Cooperation enhanced by decentralization in the building industry:

Blockchain enabled asset management in the X-Decks case

P5 – Benjamin Weihs

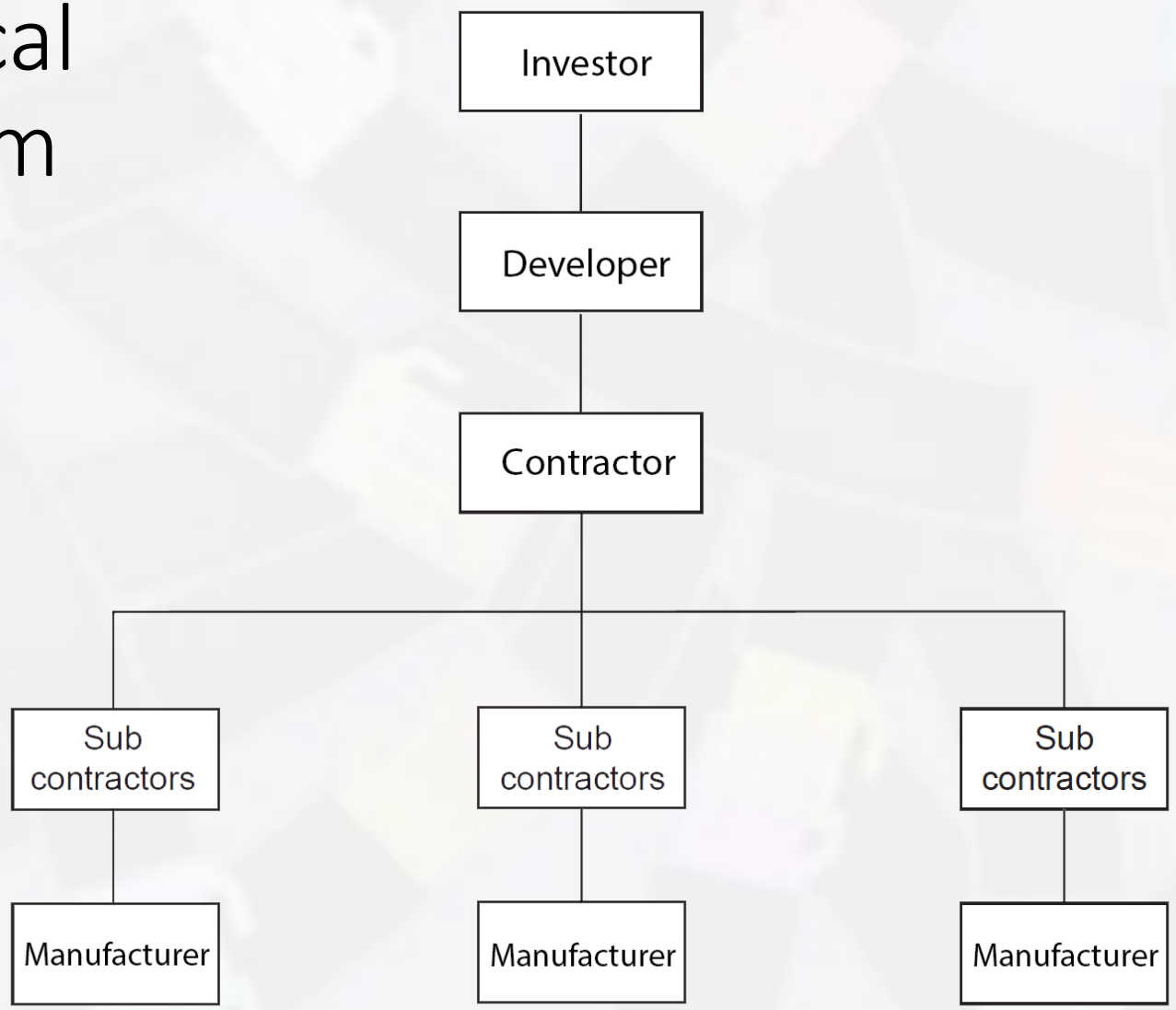
TU Delft

Royal HaskoningDHV

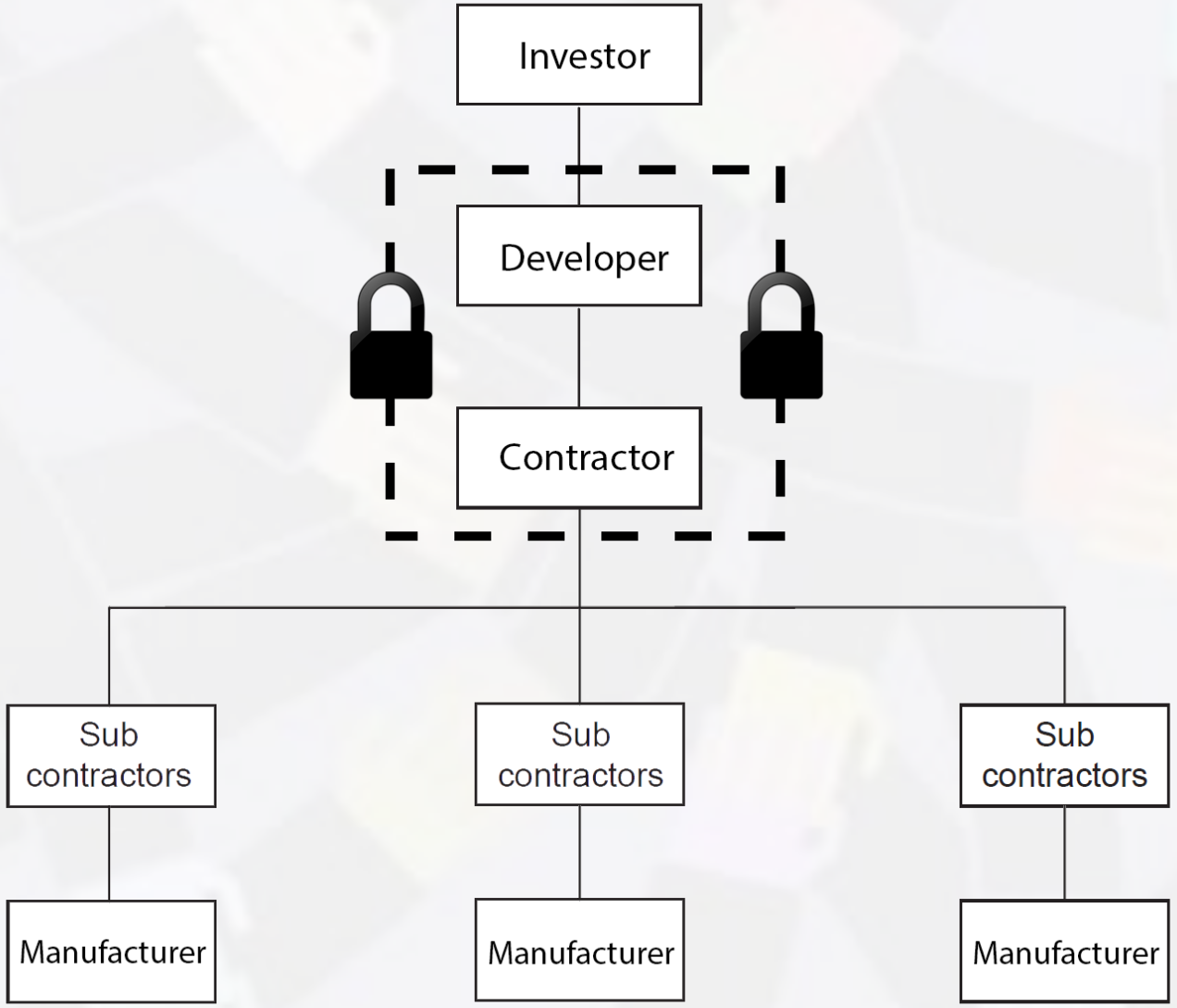
Overview

1. Research framework
2. Problem statement
3. Literature review
4. Scenarios / KPIs
5. Interviews
6. Blockchain enabled asset management framework + Prototype
7. Further research & Conclusion

Hierarchical organigram



Frictions


Investor
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Contractor
Sub contractors
Sub contractors
Sub contractors
Manufacturer
Manufacturer
Manufacturer

Frictions

- Construction execution varies in duration, which creates uncertainty. Independent **decision makers at the resource-base level tend to act in their own interests rather than in the interests of the collective**.

- **Exposing information** about costs and revenues to external stakeholders**, can easily turn into competitive disadvantages**

- Suppliers have information that is critical for effective client decision- making, but are **not motivated to fully share that information** (Winch, 2010)

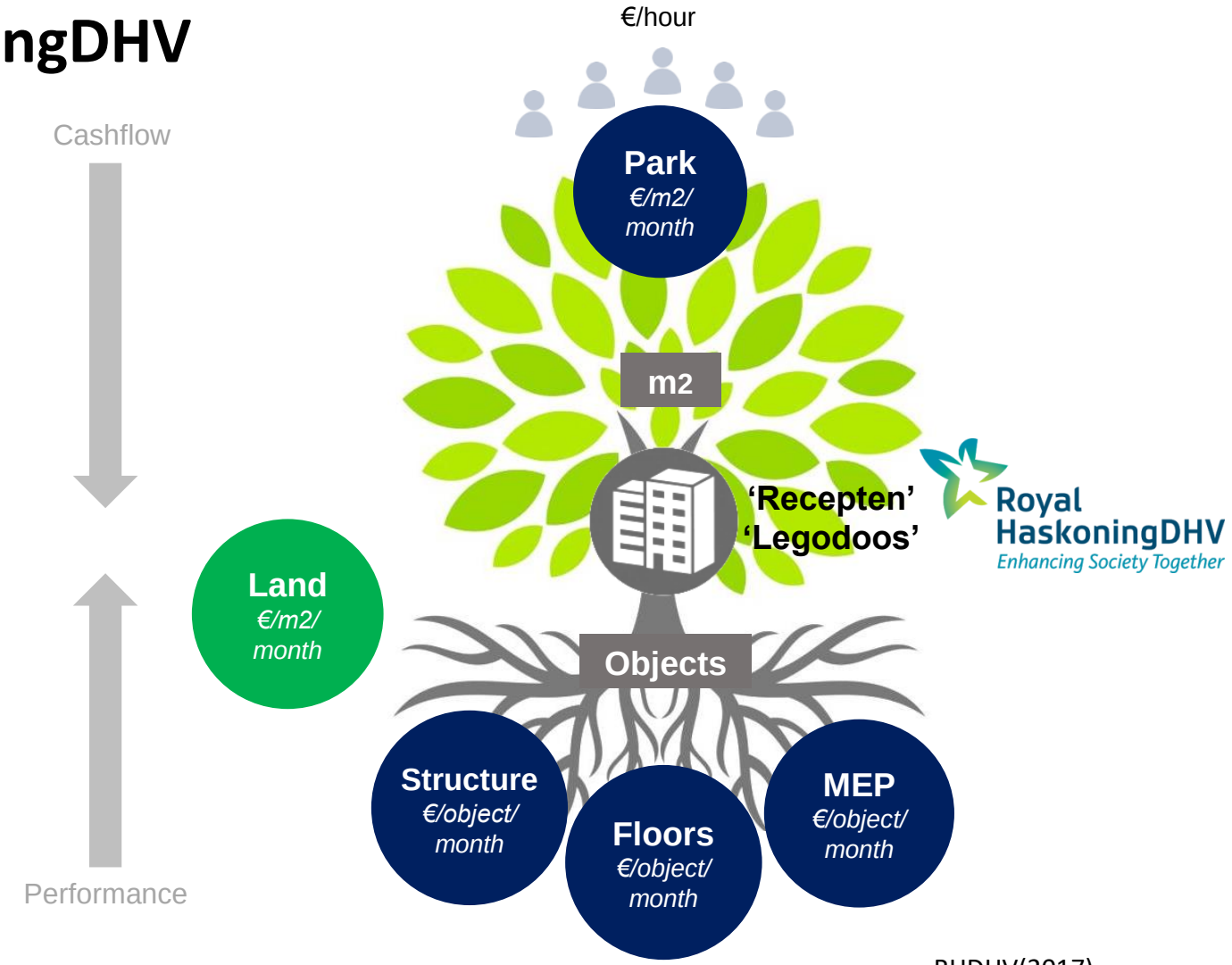
- Buyers cannot easily monitor the quality of the goods or services received, and so **suppliers are tempted to substitute lower quality goods** or be less than diligent in the supply of services.

Current status

- Sell and buy back common practice
- Modular, easy to assemble/disassemble (6 weeks)
- Hierarchical organizational structure
- Separate entity acts as a contractor
- “50% circular”

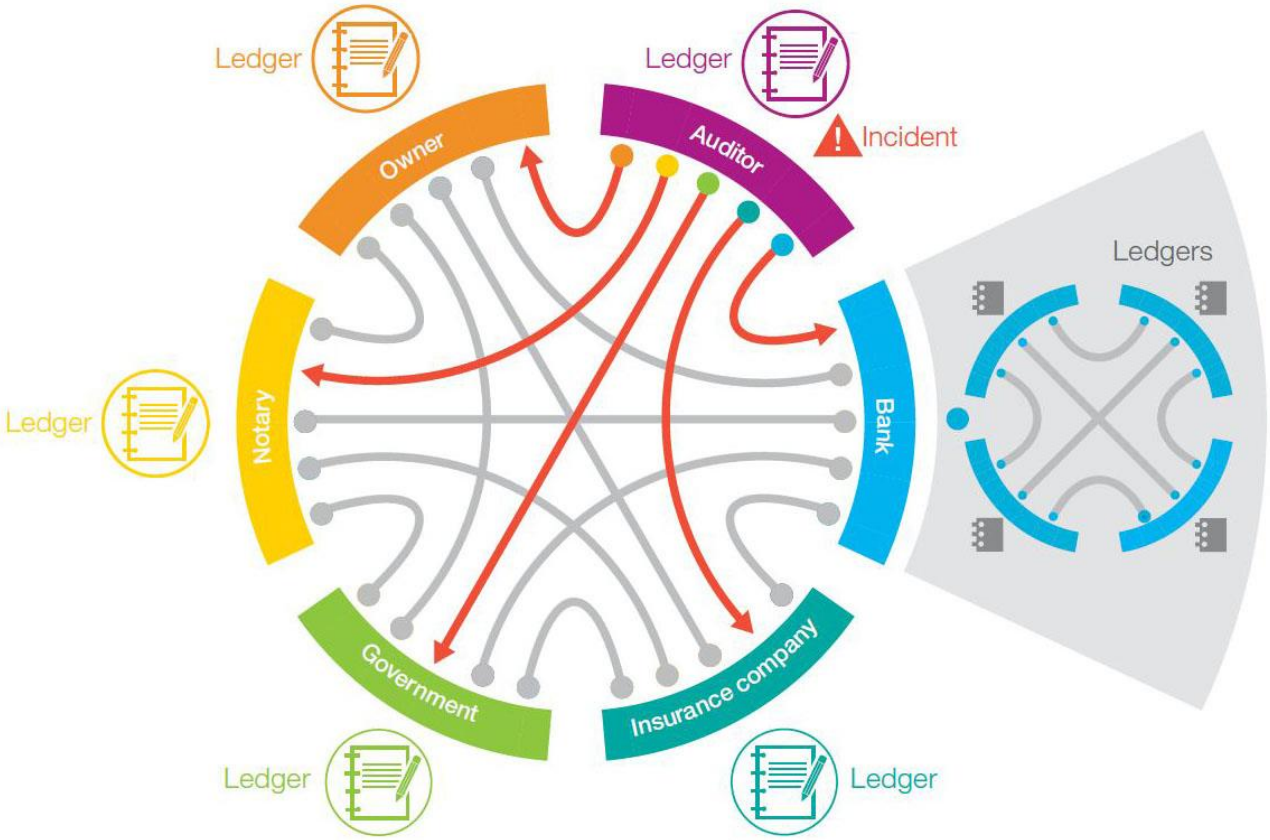
RHDHV(2018)

X-Decks concept
Royal HaskoningDHV



Royal HaskoningDHV
Enhancing Society Together

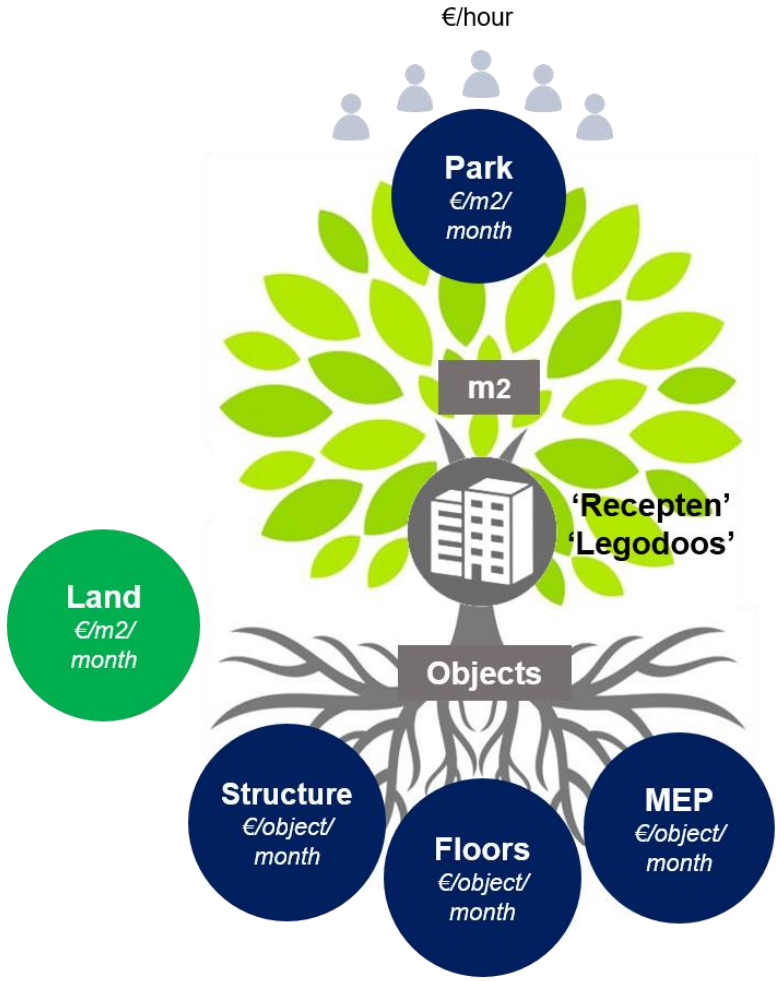
RHDHV(2017)

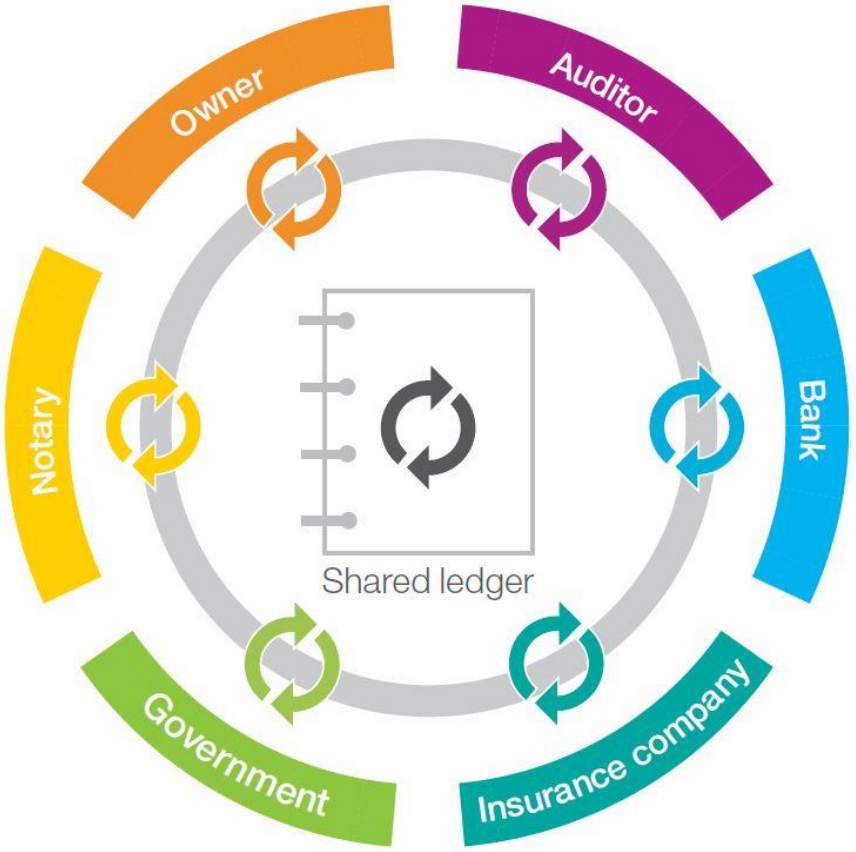


IBM (2017)

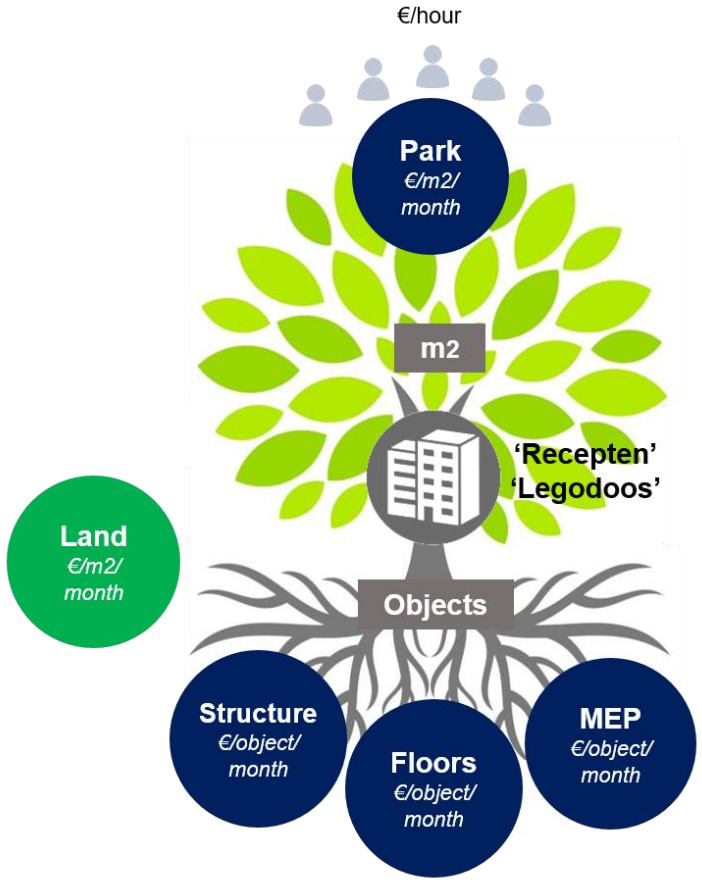
Individual ledger

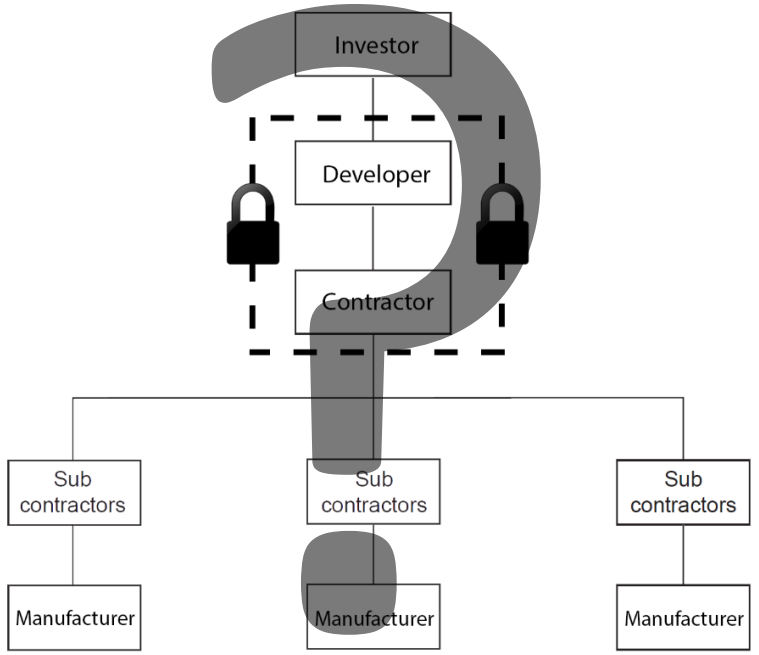
Shared ledger



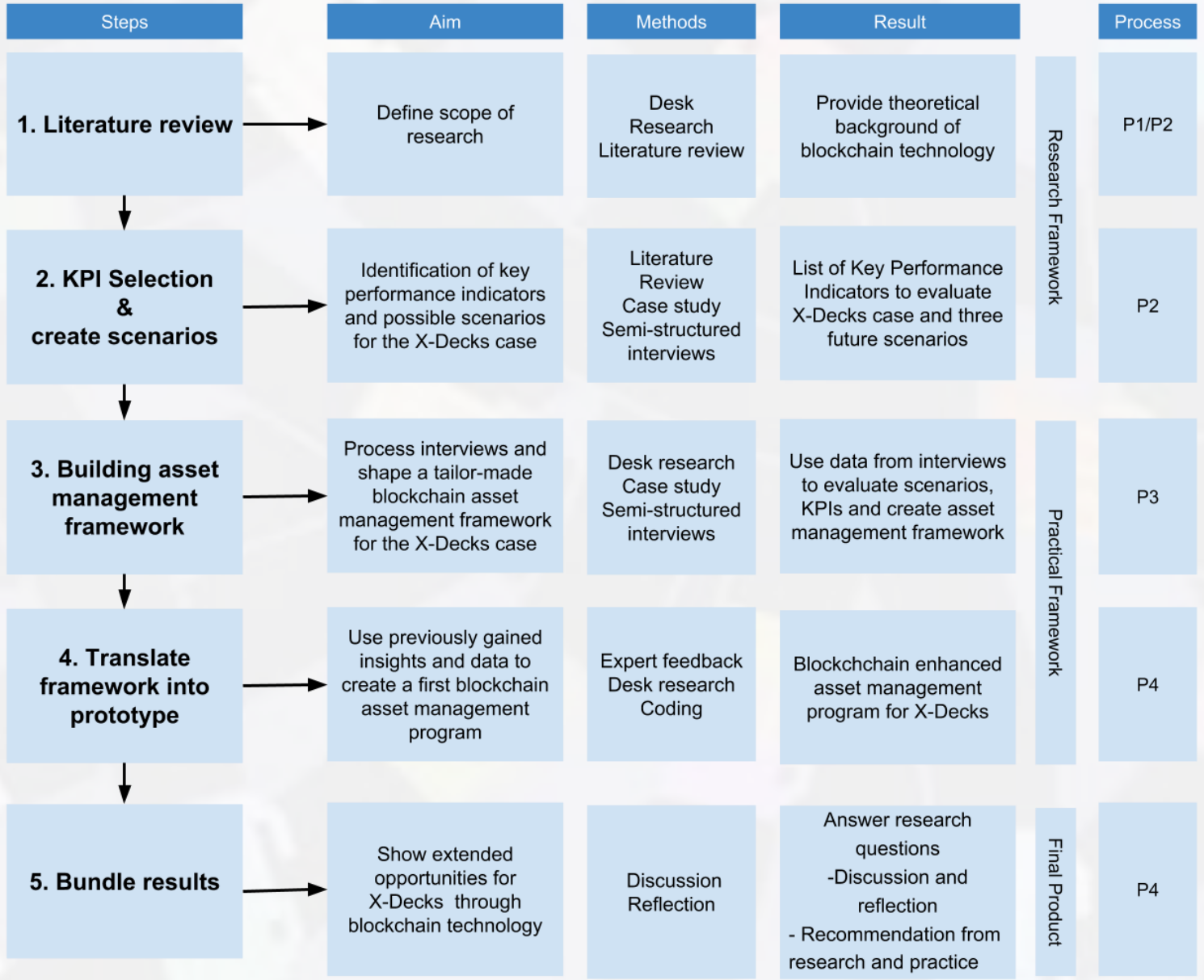


X-Decks + Blockchain





X-Decks + Blockchain =


Steps
Aim
Methods
Result
Process
1. Literature review
Define scope of research
Desk Research Literature review
Provide theoretical background of blockchain technology
P1/P2
2. KPI Selection & create scenarios
Identification of key performance indicators and possible scenarios for the X-Decks case
Literature Review Case study Semi-structured interviews
List of Key Performance Indicators to evaluate X-Decks case and three future scenarios
P2
Research Framework
3. Building asset management framework
Process interviews and shape a tailor-made blockchain asset management framework for the X-Decks case
Desk research Case study Semi-structured interviews
Use data from interviews to evaluate scenarios, KPIs and create asset management framework
P3
4. Translate framework into prototype
Use previously gained insights and data to create a first blockchain asset management program
Expert feedback Desk research Coding
Blockchchain enhanced asset management program for X-Decks
P4
Practical Framework
5. Bundle results
Show extended opportunities for X-Decks through blockchain technology
Discussion Reflection
Answer research questions -Discussion and reflection - Recommendation from research and practice
P4
Final Product

Main Research Question

How can asset management in the supply chain of the X-Decks case be applied to a blockchain enabled asset management framework?

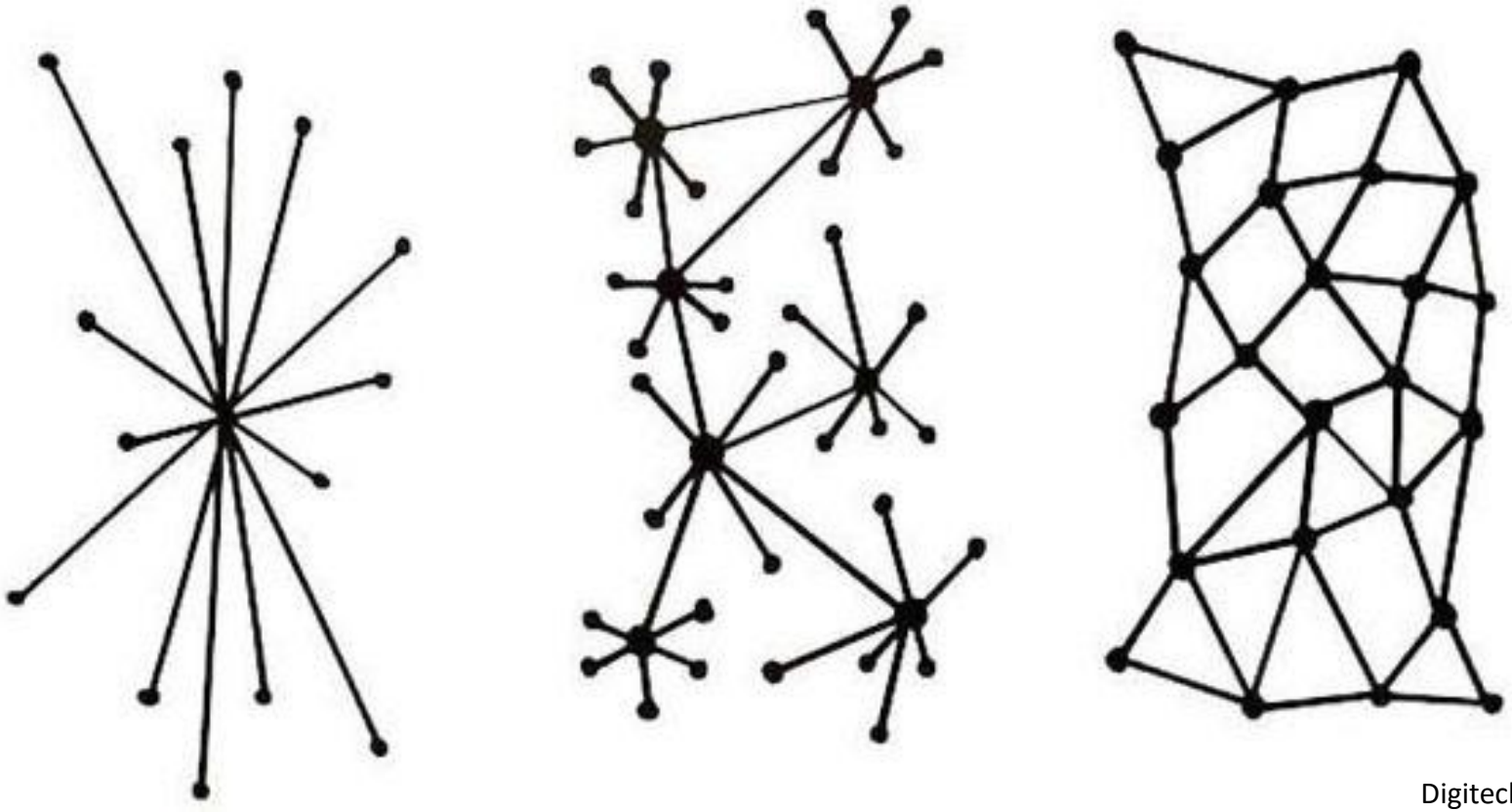
Sub Questions

1. *What is blockchain and how can it facilitate decentralised utilities?*
2. *What are the key features of the blockchain technology in application to the X-Decks case?*
3. *What are likely adoption scenarios for blockchain-based trading in the parking industry*?
4. *What roles can current market parties play in such a system?*
5. *How can different stakeholder attitudes affect the framework?*

1. What is blockchain and how can it facilitate decentralised utilities?

Key concepts

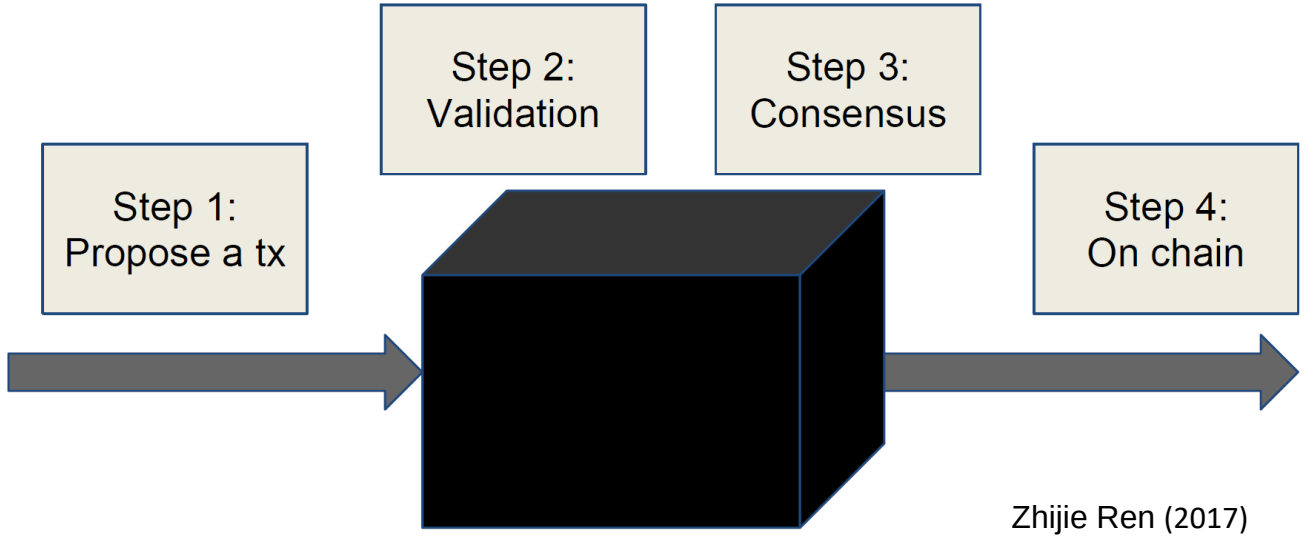
Centralization, dezentralization, distribution



Digitech (2017)

What is a blockchain?

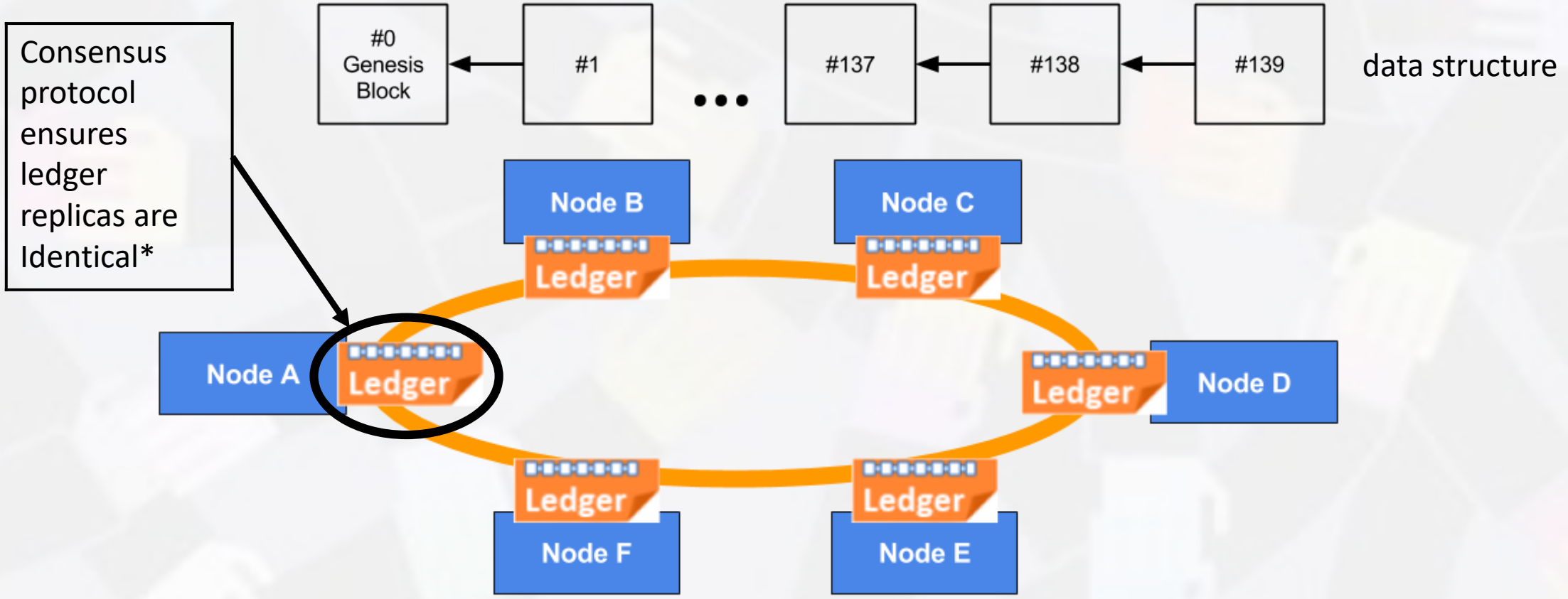
Peer-to-peer networks with public-key cryptography, timestamping of transactions along with a distributed consensus algorithm



Zhijie Ren (2017)

A chain (sequence, typically a hash chain) of **blocks** of transactions

- Each block consists of a number of (ordered) transactions
- Blockchain establishes total order of transactions



Consensus

Confirms the correctness of all transactions in a proposed block, according to endorsement and consensus policies

Agrees on order and correctness and hence on results of execution (implies agreement on global state)

Interfaces and depends on smart-contract layer to verify correctness of an ordered set of transactions in a block

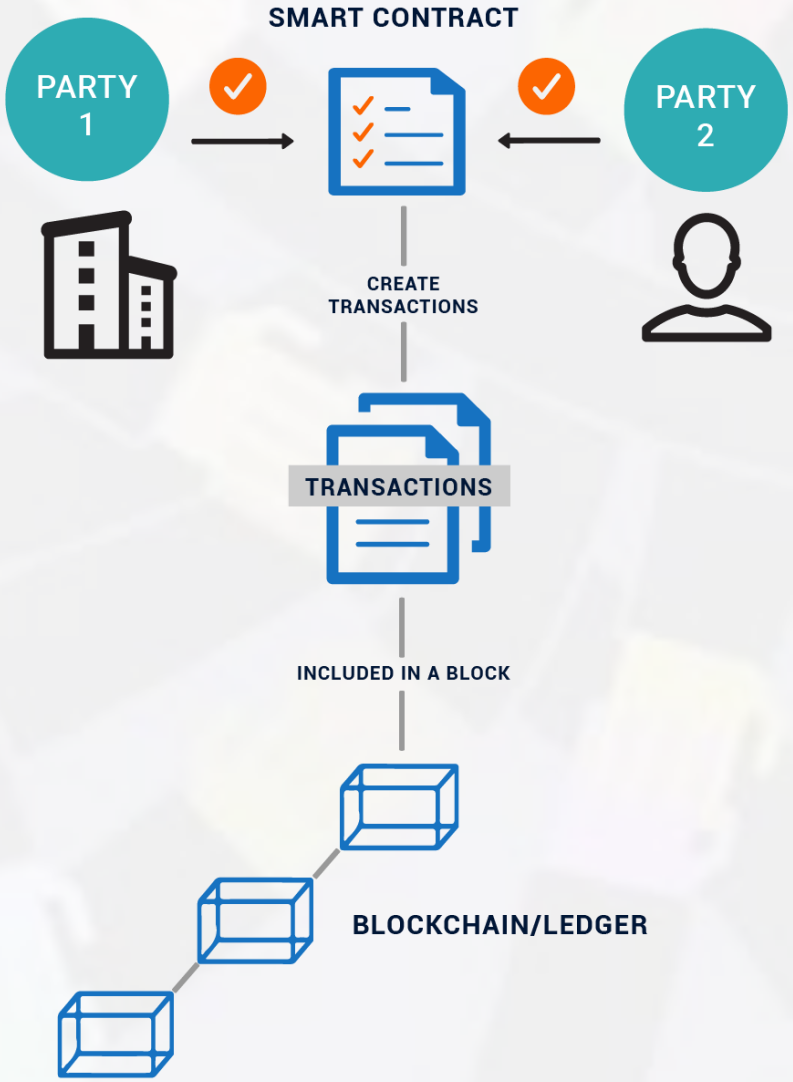
Consensus

- **Byzantine Fault Tolerant (BFT)** - number of nodes that must reach consensus is **2f+1** in a system containing **3f+1** nodes. For known and trusted participants
- **Proof of Stake (PoS)** - here nodes are randomly selected to validate blocks, and the probability of this random selection depends on the amount of stake held.
- **Proof of Work (PoW)** - is first utilized by Bitcoin that involves solving a computational challenging puzzle in order to create a new block. Significant compute cost. For anonymous participants
- **Tangle** - carries no economic incentive. Instead, it is designed in a way that requires all users to verify two transactions each time they wish to carry out one of their own. The Tangle is related to the IOTA project.
- **Proof of Elapsed Time (PoET)** - is introduced by Intel and provides a hardware based solution that utilizes a lottery function in which the node with the shortest wait time creates the next block.
- **Multi-signatures validation** needs consent from 3 out of 5 validators

Smart contracts

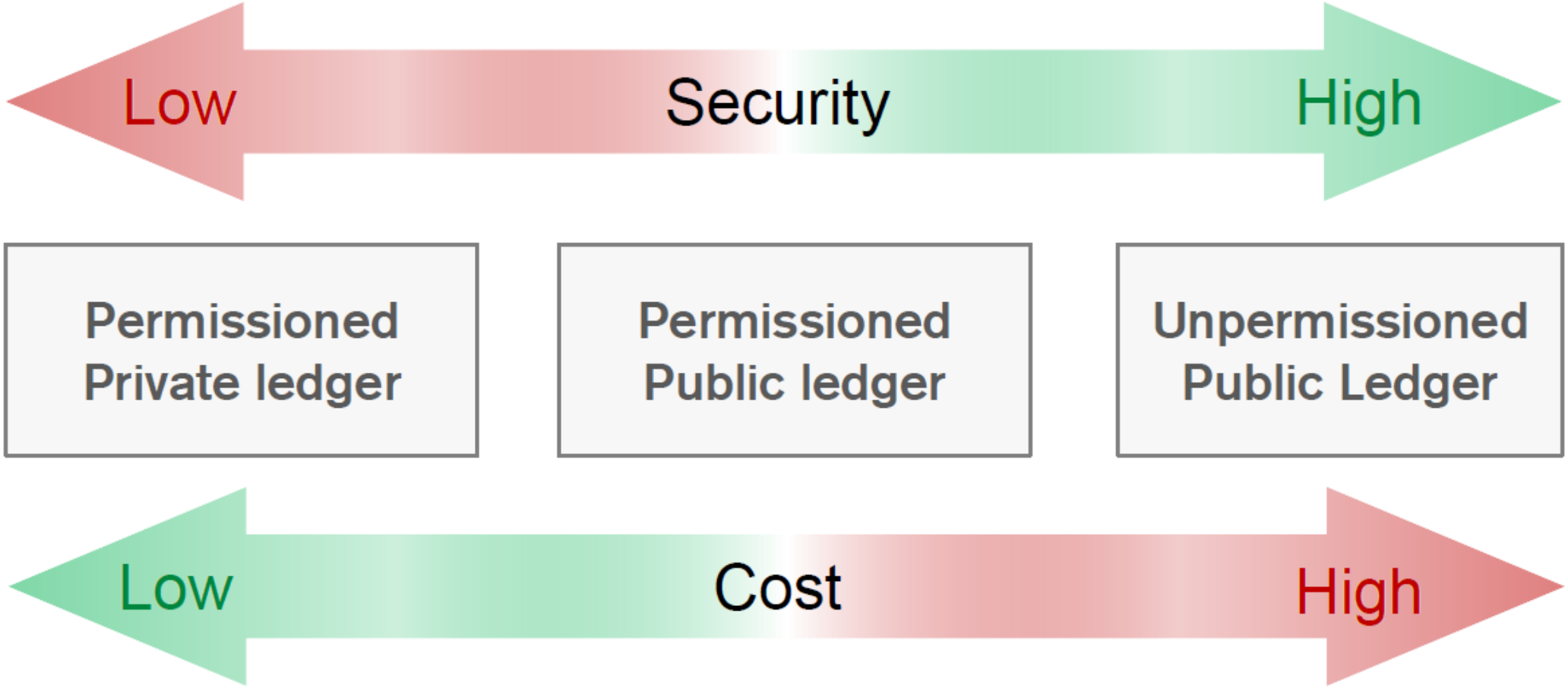
```
contract Crowdfund:
   if (account_balance > $10000)
     move account_balance to funded_account
     tell invoicing_system to send_shirt
   else
     move donation_account to original_donor
```

BLOCKCHAIN AND SMART CONTRACTS - FLOW DIAGRAM

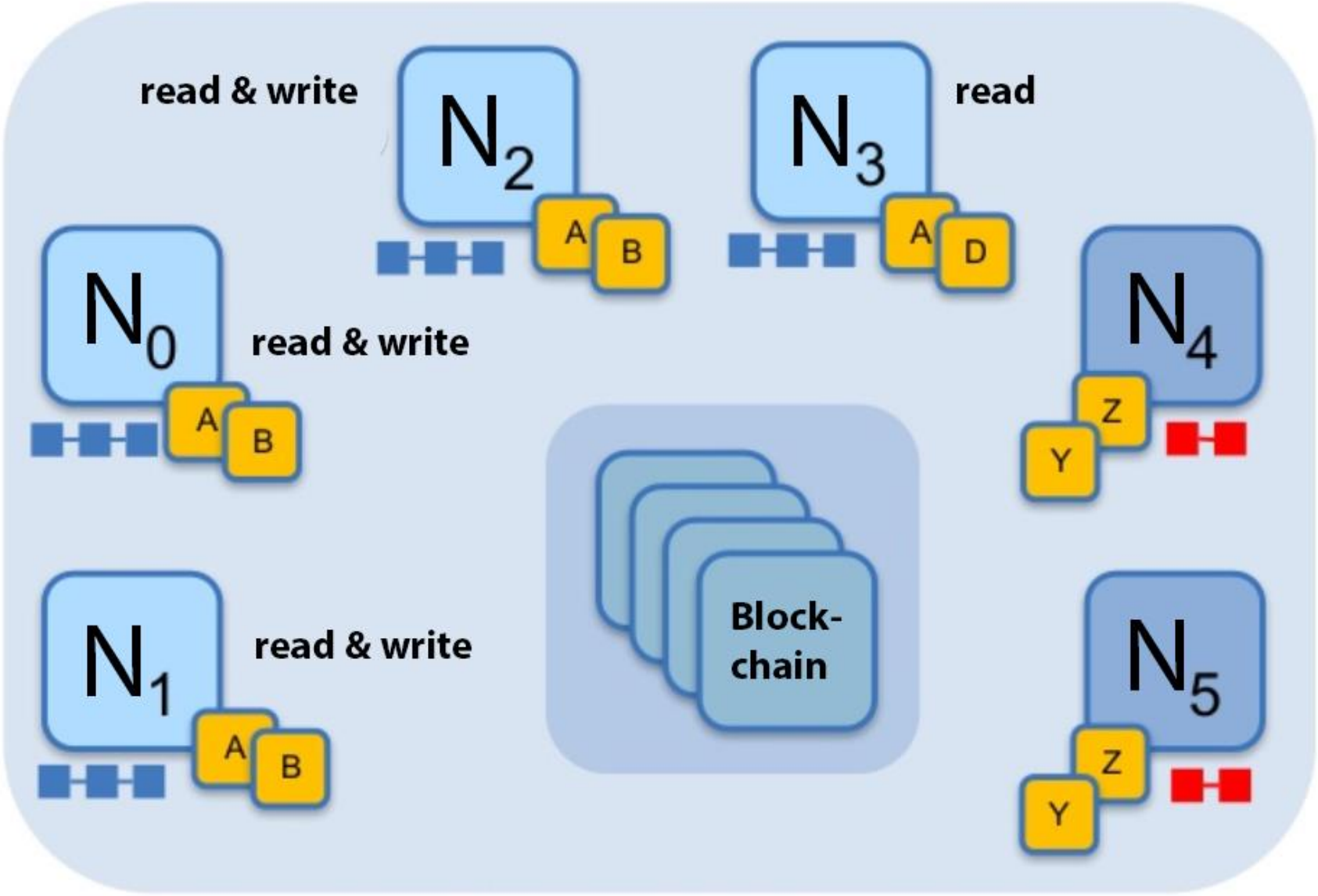


Linux Foundation(2017)

Private and public blockchains



Credit Suisse Research (2017)



Hyperledger (2018)

Blockchain evolution

2009 Bitcoin

- A hard-coded cryptocurrency application with limited stack based scripting language
- Proof-of-Work consensus
- Native currency BTC
- Permissionless blockchain

2014 Ethereum

- Distributed applications (smart contracts) in domain specific language (Solidity)
- Proof-of-Work consensus
- Native currency ETH
- Permissionless blockchain

2017 Hyperledger Fabric

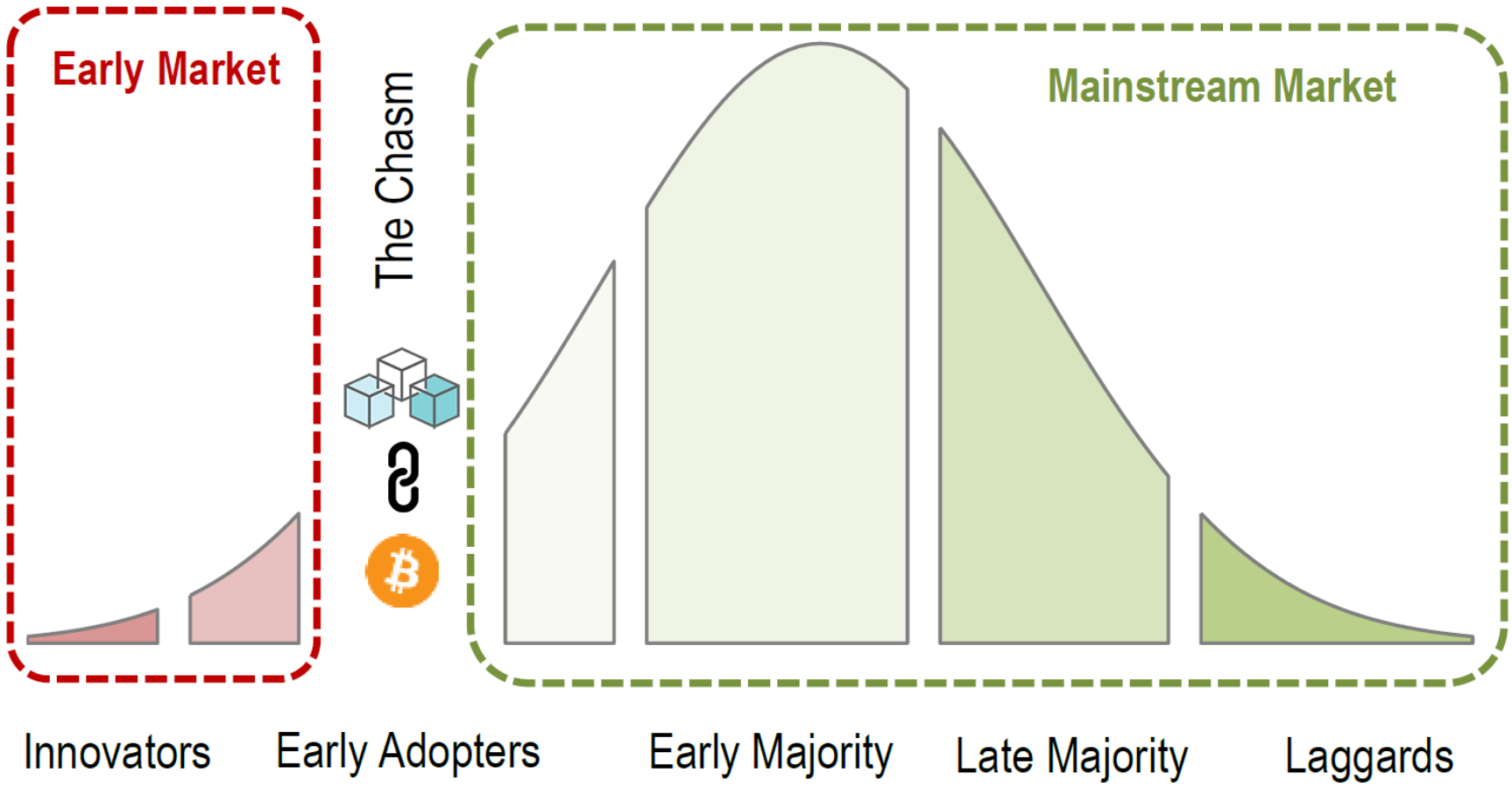
- Distributed applications in different general-purpose languages
- Modular / pluggable consensus
- No native cryptocurrency
- Multiple instances / deployments
- Permissioned blockchain system

Challenges of adaption and deployment

X-Decks related

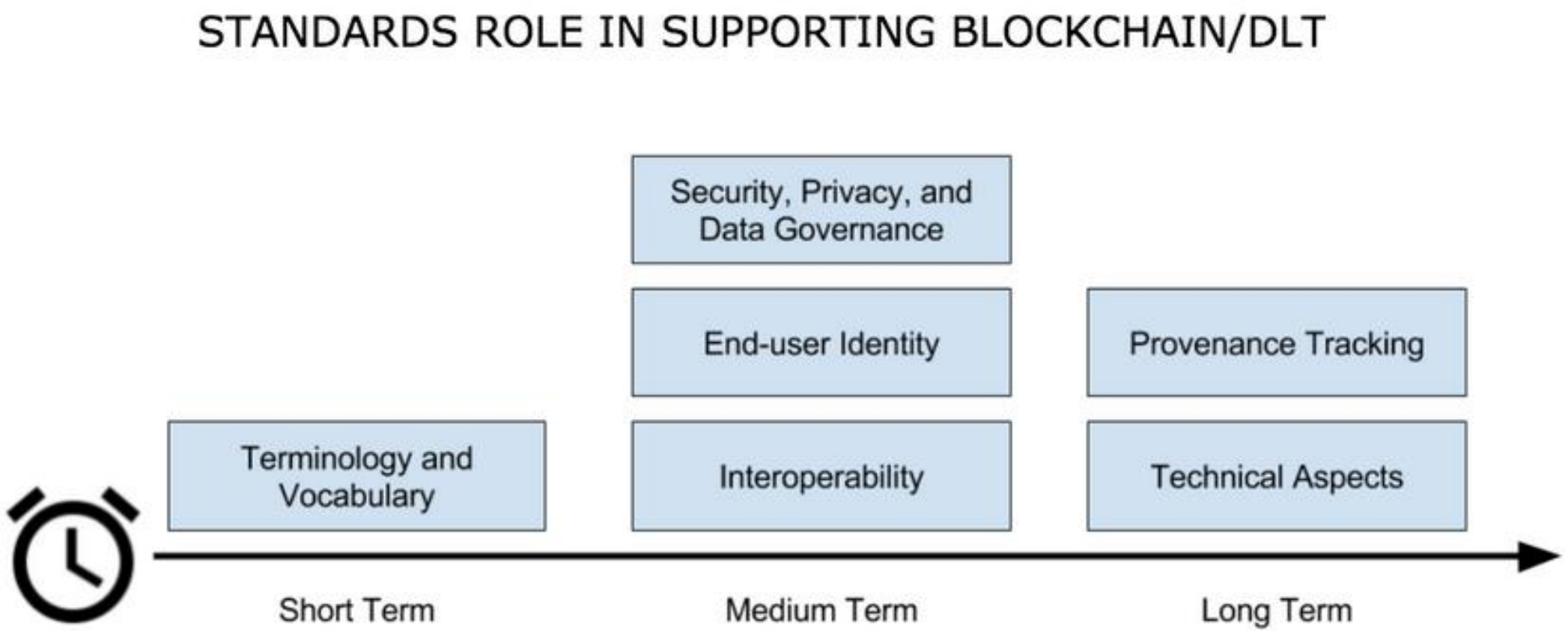
- Misconceptions and lack of knowledge
- Confidentiality vs transparency (private vs public)
- Finding and replacing paper based processes
- Gap between digital twin and physical asset
- Reaching critical mass of participating stakeholders

- Avoid under all circumstances to commit any personal data to a blockchain – it will stay there forever (GDPR – EU privacy law)



Brennan(2016)

Challenges of adaption and deployment



Linux Foundation(2017)

2. What are the key features of the blockchain technology in application to the X-Decks case?

Key features for the X-Decks case

- Enhance transparent processes and collaboration
- Distribution of liabilities makes middlemen redundant
- Improved traceability of assets, contracts and metadata e.g. for a building passport
- Start with a limited number of stakeholders (**permissioned, private blockchain**) and scale up the network step by step

KPIs

Business and Information flows

- Role and responsibilities of stakeholder
- Business model
- Payment structures and conditions
- Information flows

Applies to all categories:

Transparency & collaboration

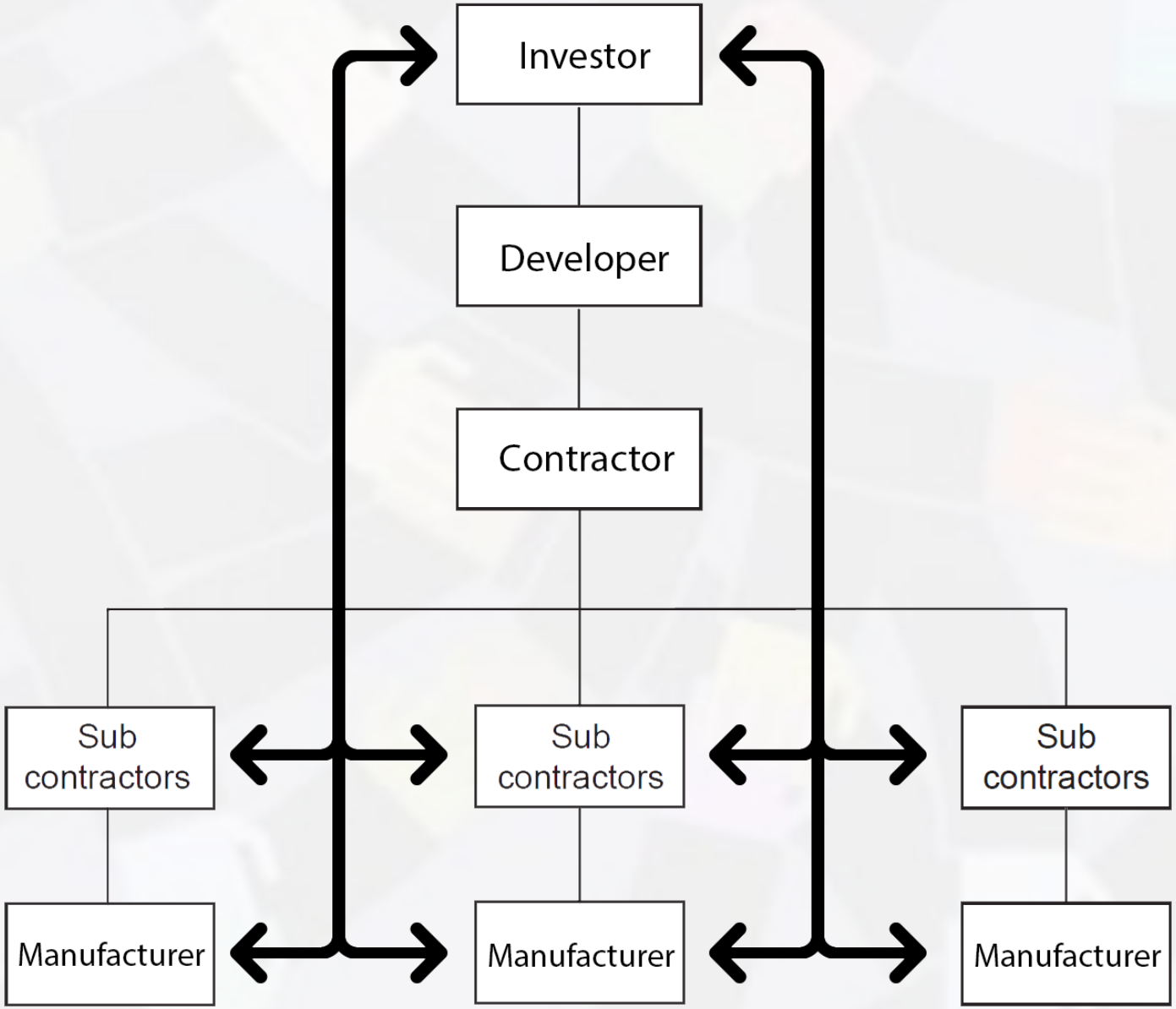
Innovation & Fictions

- Contractual procedures
- Parking as a service
- Circular processes
- Organizational silos
- Financing

Blockchain

- (Mis)conceptions / Expectations
- Needs
- Limitations and Opportunities
- Replacement of middlemen

3. What are likely adoption scenarios for blockchain-based trading in the parking industry?


Investor
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Contractor
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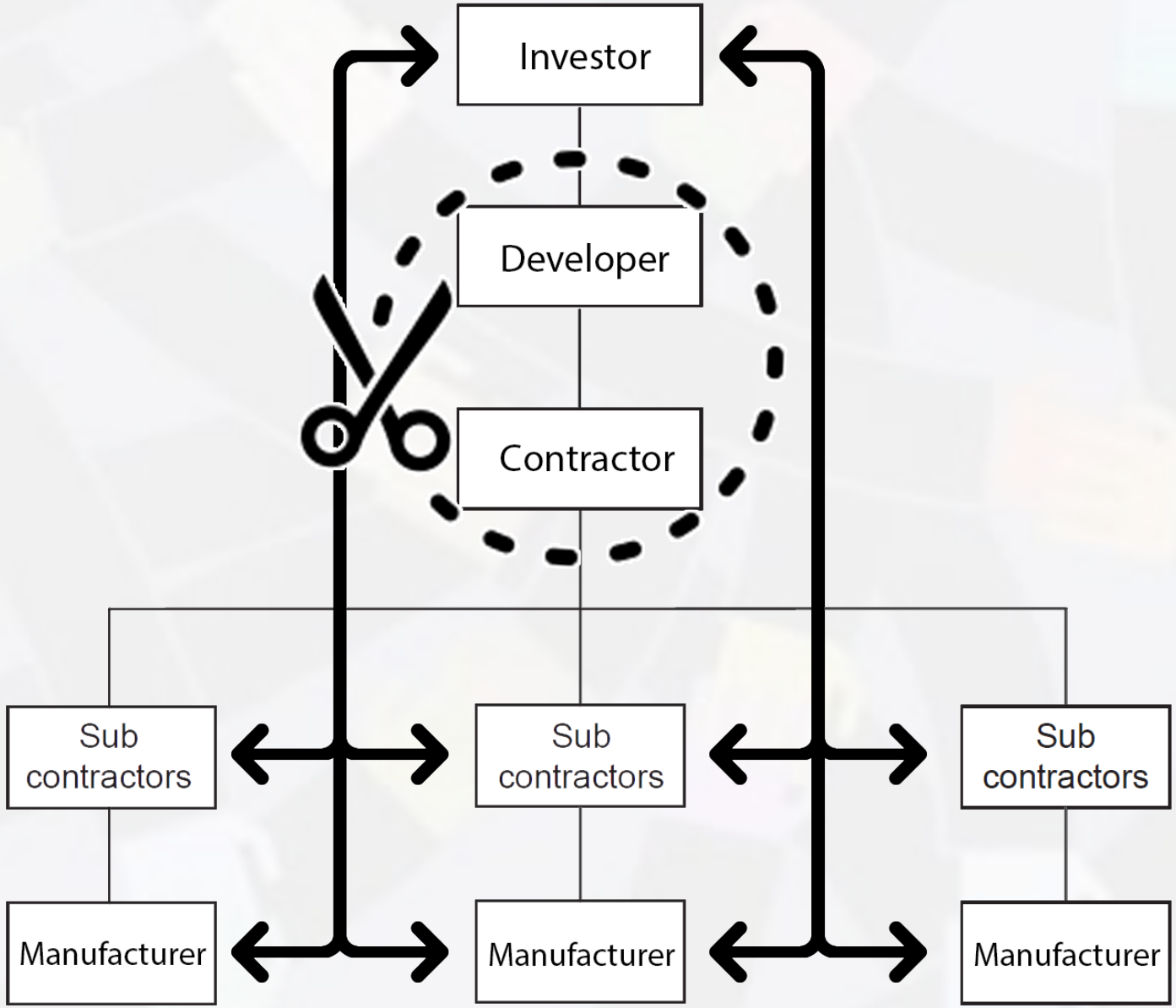
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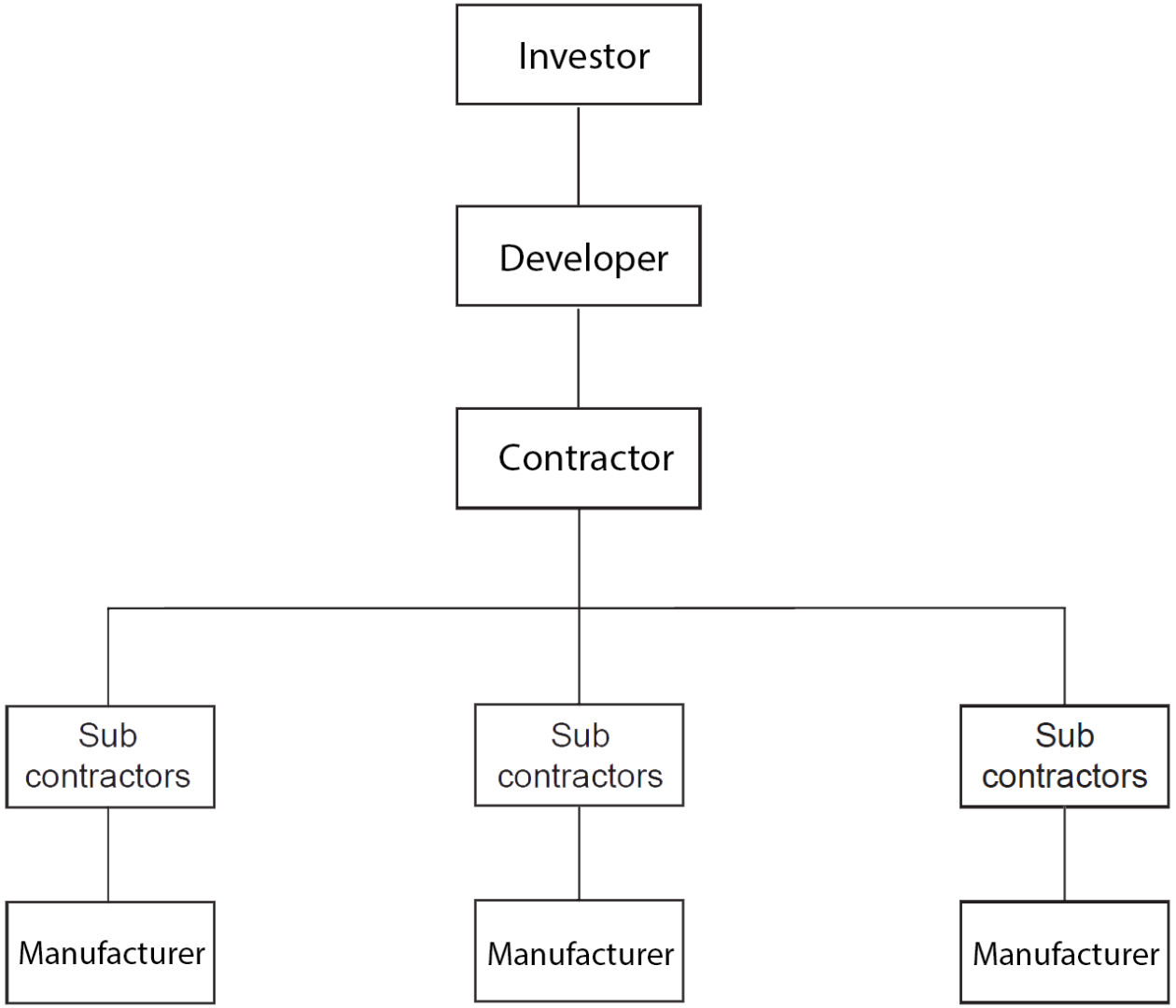
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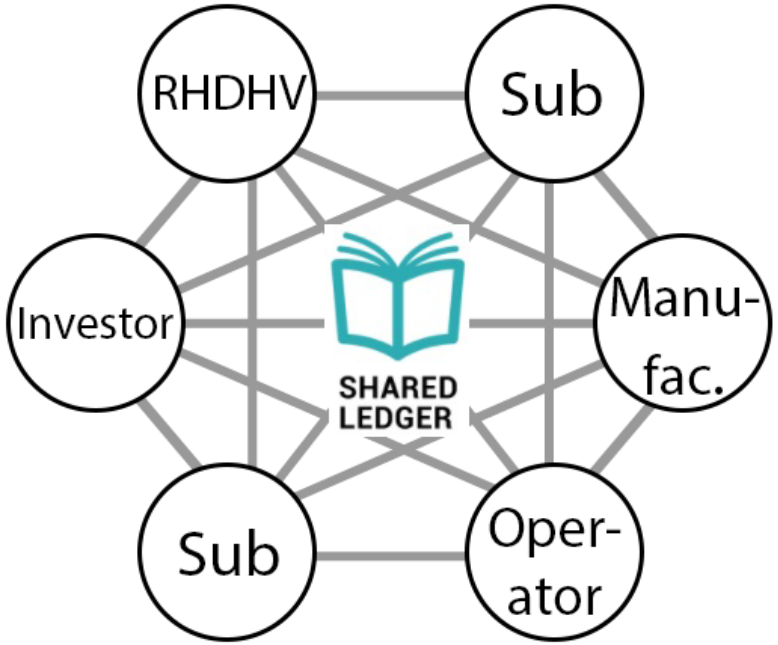
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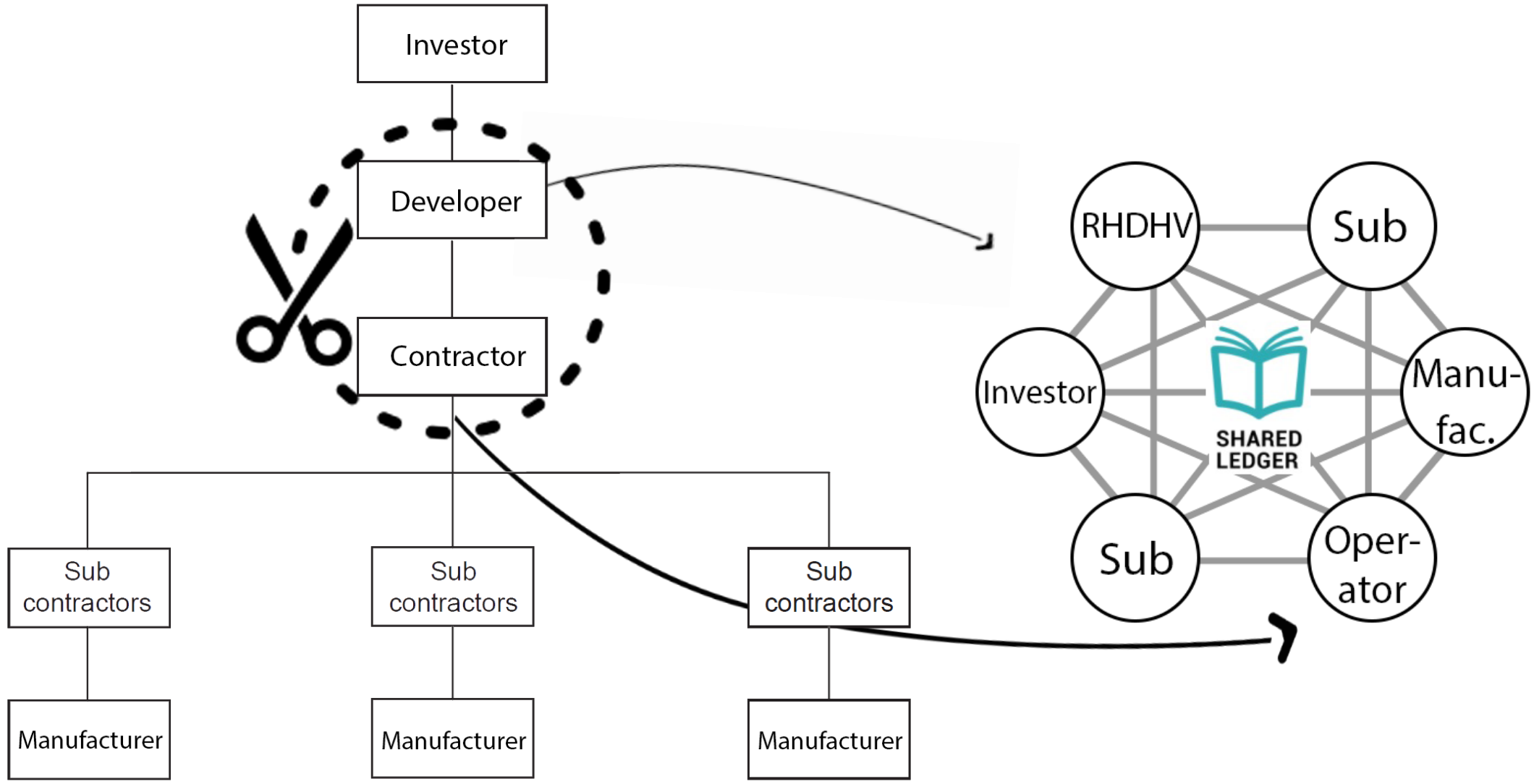
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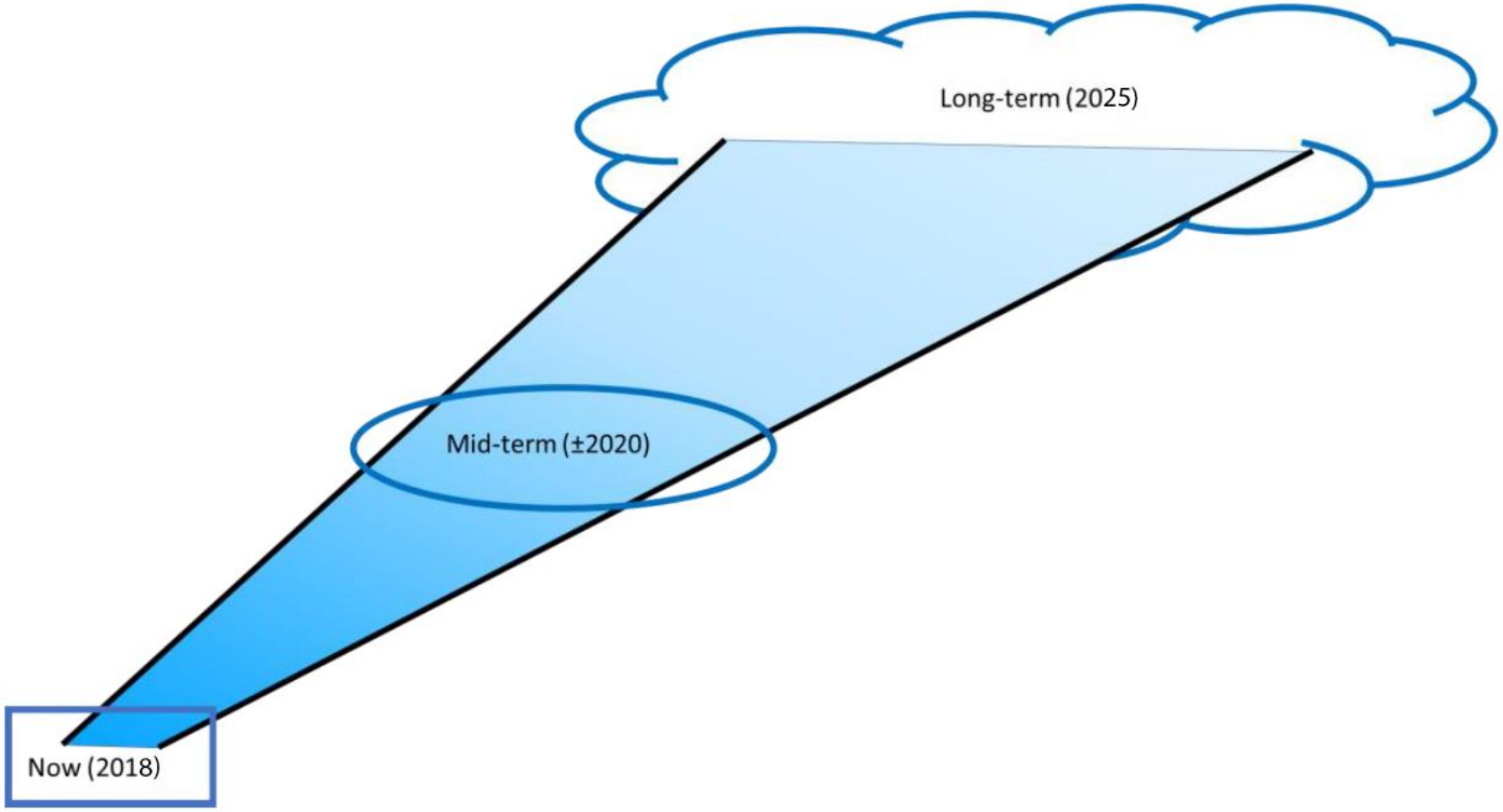
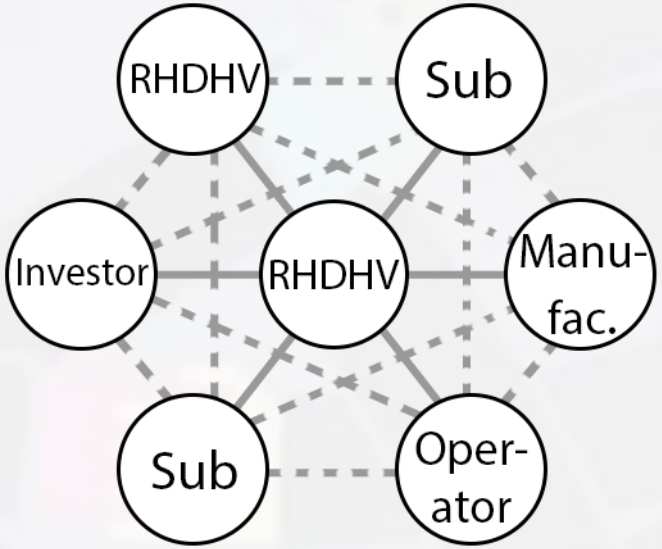
Scenarios





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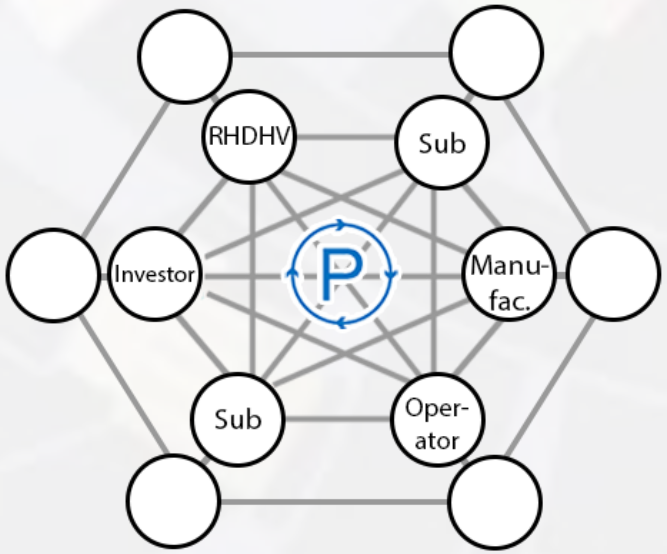
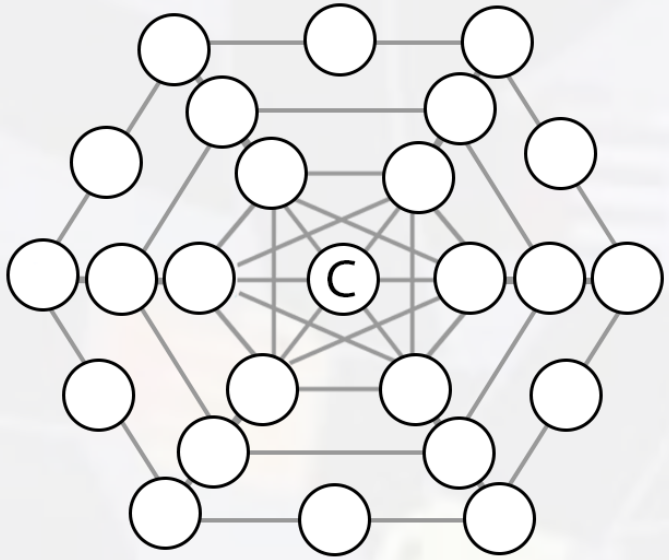


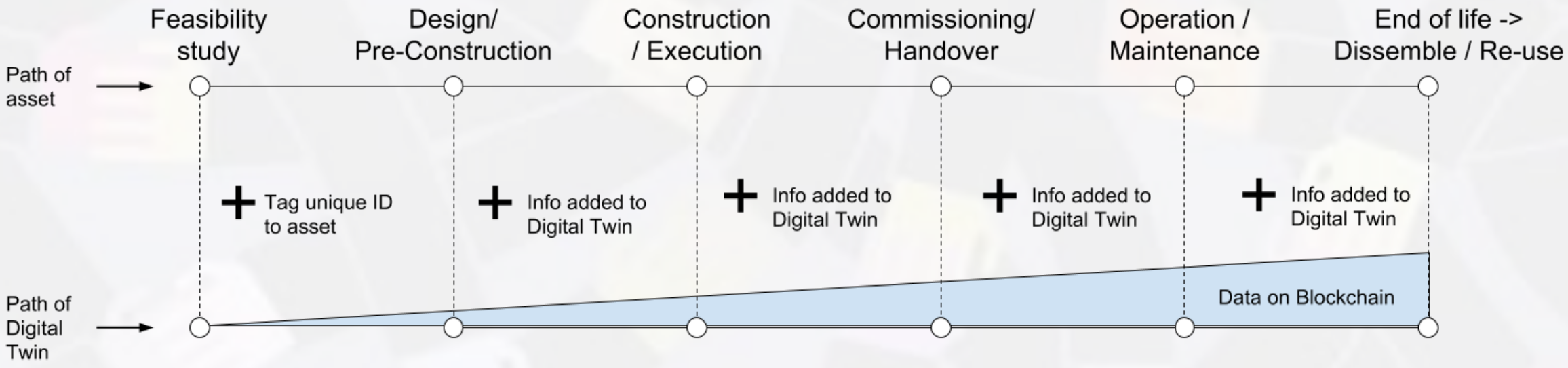
Mid-term
(+- 2020)

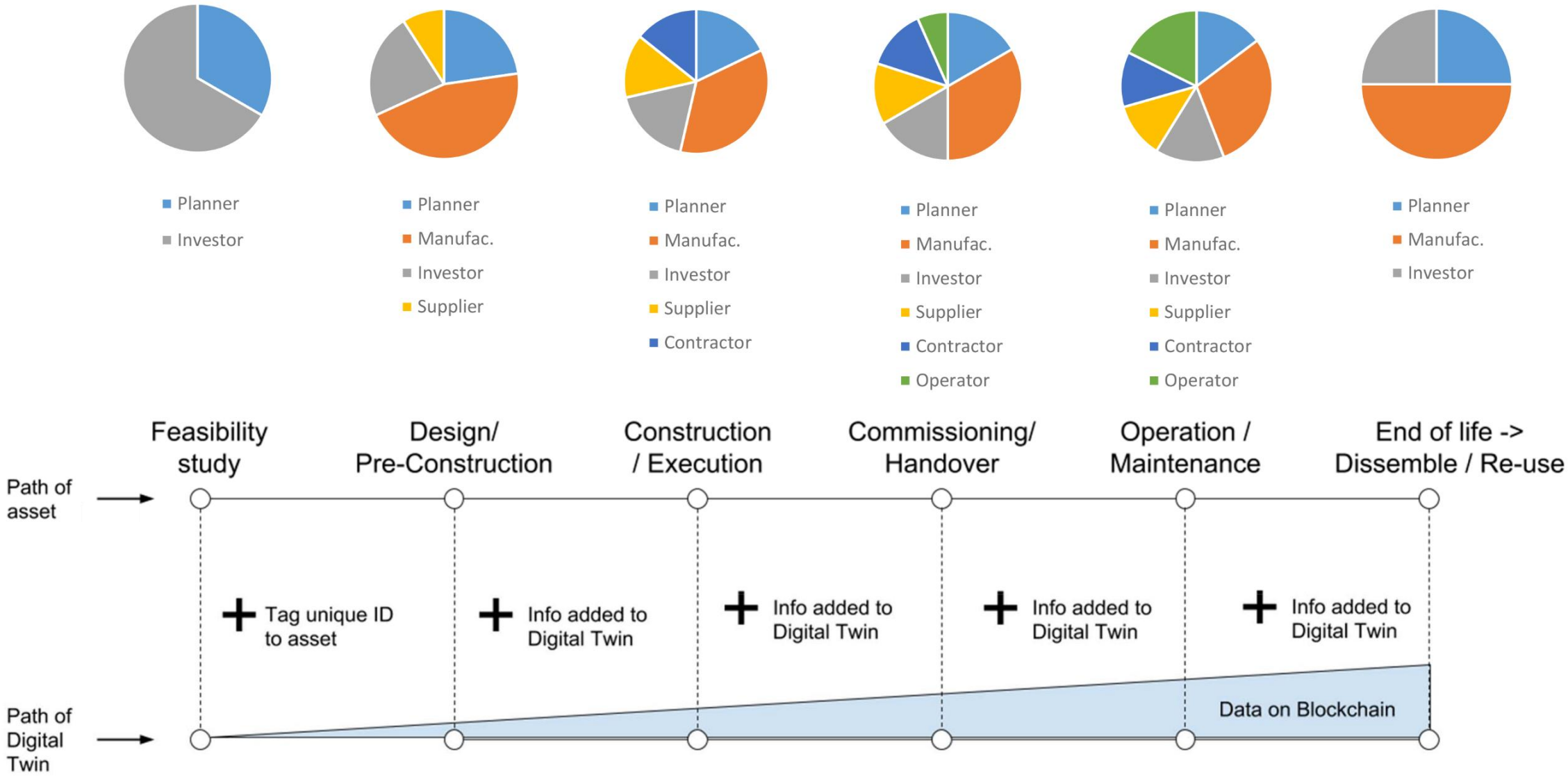


Long-term
(from 2025)

4. What roles can current market parties play in such a system?

Traceability of assets across the X-Decks lifecycle with a digital twin

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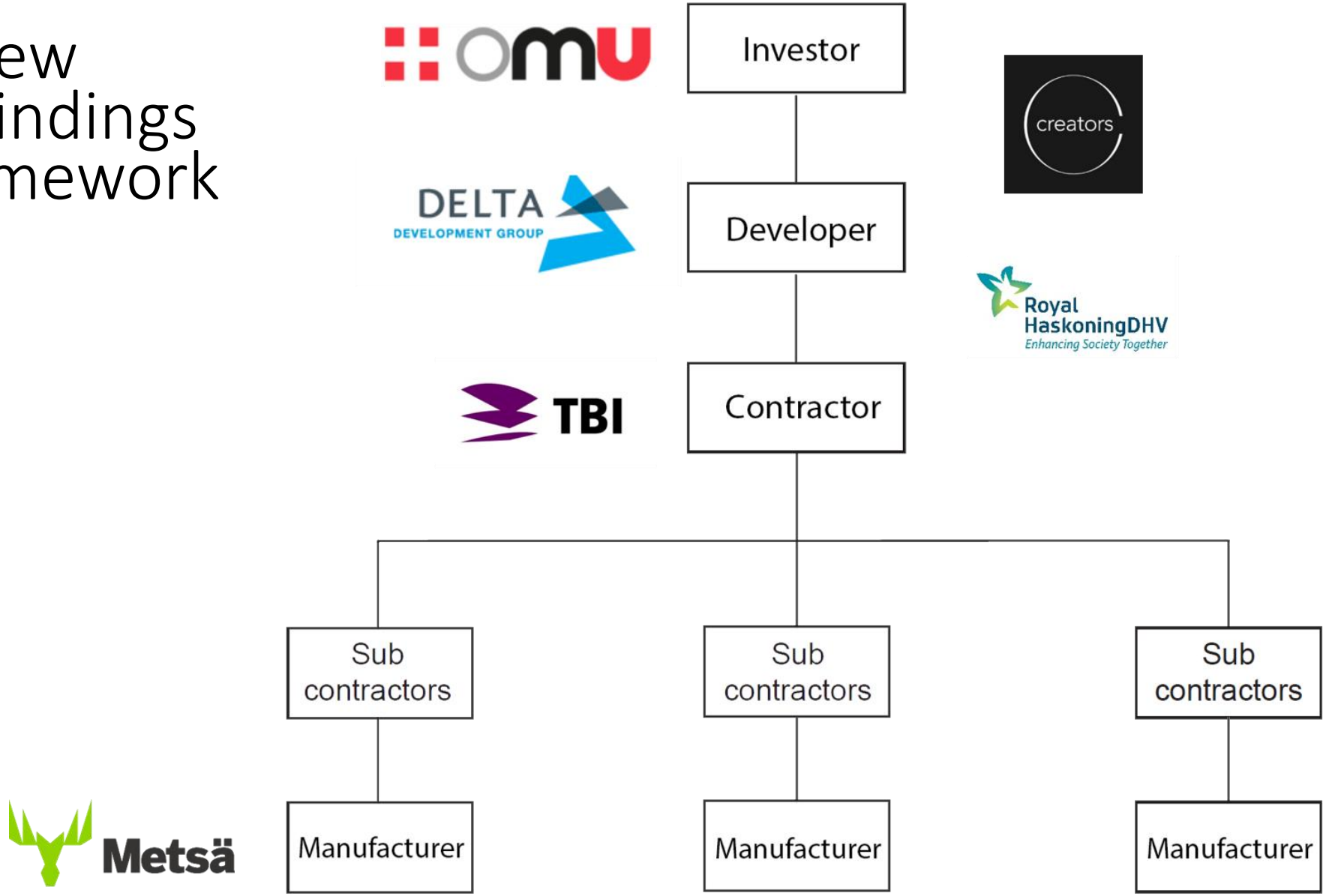
Operator
Planner
Manufac.
Investor
Feasibility study
Design/ Pre-Construction
Construction / Execution
Commissioning/ Handover
Operation / Maintenance
End of life -> Dissemble / Re-use
Path of asset
Tag unique ID to asset
Info added to Digital Twin
Info added to Digital Twin
Info added to Digital Twin
Info added to Digital Twin
Path of Digital Twin
Data on Blockchain

Interview Main findings for framework



Topic	Interview Question
Role of Stakeholder	What was the main problem or need that is covered by your company's product or service (for the X-Decks project)?
Business and Information Flows	How were you contracted and paid – can you describe the process looking back at the last three projects you have worked on /the last three contracts that you signed with contractor / investor / developer / supplier / manufacturer? What kind of information and assets were stored, monitored and transferred, and which technologies were used to do so? Which partners were important for your own business model?
Blockchain technology	Were there any blockchain related projects at your company? If no: What do you know about blockchain technology? Did you heard about any applications (in building industry)? Did you ever got the chance to invest materials or working hours to hold shares of a building project?
Blockchain enabled framework	What did you think of the suggested process via blockchain technology? What kind of barriers or roadblocks would you imagine in the blockchain space? Do you see other opportunities that can benefit from blockchain technology?

Main findings

- Make it **easily possible to join, leave and change position** of a node in every layer of the **blockchain network**

- **Reduction of the risk budget** during the building process and exploitation of new business models are the main motivations to use technological innovation

- Documentation of financial and operational data is not happening yet – just at later stages not from the beginning of building process

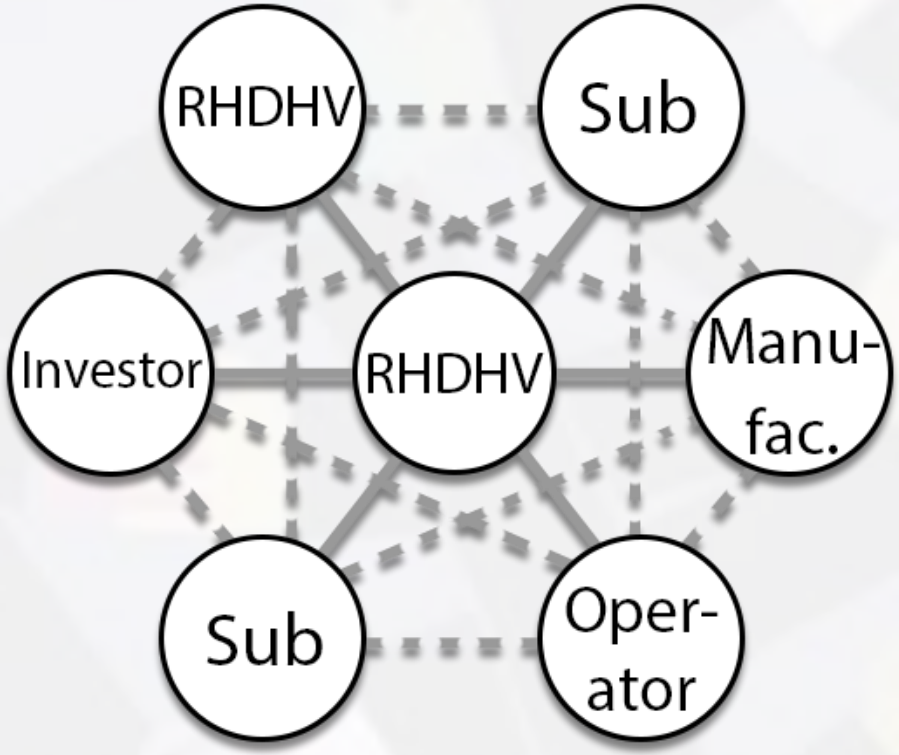
- It became clear to make a generic purpose tool for asset trading that creates capacity and offers interfaces to connect with additional services in the future (scalable)

- Need for more transparency to overcome organizational silos. Or more precise to **find a balance between preserving silos to run a business model and opening it up to enhance collective model and data collection**

- Reservation towards actively developing a prototype and holding shares in X-Decks which might be caused by conducting the interviews at an early stage of the research with just the scenarios available

Blockchain enabled asset management framework

How can asset management in the supply chain of the X-Decks case be applied to a blockchain enabled asset management framework?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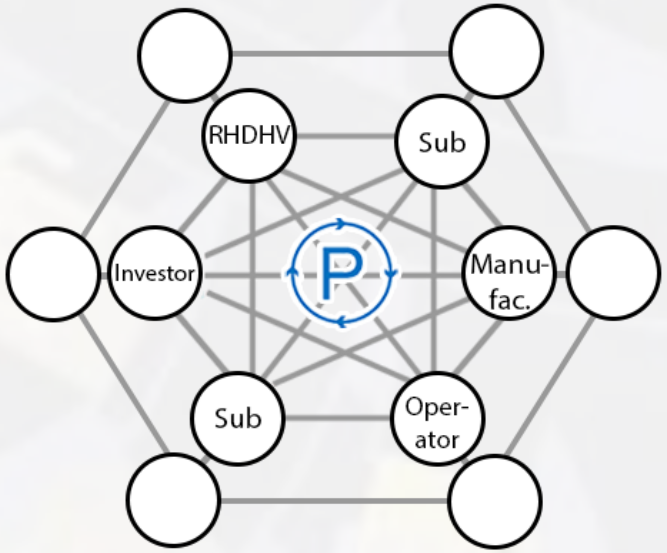
1st Model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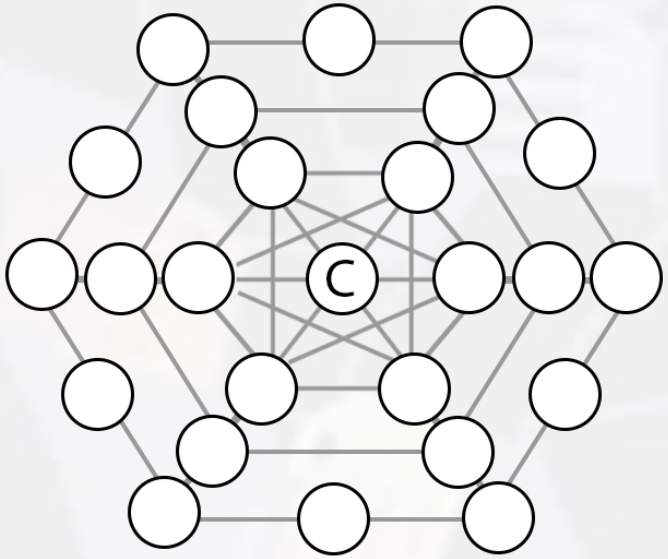
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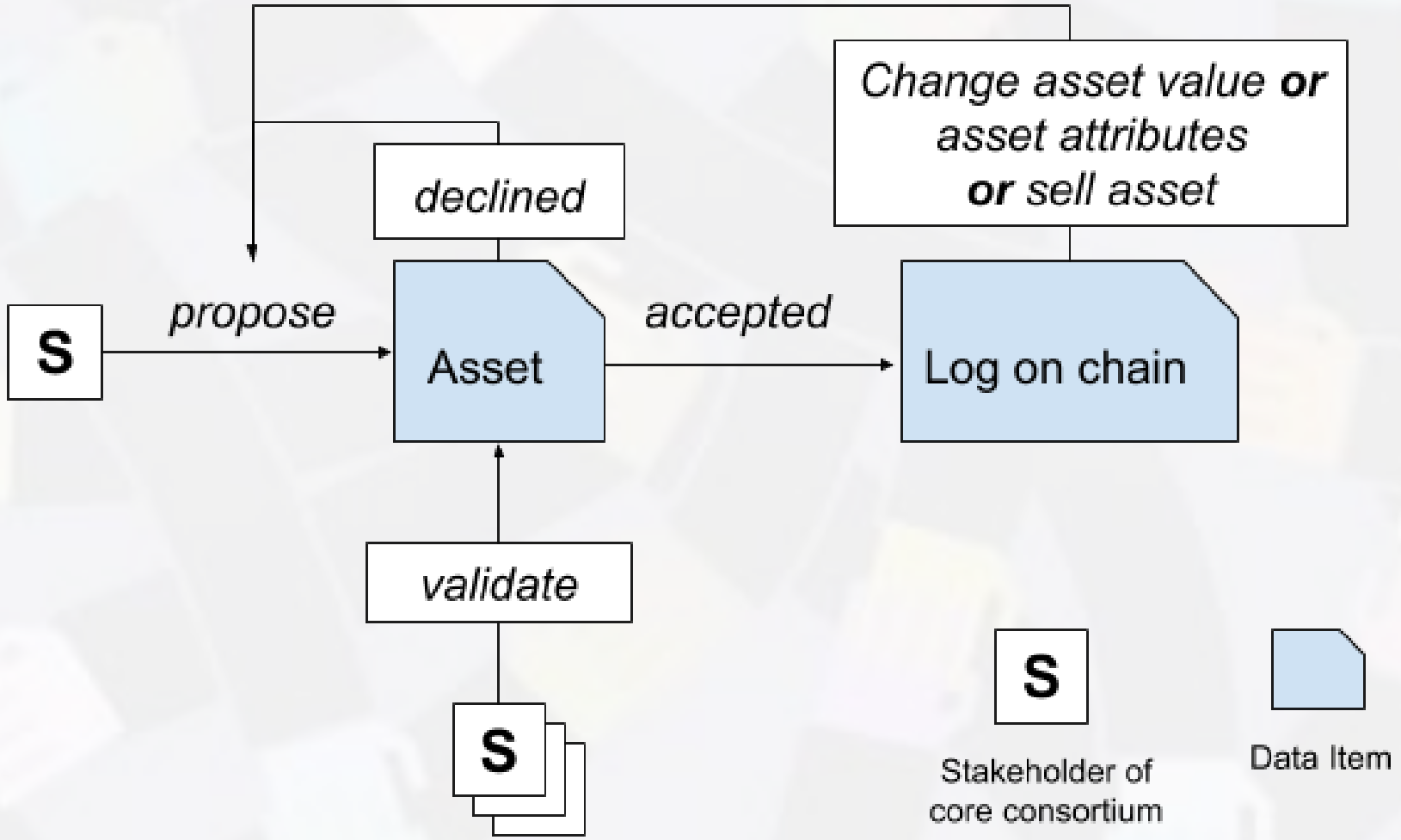
Change asset value or
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or sell asset
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Log on chain
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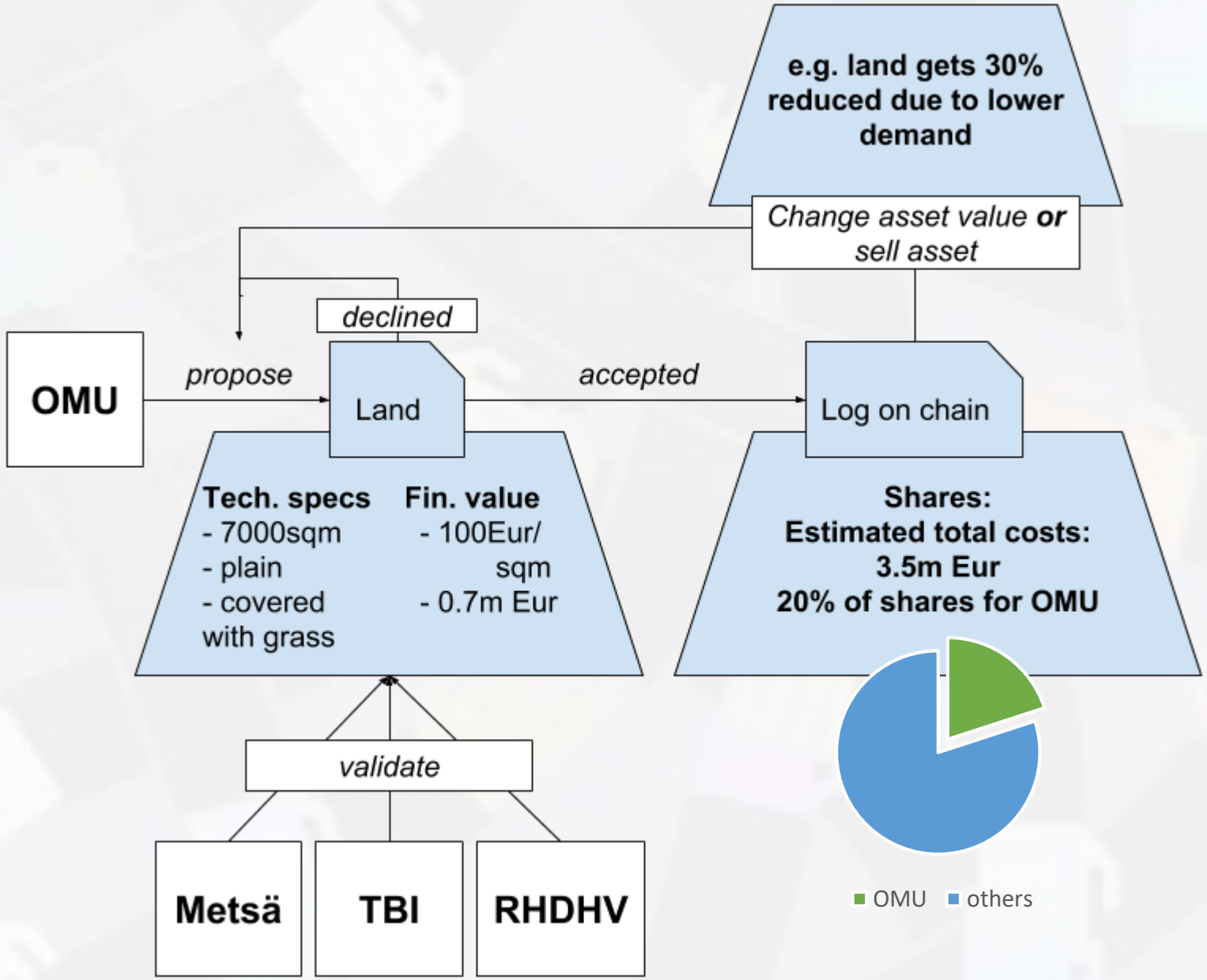
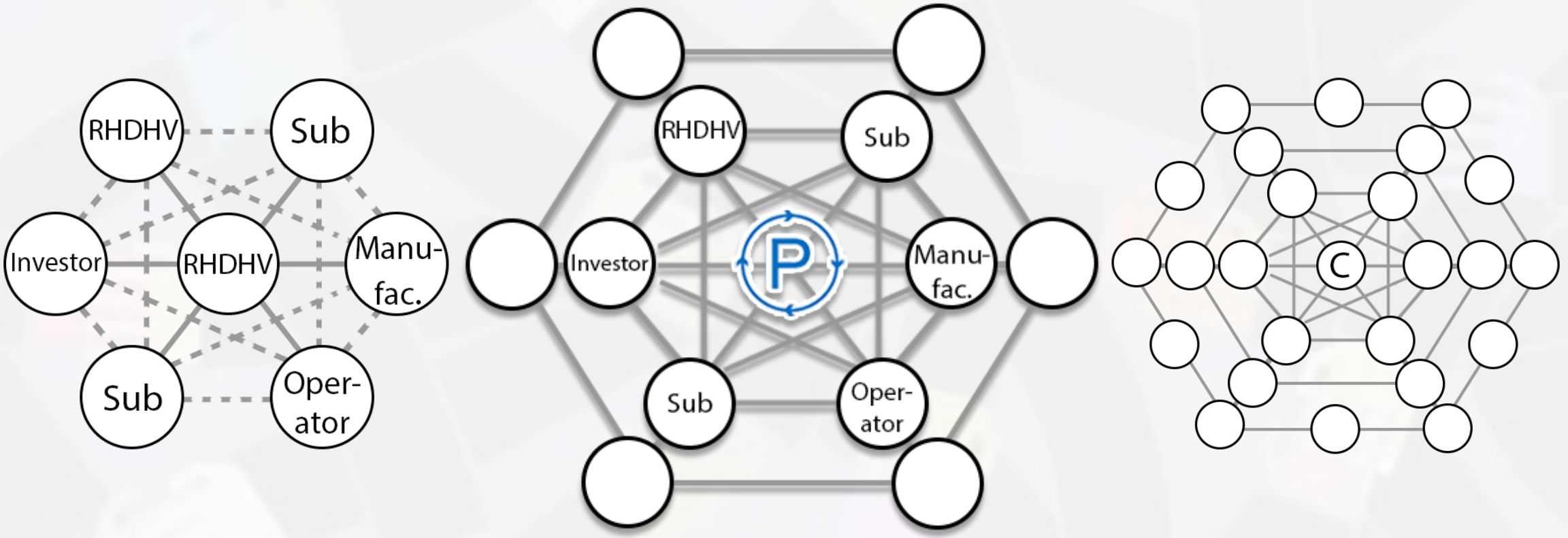
S
Stakeholder of
core consortium
Data Item


e.g. land gets 30% reduced due to lower demand
Change asset value or sell asset
declined
OMU
propose
Land
accepted
Log on chain
Tech. specs
- 7000sqm
- plain
- covered with grass
Fin. value
- 100Eur/ sqm
- 0.7m Eur
Shares:
Estimated total costs:
3.5m Eur
20% of shares for OMU
validate
Metsä
TBI
RHDHV
OMU
others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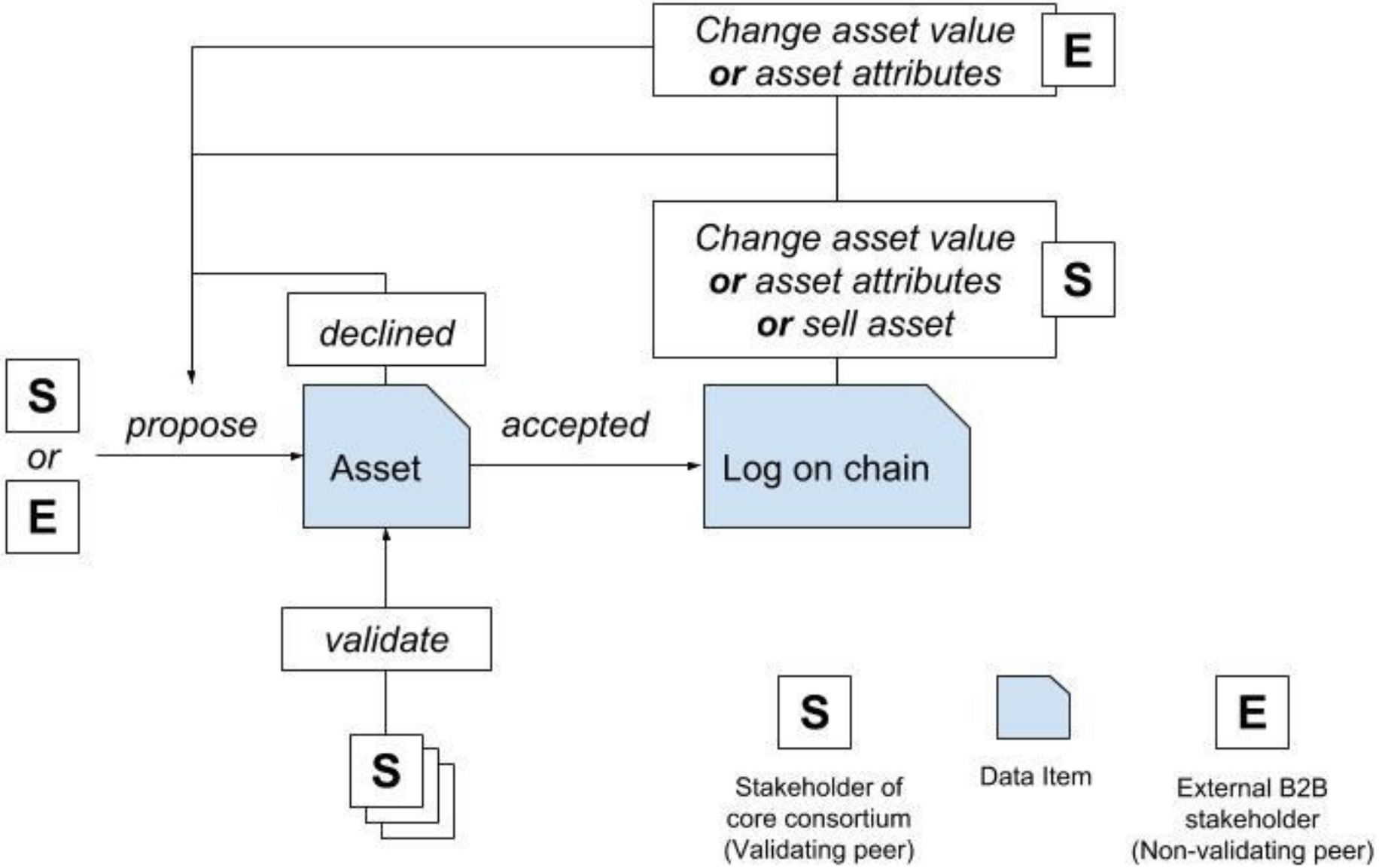
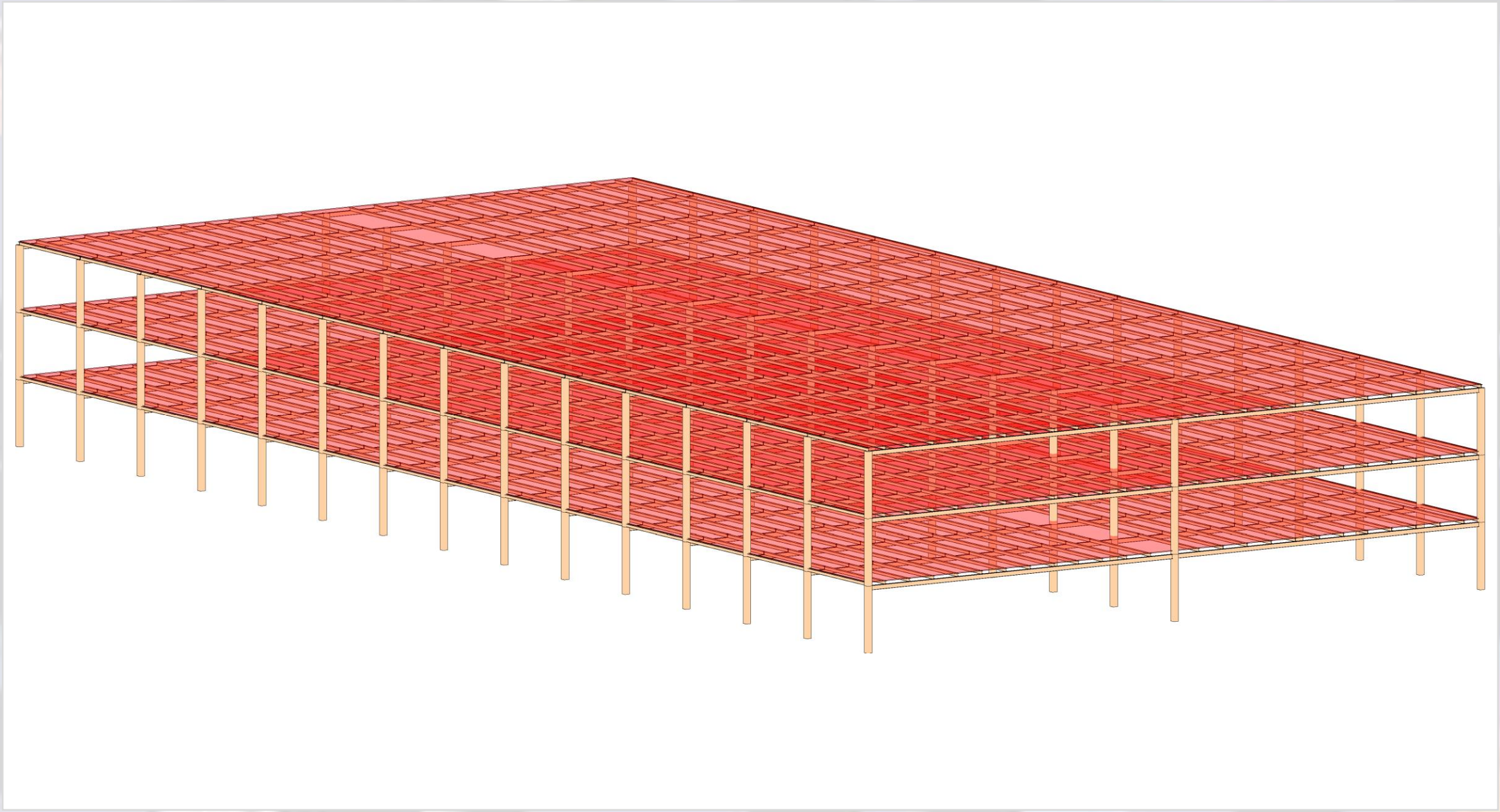
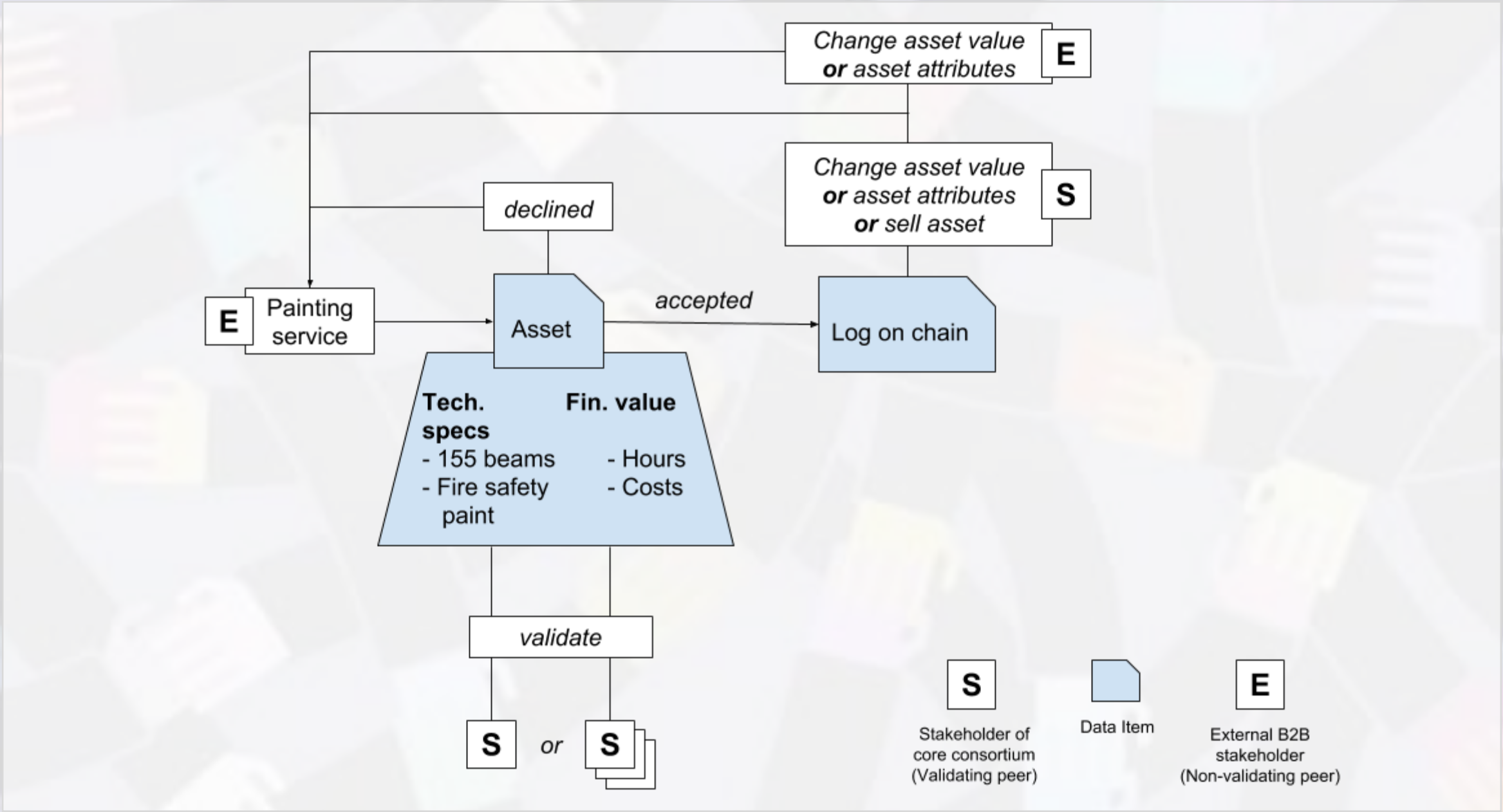
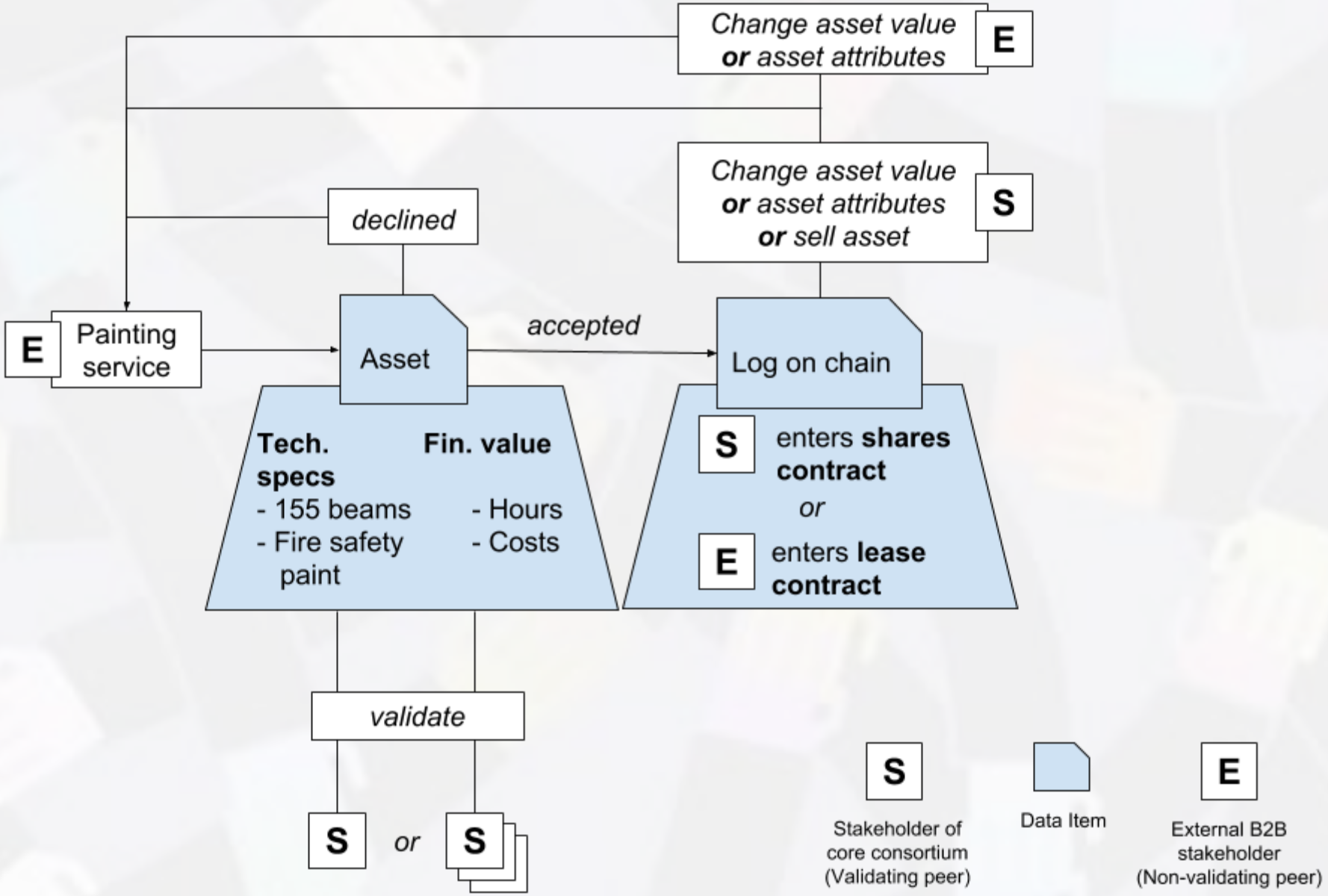
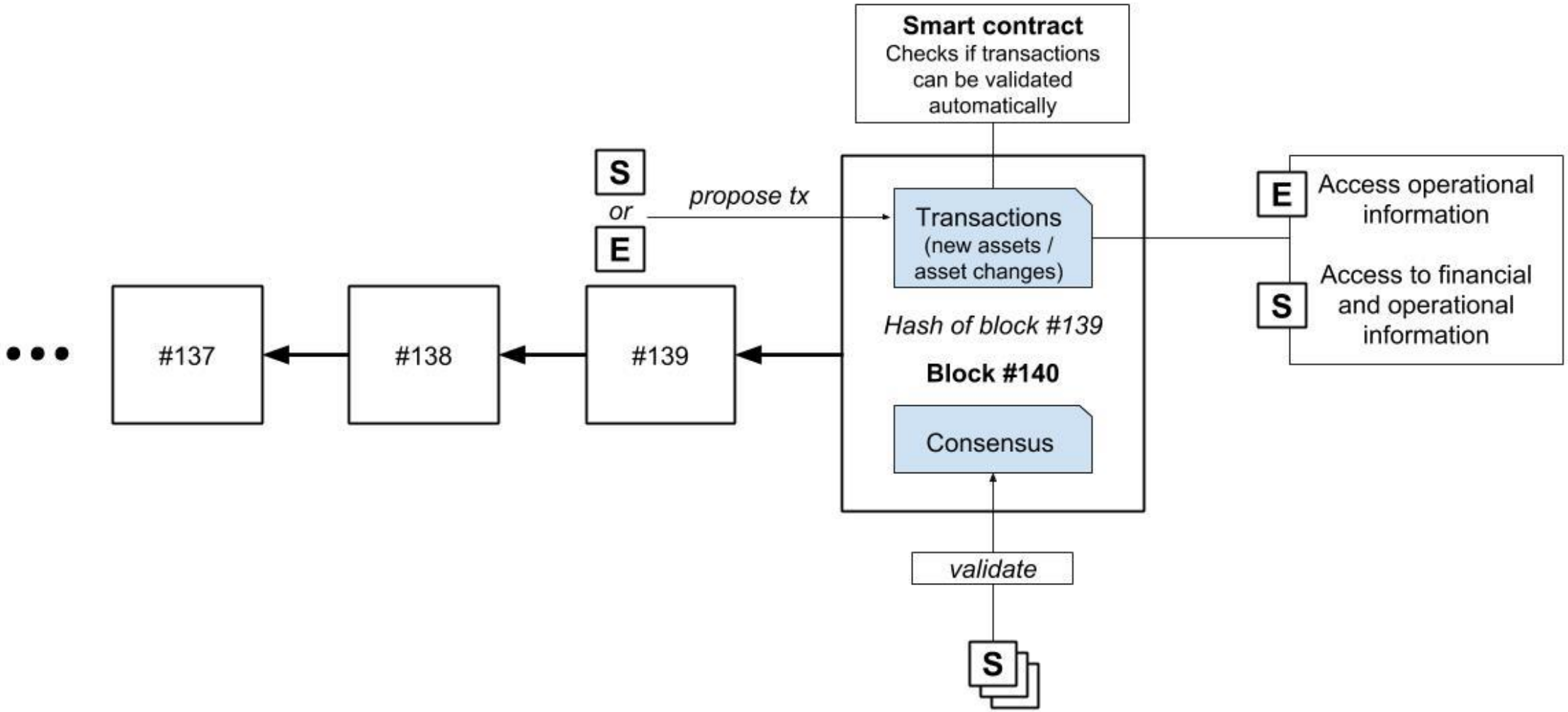
2nd Model

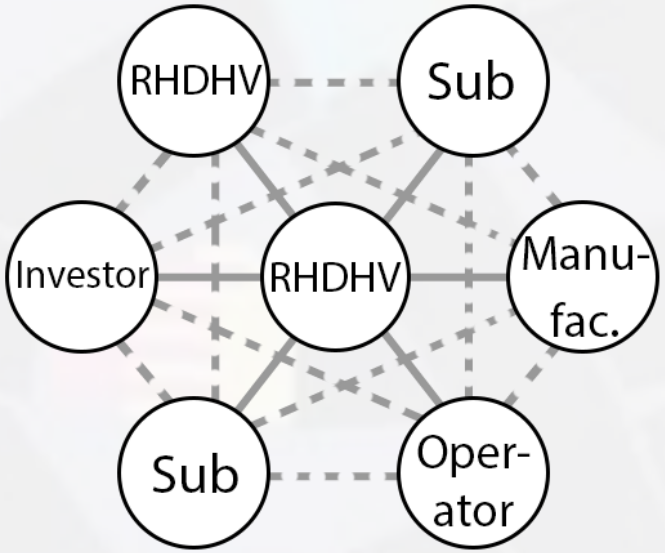

Change asset value
or asset attributes
E
Change asset value
or asset attributes
or sell asset
S
declined
S
or
E
propose
Asset
accepted
Log on chain
validate
S
S
Stakeholder of
core consortium
(Validating peer)
Data Item
E
External B2B
stakeholder
(Non-validating peer)

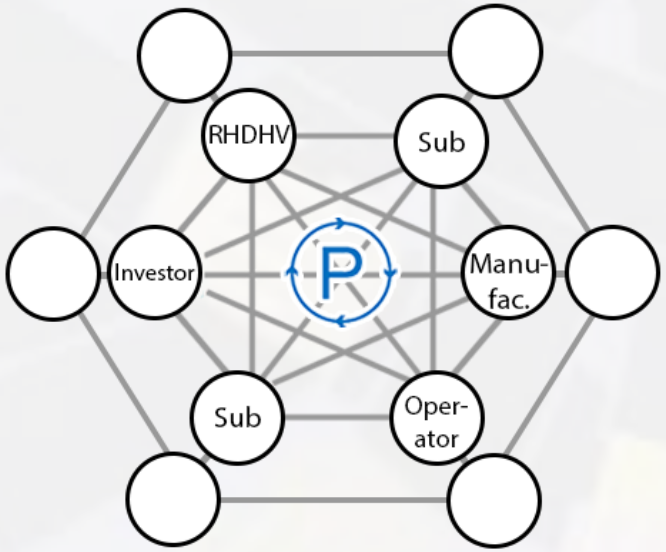


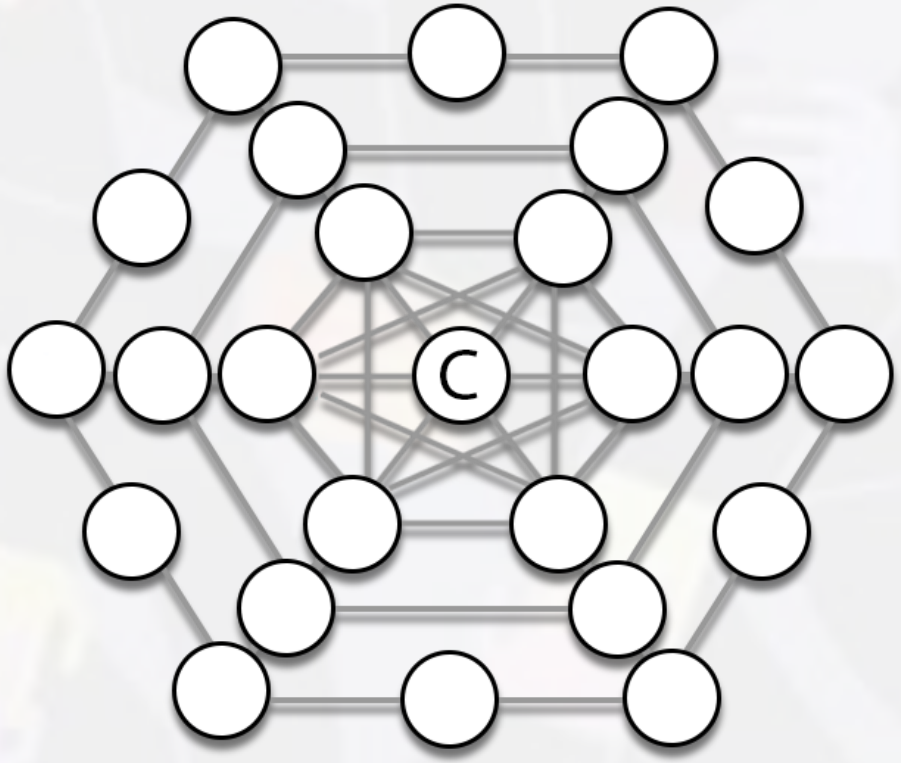

Change asset value
or asset attributes
E
Change asset value
or asset attributes
or sell asset
S
declined
E
Painting
service
Asset
accepted
Log on chain
Tech.
specs
- 155 beams
- Fire safety
paint
Fin. value
- Hours
- Costs
validate
S
or
S
S
Stakeholder of
core consortium
(Validating peer)
Data Item
E
External B2B
stakeholder
(Non-validating peer)


Change asset value
or asset attributes
E
Change asset value
or asset attributes
or sell asset
S
declined
E
Painting
service
Asset
accepted
Log on chain
Tech.
specs
- 155 beams
- Fire safety
paint
Fin. value
- Hours
- Costs
S
enters shares
contract
or
E
enters lease
contract
validate
S
or
S
S
Stakeholder of
core consortium
(Validating peer)
Data Item
E
External B2B
stakeholder
(Non-validating peer)

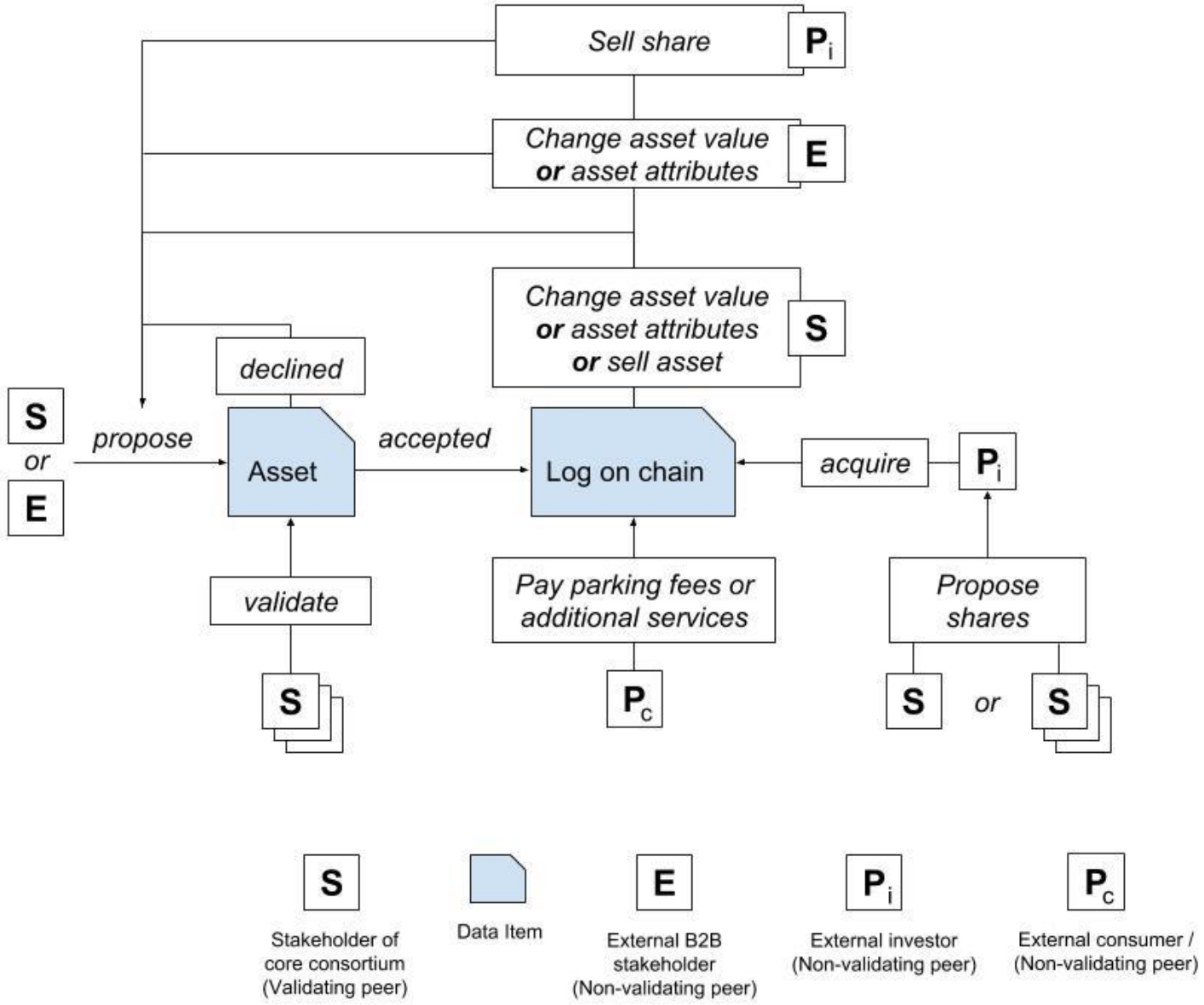

Smart contract
Checks if transactions can be validated automatically
S
or
E
propose tx
Transactions
(new assets / asset changes)
Hash of block #139
Block #140
Consensus
validate
S
E
Access operational information
S
Access to financial and operational information
#137
#138
#139

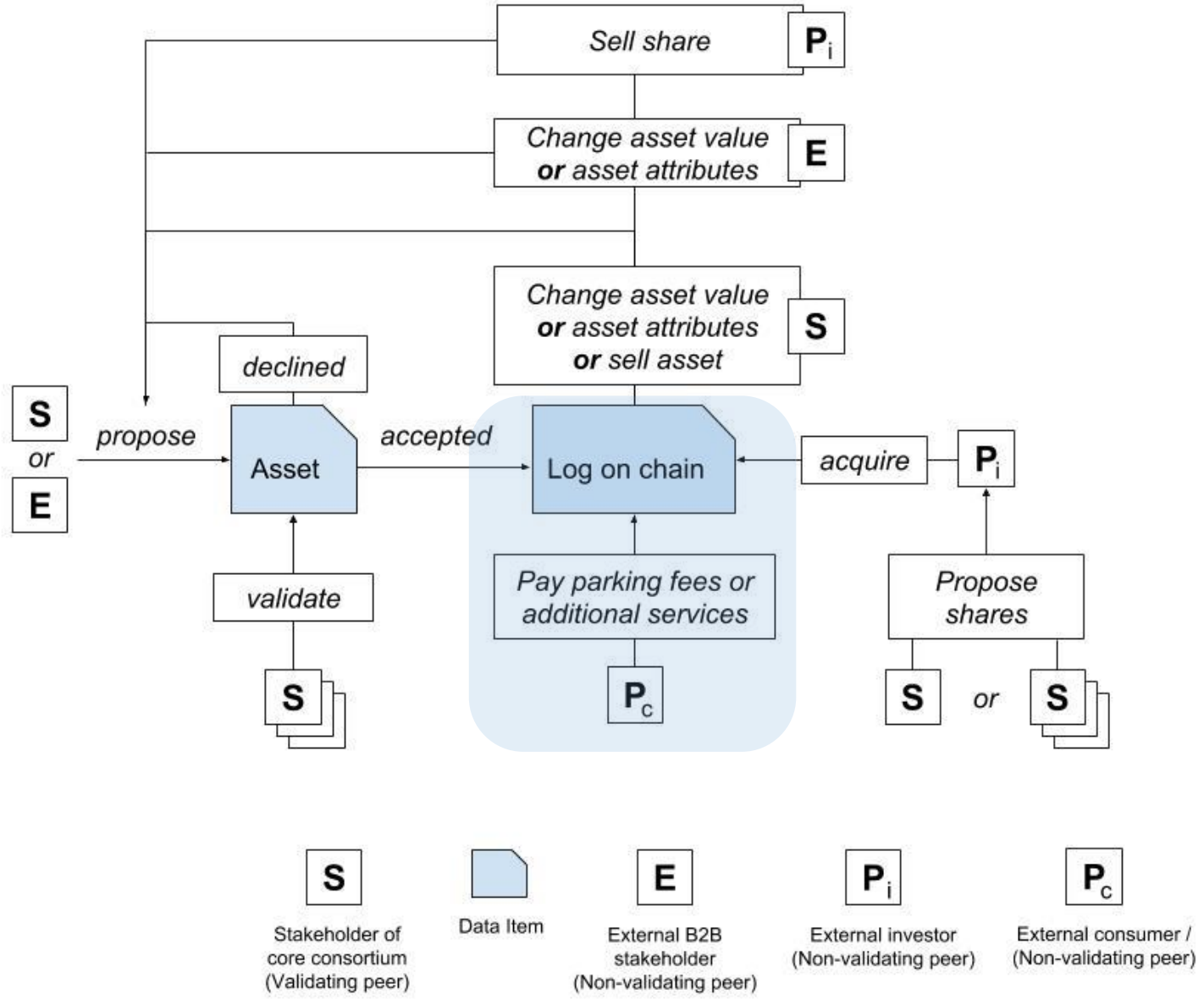

RHDHV
Sub
Investor
RHDHV
Manu-
fac.
Sub
Oper-
ator


RHDHV
Sub
Investor
P
Manu-
fac.
Sub
Oper-
ator


C

3rd Model


Sell share
Pi
Change asset value
or asset attributes
E
Change asset value
or asset attributes
or sell asset
S
declined
S
or
E
propose
Asset
accepted
Log on chain
acquire
Pi
validate
Pay parking fees or
additional services
Propose
shares
S
Pc
S
or
S
S
Stakeholder of
core consortium
(Validating peer)
Data Item
E
External B2B
stakeholder
(Non-validating peer)
Pi
External investor
(Non-validating peer)
Pc
External consumer /
(Non-validating peer)


Sell share
Pi
Change asset value
or asset attributes
E
Change asset value
or asset attributes
or sell asset
S
declined
S
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E
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Asset
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Log on chain
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Pay parking fees or
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S
S
or
S
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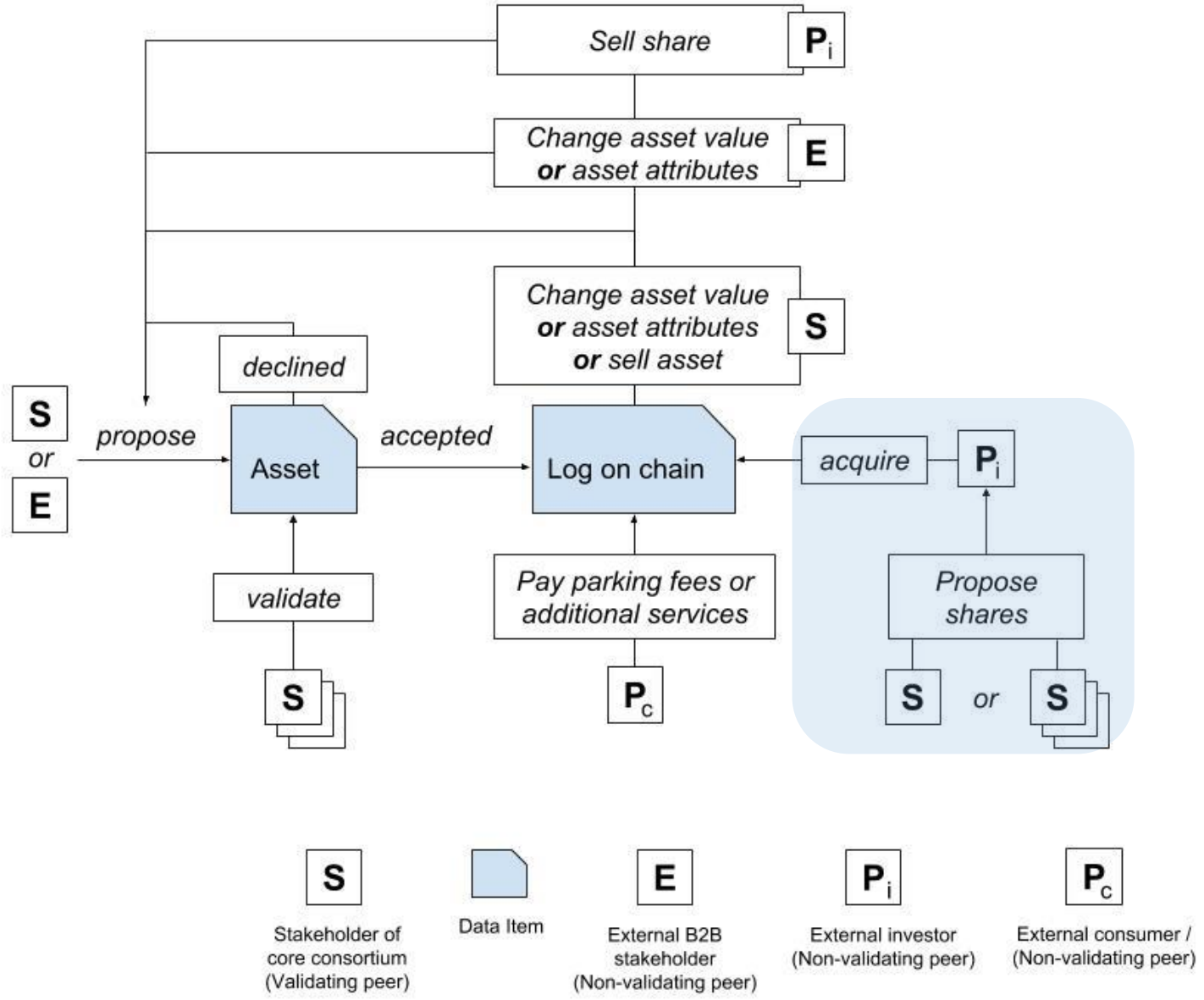
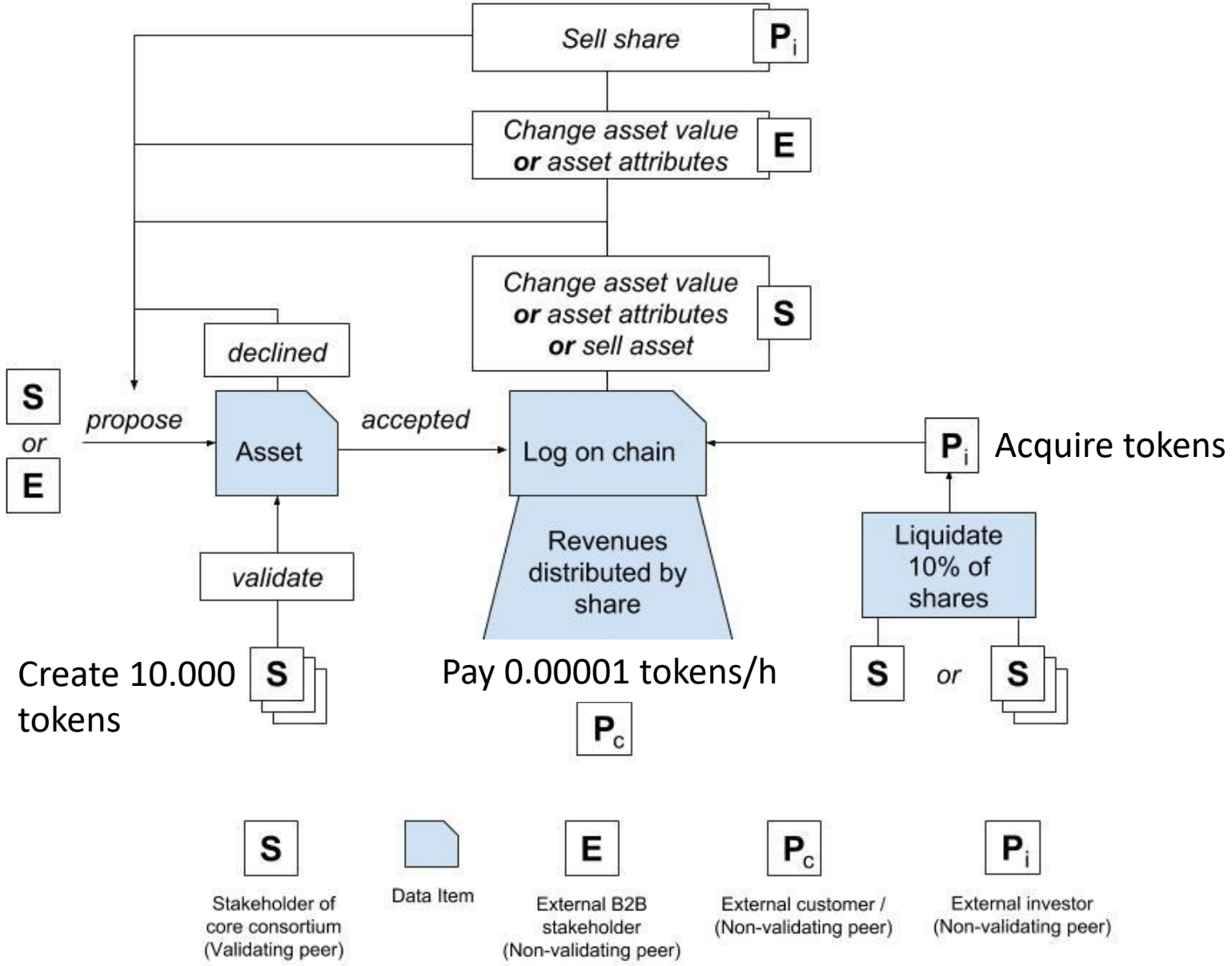
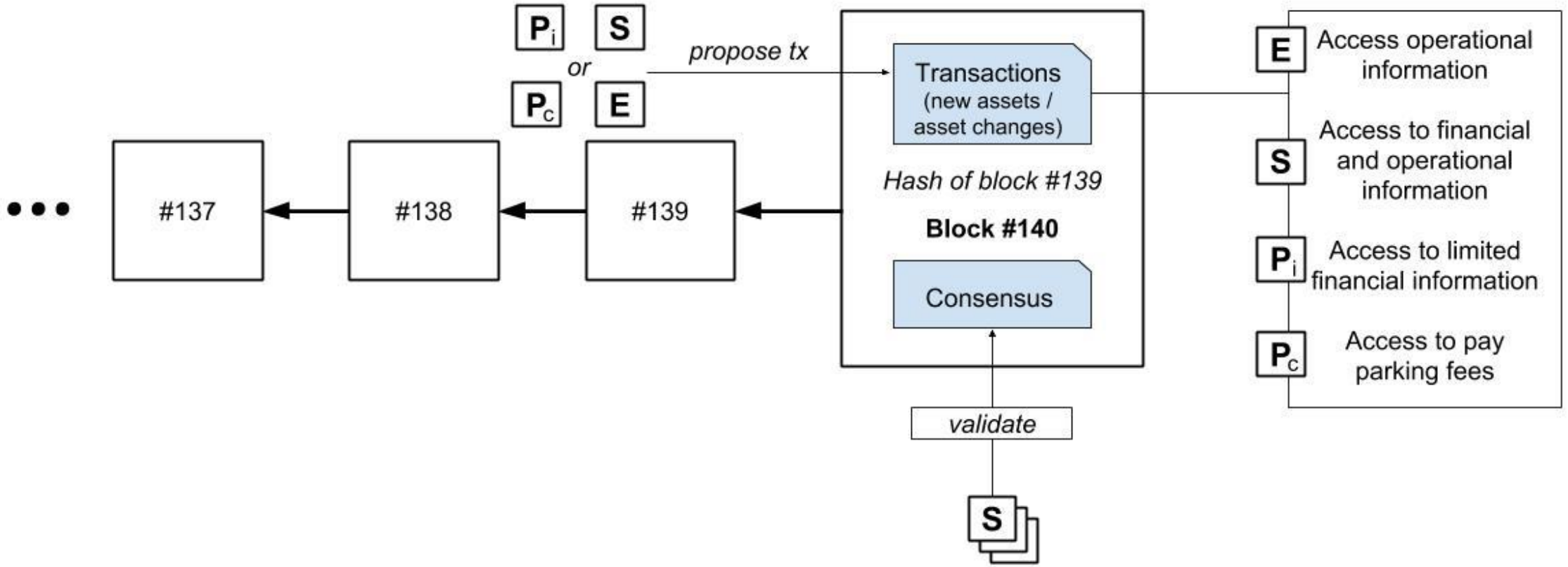
S
Stakeholder of
core consortium
(Validating peer)
Data Item
E
External B2B
stakeholder
(Non-validating peer)
Pi
External investor
(Non-validating peer)
Pc
External consumer /
(Non-validating peer)


Sell share
Pi
Change asset value
or asset attributes
E
Change asset value
or asset attributes
or sell asset
S
declined
S
or
E
propose
Asset
accepted
Log on chain
acquire
Pi
validate
Pay parking fees or
additional services
Propose
shares
S
S
or
S
Pc
S
Stakeholder of
core consortium
(Validating peer)
Data Item
E
External B2B
stakeholder
(Non-validating peer)
Pi
External investor
(Non-validating peer)
Pc
External consumer /
(Non-validating peer)

Shares as tokens

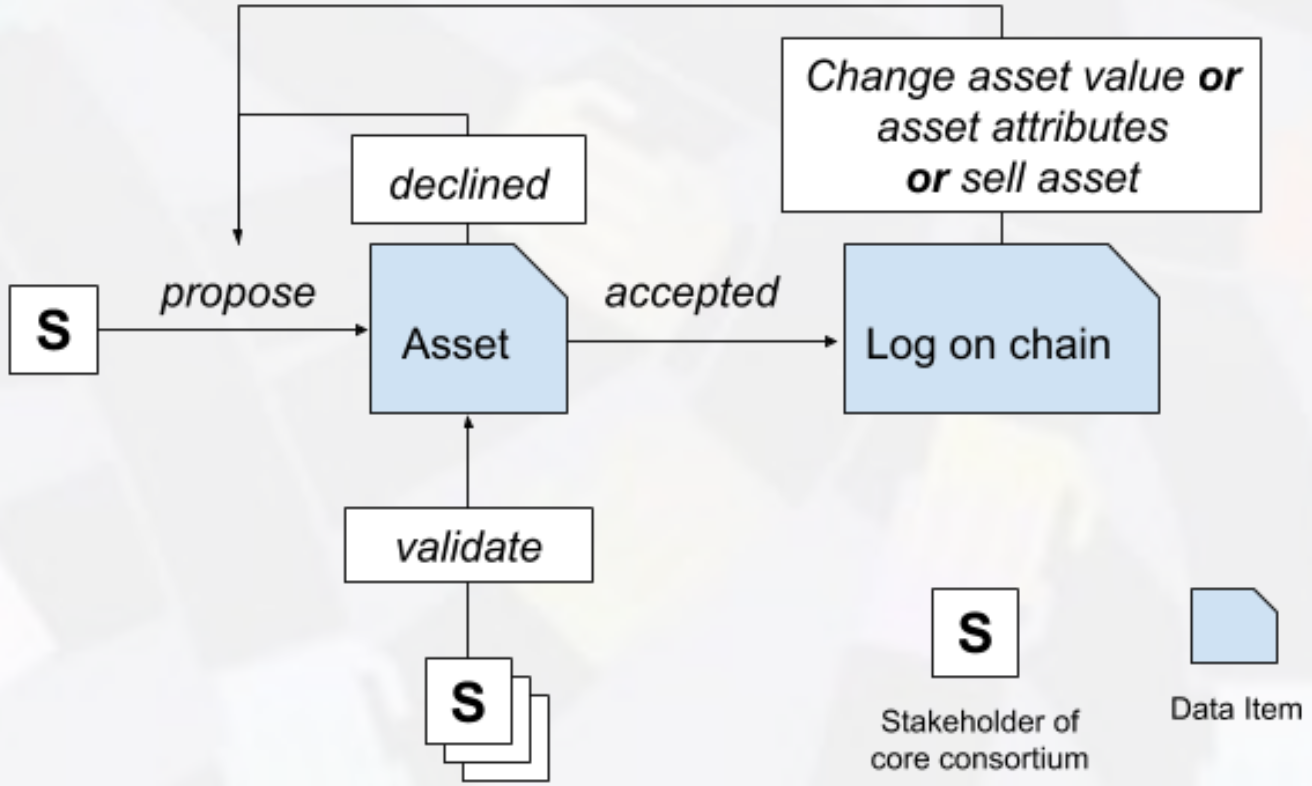



Pi
S
or
Pc
E
propose tx
Transactions
(new assets /
asset changes)
Hash of block #139
Block #140
Consensus
validate
S
#137
#138
#139
E
Access operational
information
S
Access to financial
and operational
information
Pi
Access to limited
financial information
Pc
Access to pay
parking fees

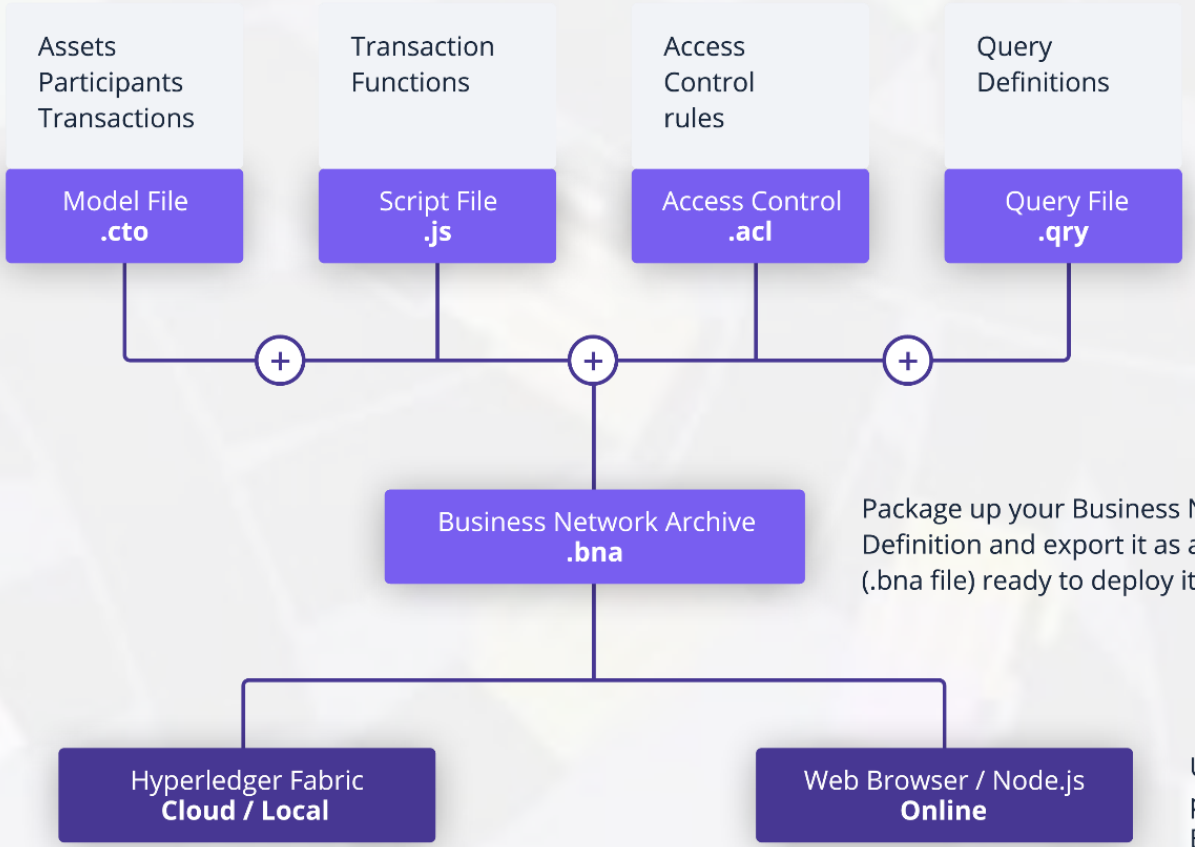
Prototype demo

https://github.com/3en3en/xdecks-network

Prototype demo



Business network file structure



Use Composer to create a Business Network Definition, comprised of Model (.cto), Script (.js), ACL (.acl) and Query (.qry) files.

Package up your Business Network Definition and export it as an archive (.bna file) ready to deploy it somewhere.

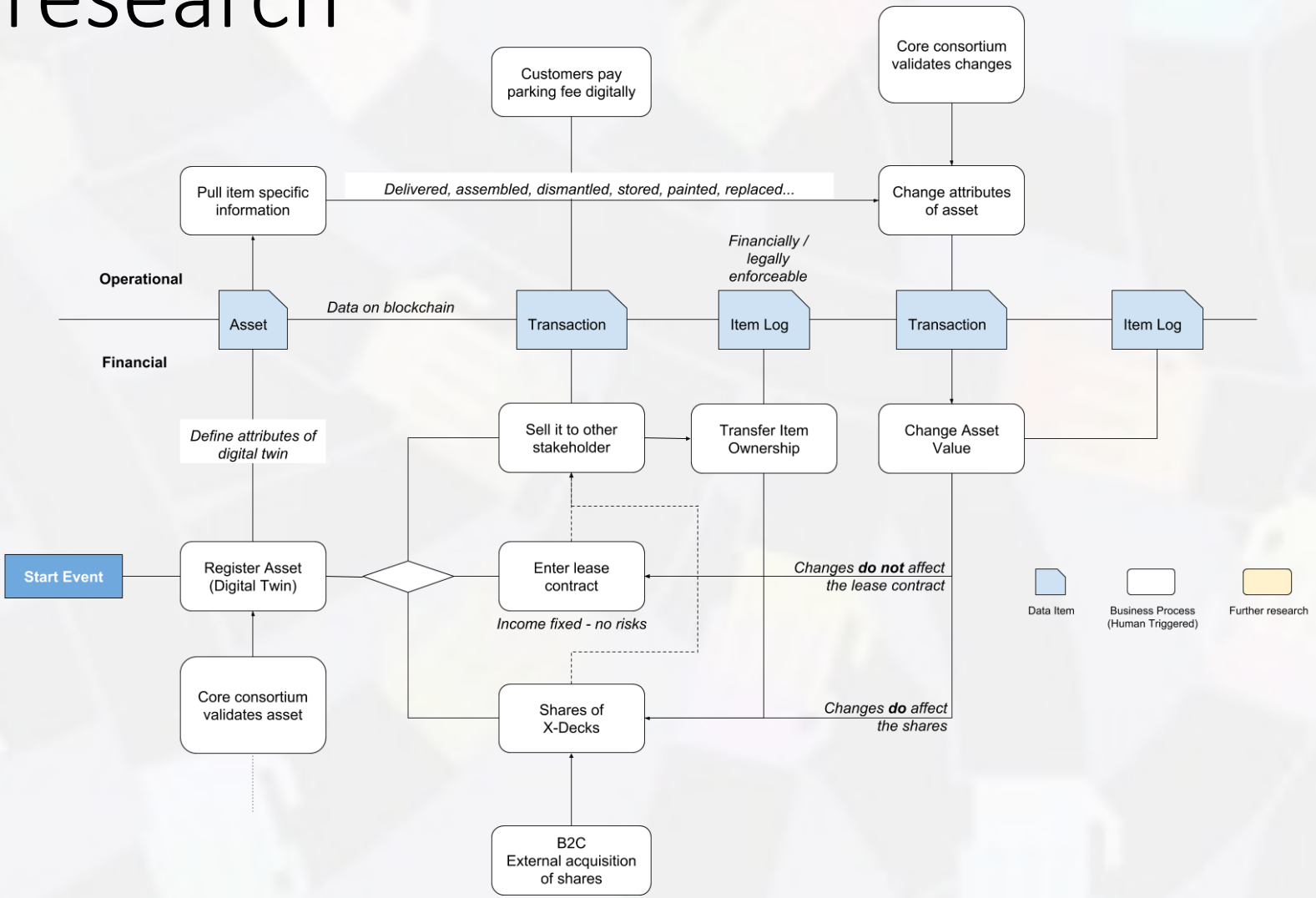
Use ID Cards (which include connection profiles and credentials) to deploy your Business Network Definition to a distributed ledger.

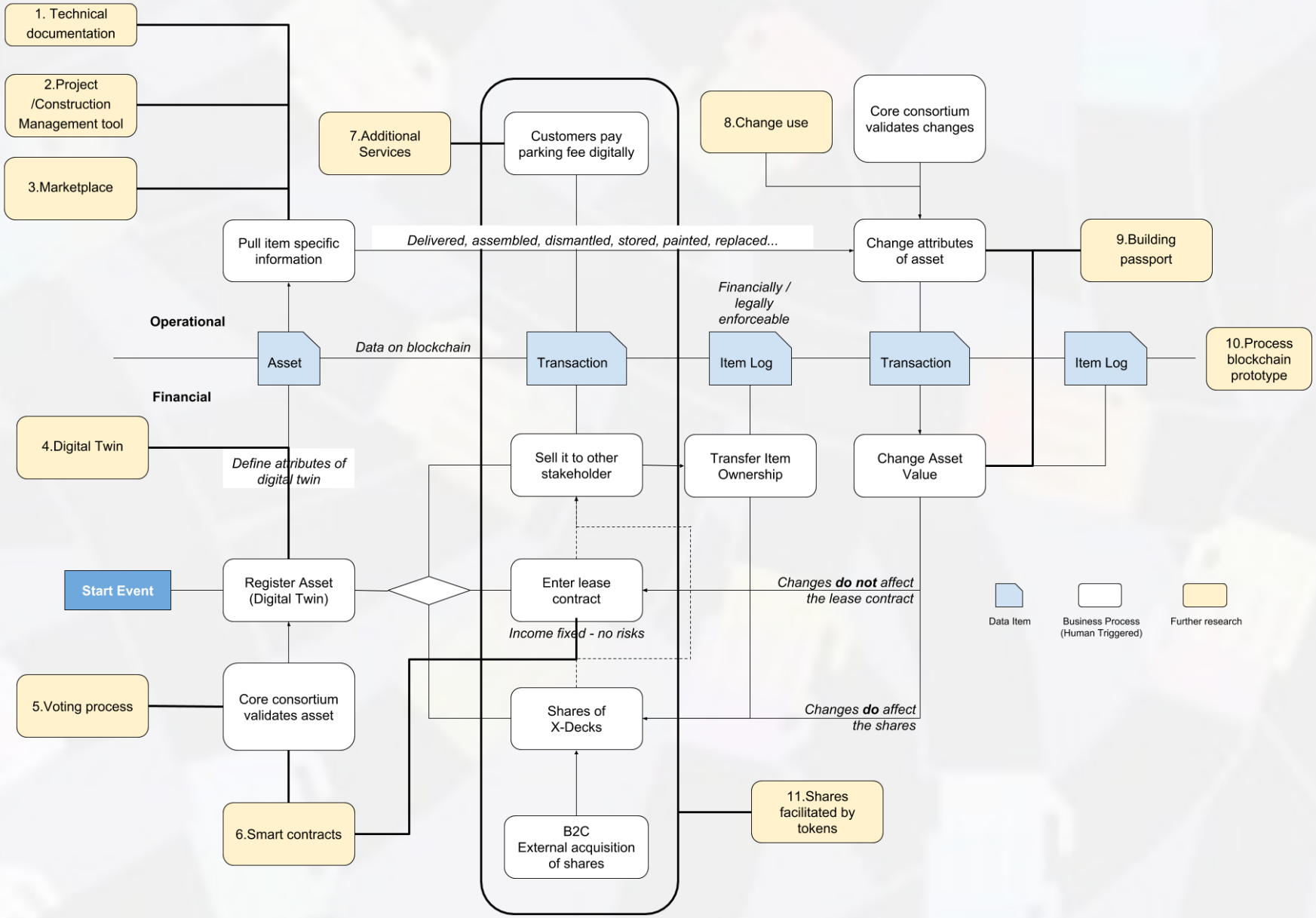
Linux Foundation (2018)

Further research

- Continue to involve stakeholders, concretize chances, liabilities, success factors
- Connect building passport, Digital Twin & smart contracts

Further research




1. Technical documentation
2.Project /Construction Management tool
3.Marketplace
7.Additional Services
Customers pay parking fee digitally
8.Change use
Core consortium validates changes
Pull item specific information
Delivered, assembled, dismantled, stored, painted, replaced...
Change attributes of asset
9.Building passport
Financially / legally enforceable
Operational
Asset
Data on blockchain
Transaction
Item Log
Transaction
Item Log
10.Process blockchain prototype
Financial
4.Digital Twin
Define attributes of digital twin
Sell it to other stakeholder
Transfer Item Ownership
Change Asset Value
Start Event
Register Asset (Digital Twin)
Enter lease contract
Changes do not affect the lease contract
Income fixed - no risks
Data Item
Business Process (Human Triggered)
Further research
5.Voting process
Core consortium validates asset
Shares of X-Decks
Changes do affect the shares
6.Smart contracts
B2C External acquisition of shares
11.Shares facilitated by tokens

Conclusion

- **Liabilities and shares** to become part of a core consortium are **new duties** for the stakeholders and are **faced with reluctance**

Conclusion

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BUT

Conclusion

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BUT

- Blockchain can create a new, **trustable environment** to facilitate **organizational, managerial and financial changes** that are **very much needed by all stakeholders** to **lower risks**, **enhance cooperation, transparency and agility.**

Conclusion

- **Liabilities and shares** to become part of a core consortium are **new duties** for the stakeholders and are **faced with reluctance**

BUT

- Blockchain can create a new, **trustable environment** to facilitate **organizational, managerial and financial changes** that are **very much needed by all stakeholders** to **lower risks**, **enhance cooperation, transparency and agility**

AND

- Seeking for new solutions can result in **competitive advantages to enter new business segments over the whole lifecycle of a building** and strengthen the stakeholders' role as a **pioneer in the field of digital transformation** in the build environment. **+X-Decks suitable case**

Breaking News

From Delft to the World

Students earn money with blockchain enabled parking project

It is in your hands

And below here is a load of gibberish, just to fill the space out and so you can see how text flows through a newspaper.

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis vehicula lacus eros, sit amet malesuada purus euismod ut. Duis et felis sit amet eros interdum varius. Curabitur tortor odio, gravida quis felis in, pretium rhoncus quam. Aenean ante tellus, faucibus vel gravida sagittis, bibendum a sapien. Quisque vel malesuada nibh, vitae adipiscing tellus. Integer et dictum odio. Morbi luctus ante id diam congue mattis. Fusce accumsan at nibh sit amet volutpat. Fusce aliquet gravida diam. Phasellus justo elit, posuere ac egestas ut, varius vitae nibh. Integer consequat erat velit, non dapibus neque volutpat vitae. Phasellus a porttitor turpis. Vivamus laoreet quam mi, at porttitor ipsum faucibus in.

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Will this shake the real estate industry?

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Curabitur vel nunc tincidunt, sagittis lorem sit amet, condimentum libero. Integer pharetra consequat pulvinar. Nam non magna ornare, sollicitudin elit quis, varius nunc. Donec in semper nunc, sit amet rhoncus erat. In hac habitasse platea dictumst. Sed pellentesque augue non placerat molestie. Phasellus fringilla commodo tellus a pellentesque. Donec tempor, mi id scelerisque venenatis, sapien purus gravida tortor, non tempor odio lectus quis enim. Phasellus ut eros porta, tempus libero vitae, sodales mauris. Aenean laoreet, justo eget pharetra luctus, augue velit laoreet diam, at facilisis leo elit a massa. Proin felis sapien, rhoncus at arcu id, euismod commodo turpis. Cras fringilla eleifend eros eget euismod. Integer ullamcorper convallis metus a ornare. Suspendisse quis augue convallis, laoreet tortor quis, lobortis neque. Praesent semper lacus at sem tincidunt euismod. Phasellus viverra ipsum in augue ultrices dignissim.

First of its kind

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