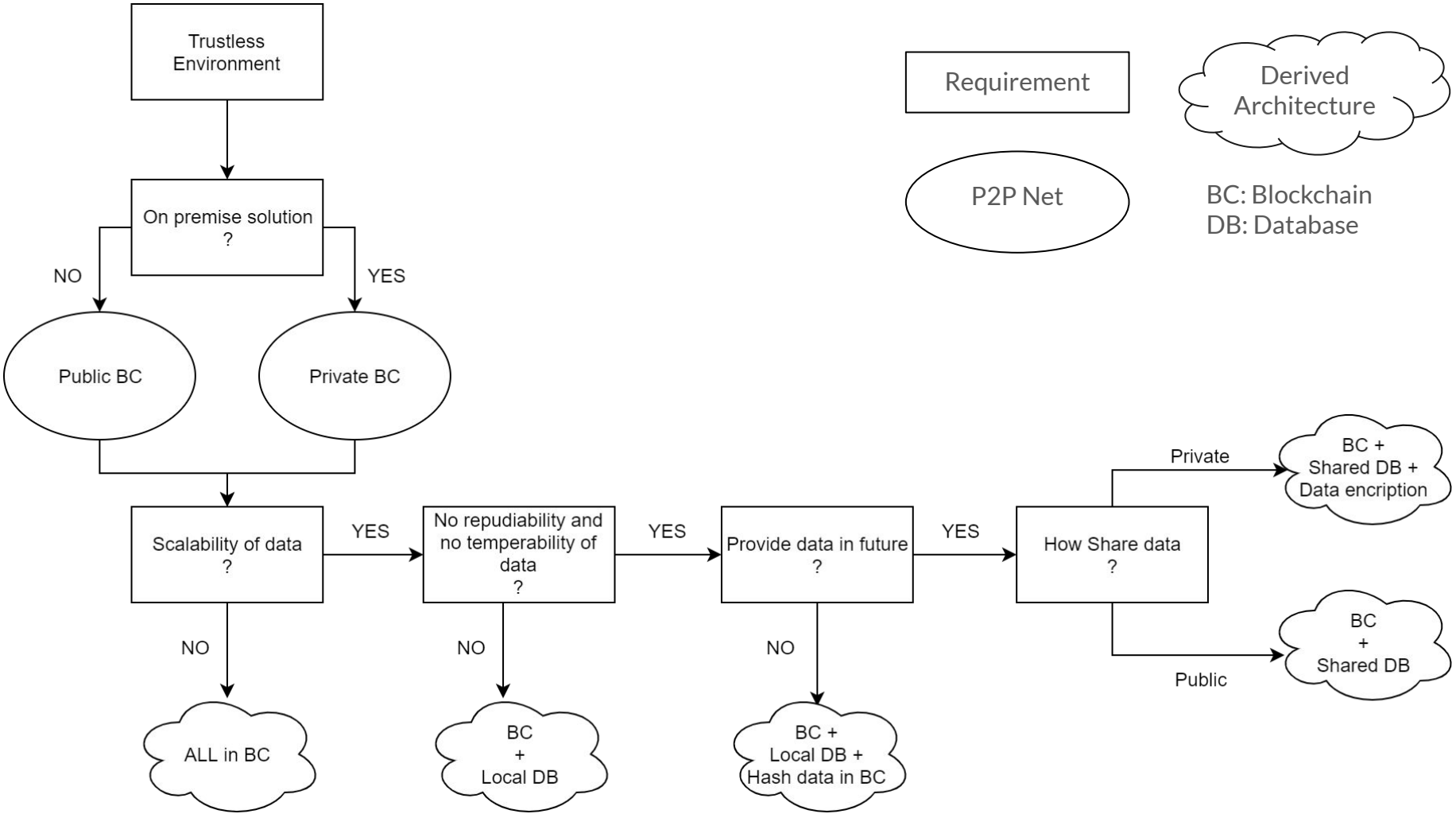
(RQ-Audit) Data verification and auditability (Drug) (Soybean) (Fashion)

(RQ-Exch) Interoperable data exchange (Drug) (Precast) (Soybean) (Fashion)

(RQ-Conf) Data confidentiality (at least partial) (Drug) (Precast)

(RQ-Premise) Not rely on third party providers [8]

(RQ-Scalab) Data scalability [4]


Trustless Environment
On premise solution ?
NO
YES
Public BC
Private BC
Scalability of data ?
YES
No repudiability and no temperability of data ?
YES
Provide data in future ?
YES
How Share data ?
Private
BC + Shared DB + Data encription
Public
BC + Shared DB
NO
ALL in BC
NO
BC + Local DB
NO
BC + Local DB + Hash data in BC
Requirement
Derived Architecture
P2P Net
BC: Blockchain
DB: Database

Solutions in literature - 1

Z. Wang et al [5] propose a solution involving only a private blockchain satisfying RQ-Conf and RQ-Premise, and RQ-Scalab depends on the performance of the blockchain

- This approach is suitable for the Precast use case

Mazzei et al [4] propose a sole public blockchain solution, satisfying RQ-Exch and RQ-Audit

- This approach is suitable for the Fashion and Soybean use cases, unless they have particular needs for RQ-Scalab

Solutions in literature - 2

K. Salah et al [6] propose a solution involving a public blockchain and a distributed data sharing platform. This satisfies RQ-Exch and RQ-Audit, and partially RQ-Premise and RQ-Scalab for the data storage

- This approach is suitable for the Soybean and Fashion use cases

The aforementioned approaches cannot satisfy all the listed requirements. A mixture can be used as a trade-off between pros and cons of each solution [9]

- Such solutions can be beneficial for most of the use cases, especially the Drug use case which has more requirements than the others, but are hard to build

Available technology

- Blockchain
  - Ethereum
  - EOS
  - Hyperledger Fabric
- Storage
  - Relational databases
  - Apache Cassandra
  - IPFS
- Mix
  - Filecoin (not released yet)

Practical Example - Soybean Use Case

Requirements:

- On premise solution (only actors involved)
- Data scalability
- No repudiability and no temperability of data
- Data available in the future
- Private Data

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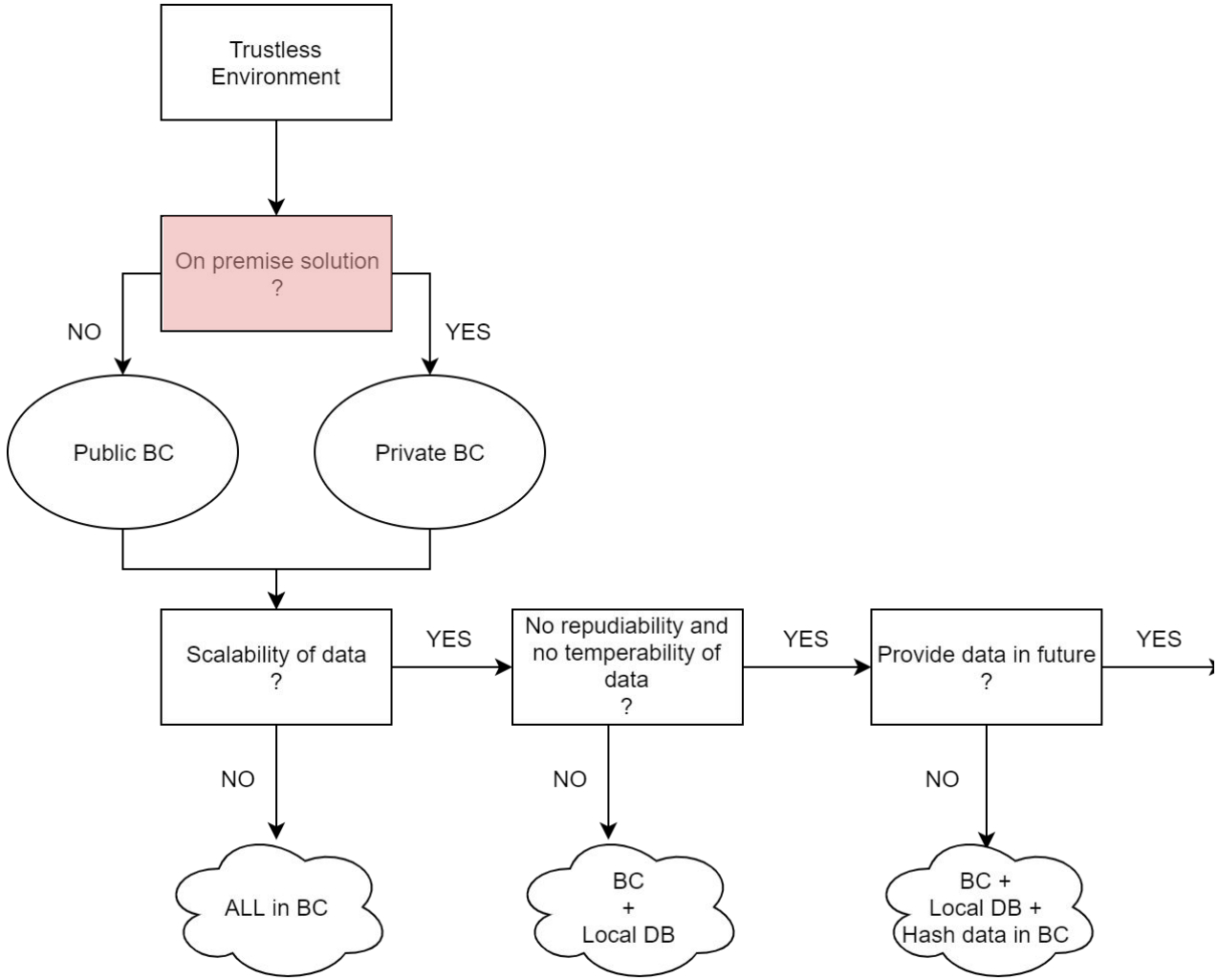

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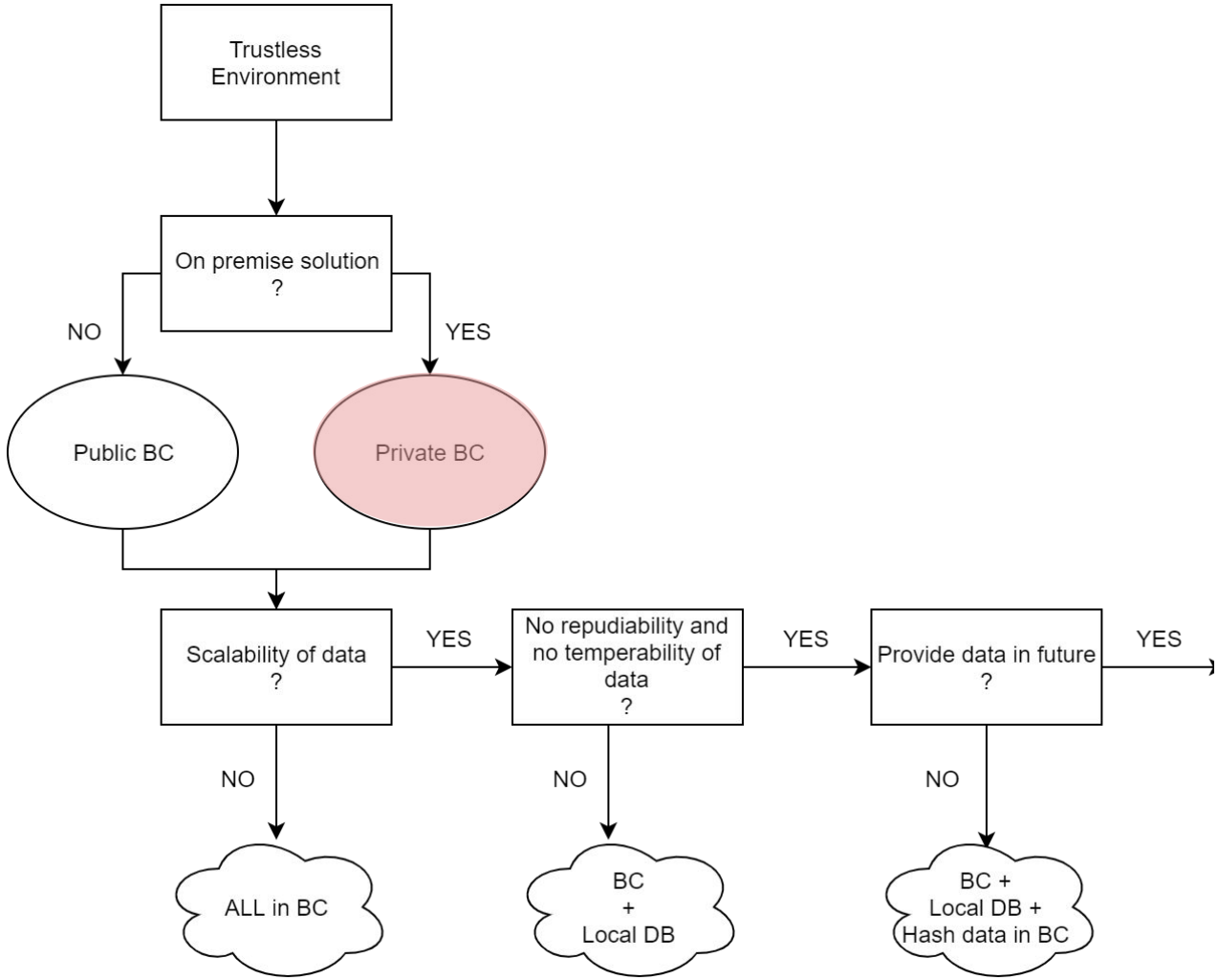

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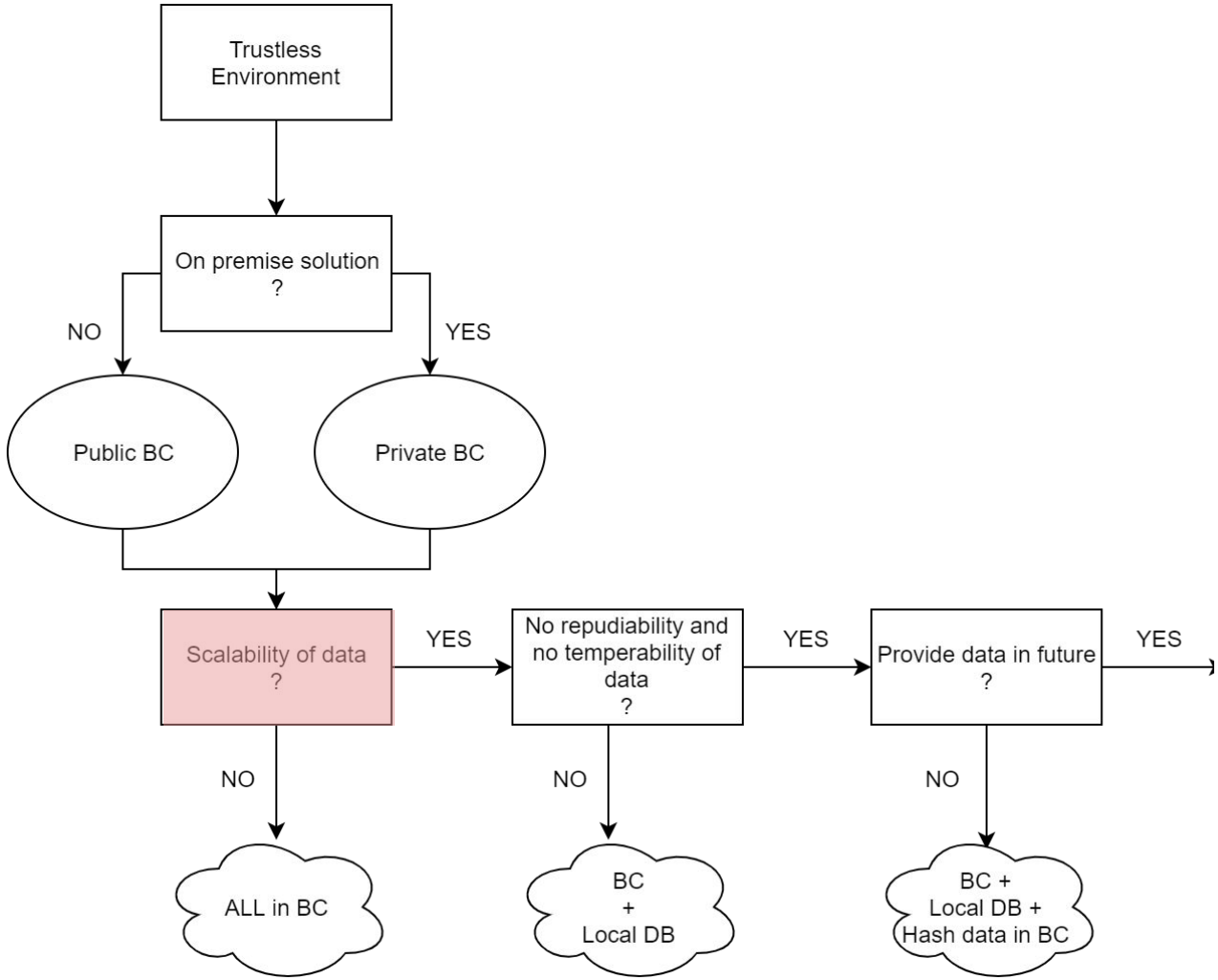

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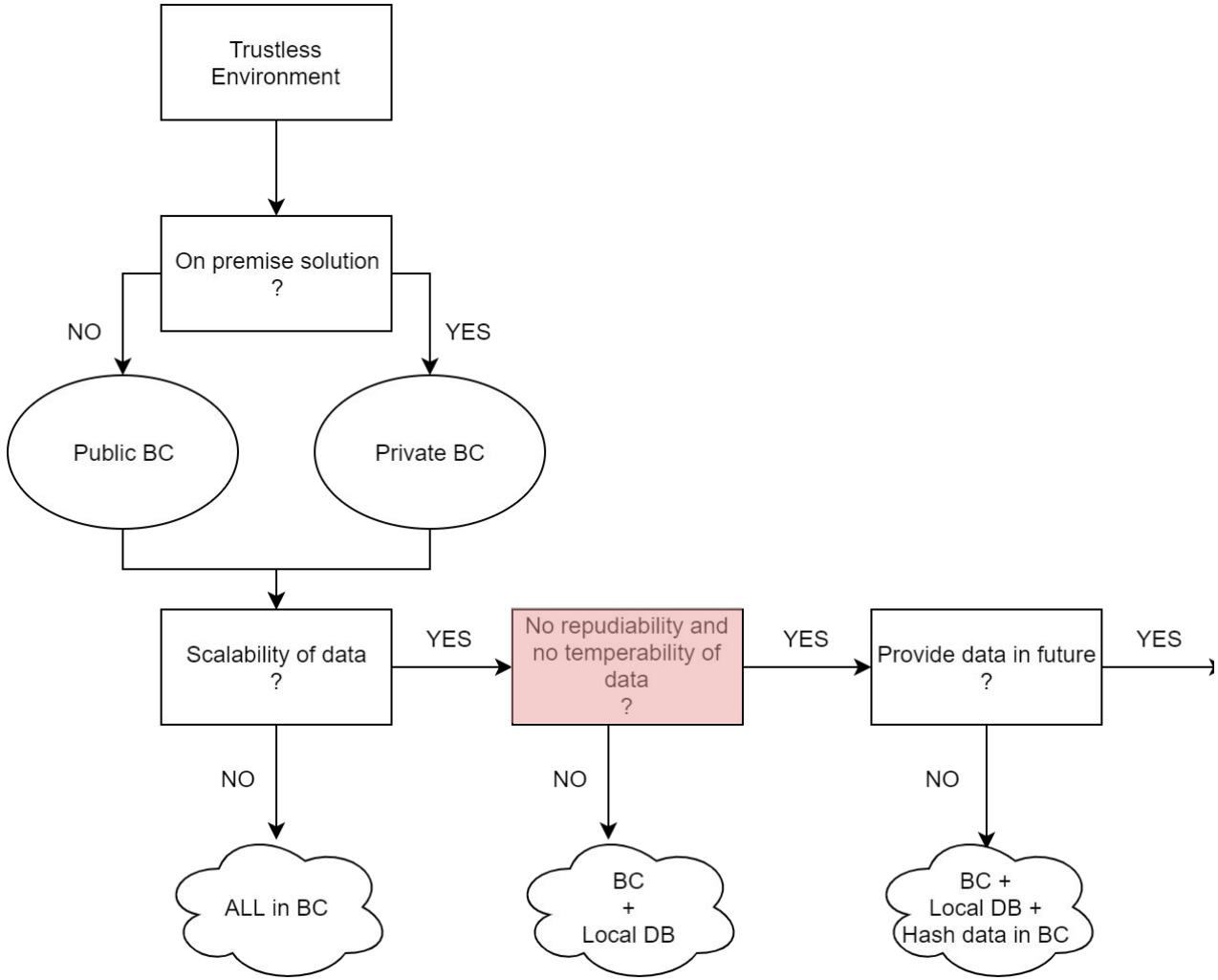

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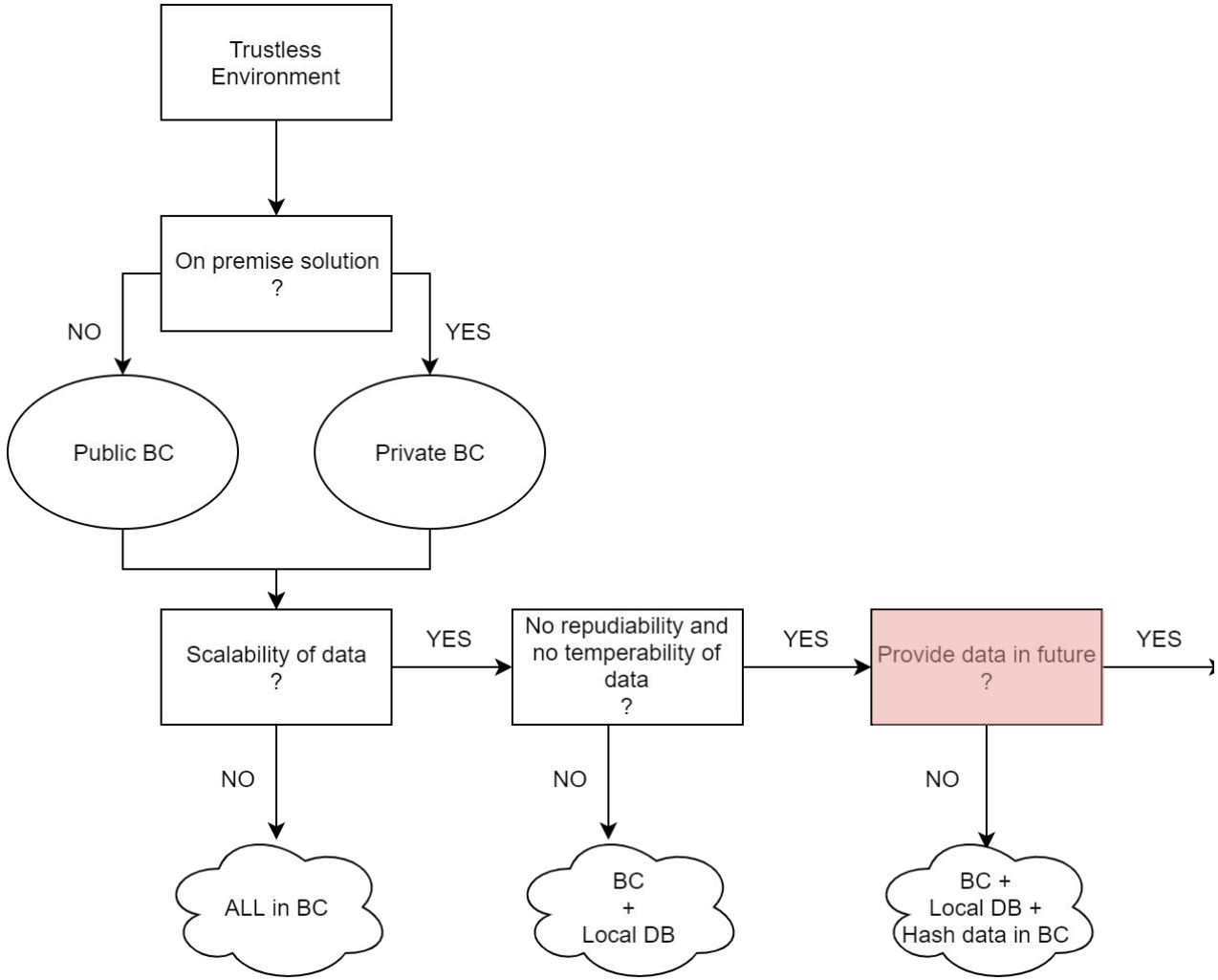

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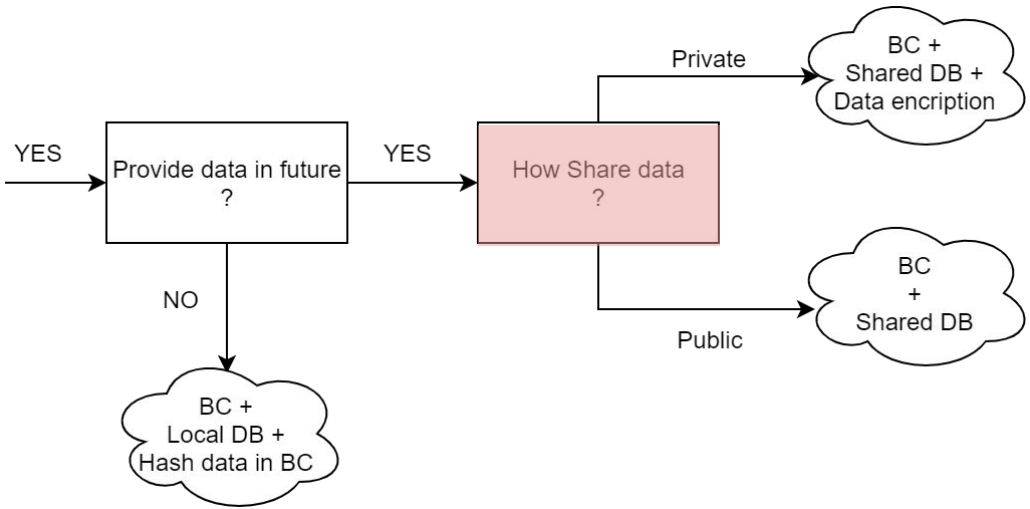

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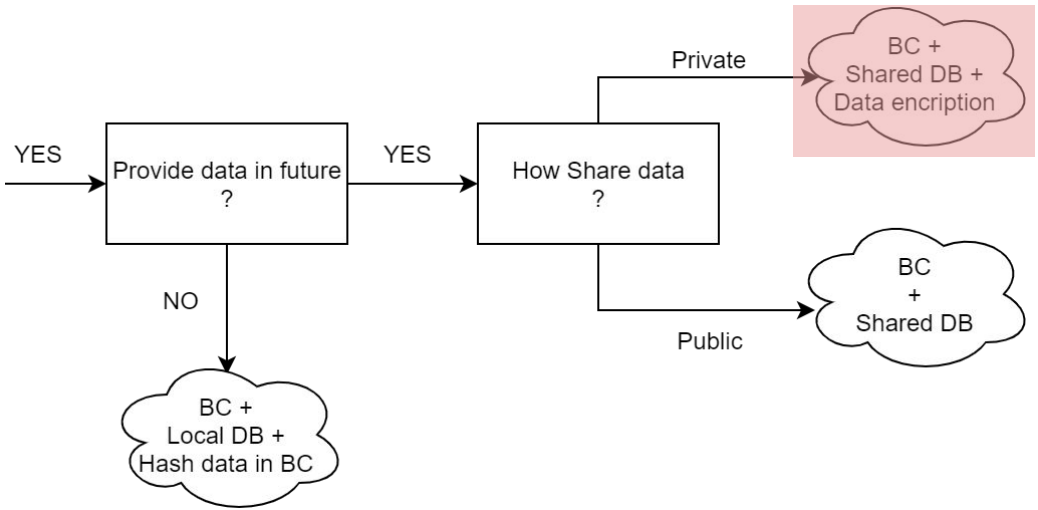

Exemplary architecture for Soybean Use Case

- Private Blockchain -> Hyperledger Fabric
- Shared DB -> Apache Cassandra
- Data Encryption -> Standard encryption methods and hashes in the BC

References

[1] Blockchains for Supply Chain Management: Architectural Elements and Challenges Towards a Global Scale Deployment, A. Litke et al

[2] Drug Supply Chain Security Act (DSCSA)

[3] Issues in Supply Chain Management, D. M. Lambert et al

[4] A Blockchain Tokenizer for Industrial IOT trustless applications, D. Mazzei et al

[5] Blockchain-based framework for improving supply chain traceability and information sharing in precast construction, Z. Wang et al

References

[6] Blockchain-Based Soybean Traceability in Agricultural Supply Chain, K. Salah et al

[7] Fashion and Apparel Industry, OriginTrail post on Medium (link)

[8] Cloud Computing in Support of Supply Chain Information System Infrastructure: Understanding When to go to the Cloud, Y. Wu et al

[9] Interledger Approaches, V. Siris et al

THANKS!

Questions?