Designing Yield Estimation Mechanism Using Blockchain Technology

Yield Estimation

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TCMB, Inflation Report 2018

"Driven by fresh vegetable products, the unprocessed food group stood out as the highest contributor to consumer inflation in the first half of 2018"

"The conjunctural reasons underlying the price hikes in unprocessed food products are evaluated from the perspective of structural problems"

"the inability to make an efficient and dynamic agricultural production plan is considered to be a significant structural problem. Developing a production plan requires strengthening of agricultural statistics, yield estimation and early warning system infrastructure."

"Establishing a systematic structure to facilitate a dynamic follow-up and estimation of agricultural yields will also contribute to the timely adoption of measures required to maintain sustainability of supply and price stability"

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  it can be used to take action during the growing season

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Years	Cultivation Area (decare)	Production (ton)
2017	80.000	523.000
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Onion Production in Polatli

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- In this study, we will propose a blockchain based solution to determine the yield of agricultural products.

  Our solution can be considered as a platform that enables the producers to share their farming plan with the other players, and makes them to review their investments for the oncoming season.

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registration authority (RA), manages the registration process of farmers and auditors by assigning each entity a unique credential if he satisfies the conditions.

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- we build the system on top of a permission blockchain network

Problem Formulation

Security Discussion

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Security Discussion

- A malicious producer may
  - declare a yield commitment of the rate different than he has planned
  - change his plan after announcing his commitment according to the others' sharing
  - prefer not to declare a commitment
  - try to change the existing commitments in the database that show him dishonest

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(1) Designing an efficient mechanism to enforce the auditors to report the ‘correct rate’

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(2) Designing an efficient mechanism to enforce the producers to stick to their commitments without discouraging them to declare commitments, or even to register in the system

Preliminaries

Distributed Ledger

- a database shared through a network of players
- all copies of the ledger are periodically updated when any alteration is occurred

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- a database shared through a network of players
- all copies of the ledger are periodically updated when any alteration is occurred
- A robust distributed ledger has two properties :
  - safety, all non-faulty players in the network agree on a total order for the transactions recorded in the ledger
  - liveness, an honestly generated transaction is eventually accepted by all non-faulty players

Preliminaries

Blockchain

- an efficient mechanism that enables us to realize a robust distributed ledger
- considered as a set of blocks that contains an ordered records of transactions

  (each block is pointed by the next block with a reference that is a hash value of the block called parent block)

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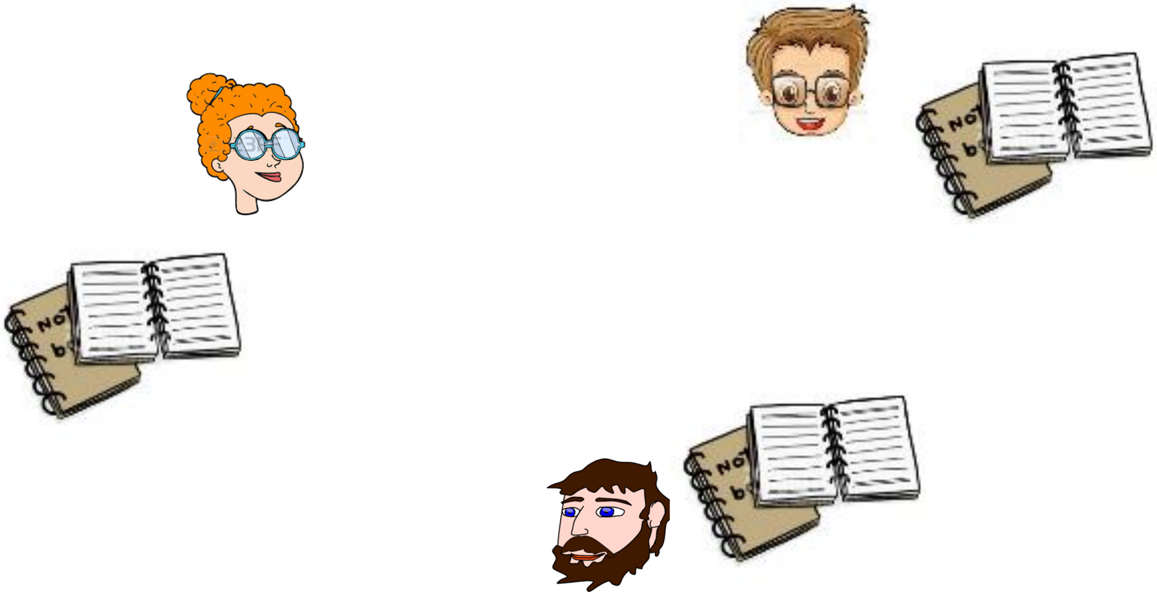
Smart Contracts

- q piece of codes that autonomously execute the terms of a contract
- they are triggered by addressing a transaction to them
- they are executed independently and automatically in a prescribed manner on every node in the network

Preliminaries



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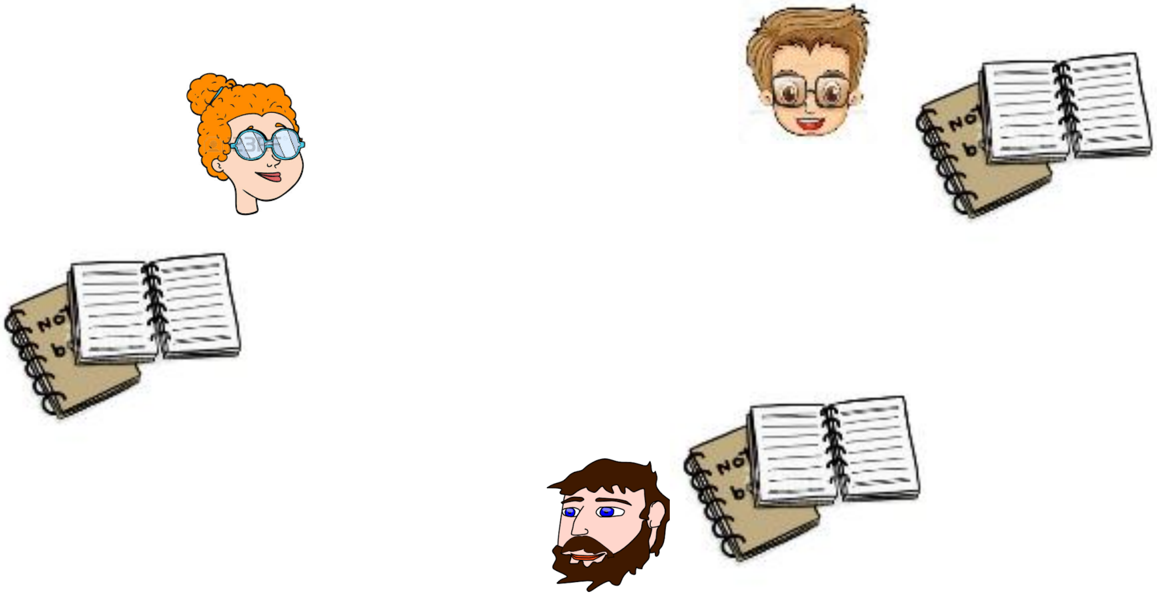

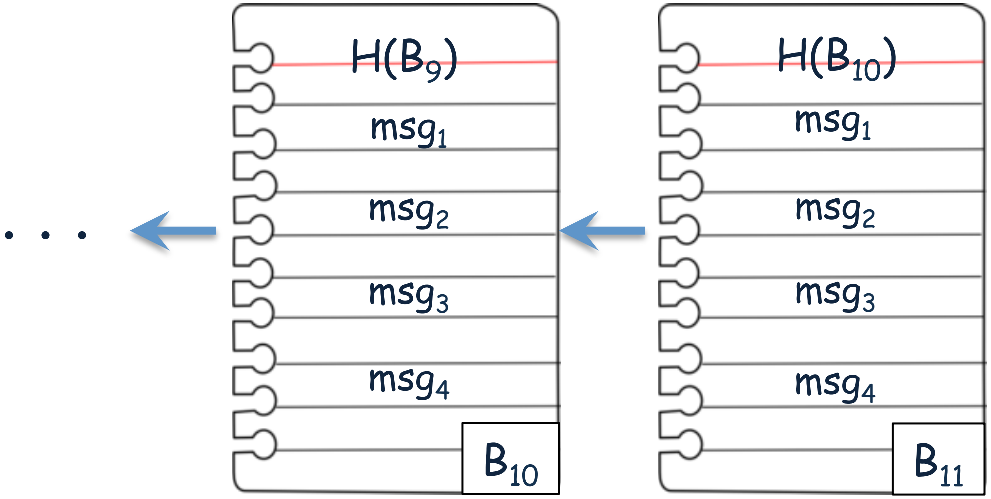

. . .

$H(B_9)$

msg_1

msg_2

msg_3

msg_4

B_{10}

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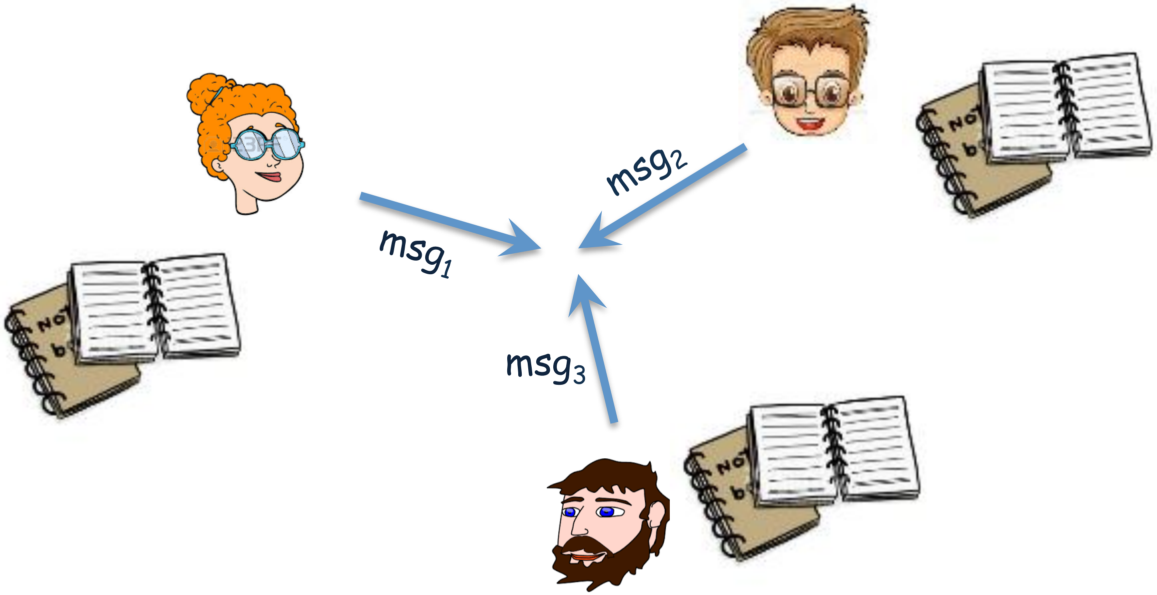

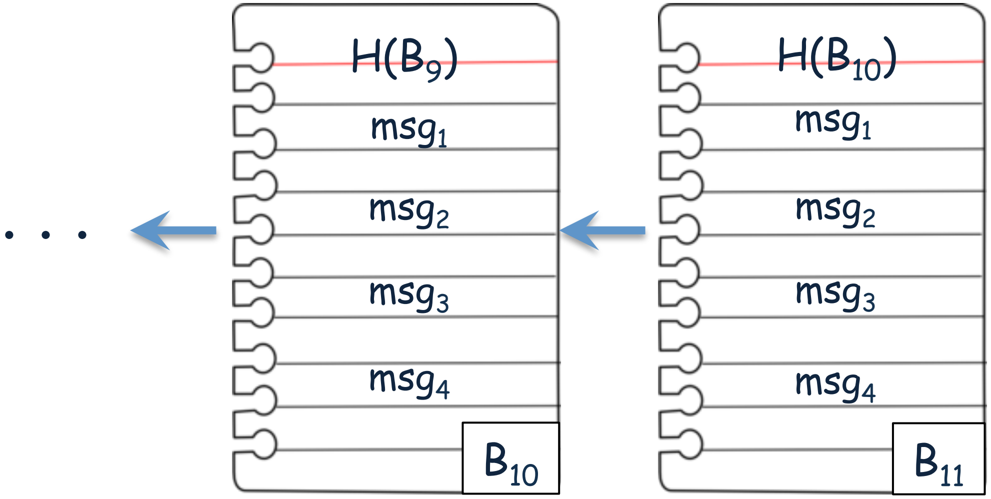

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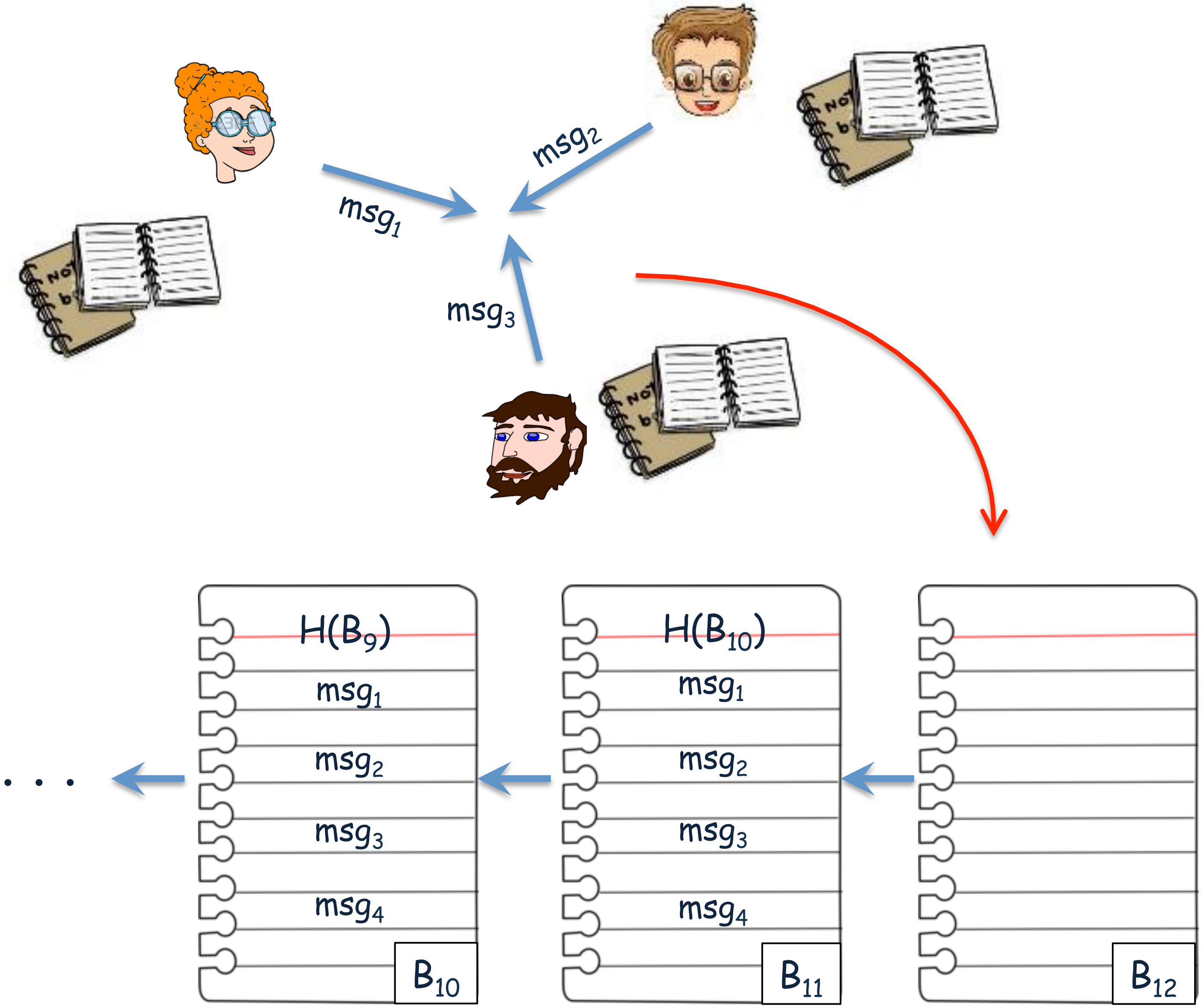

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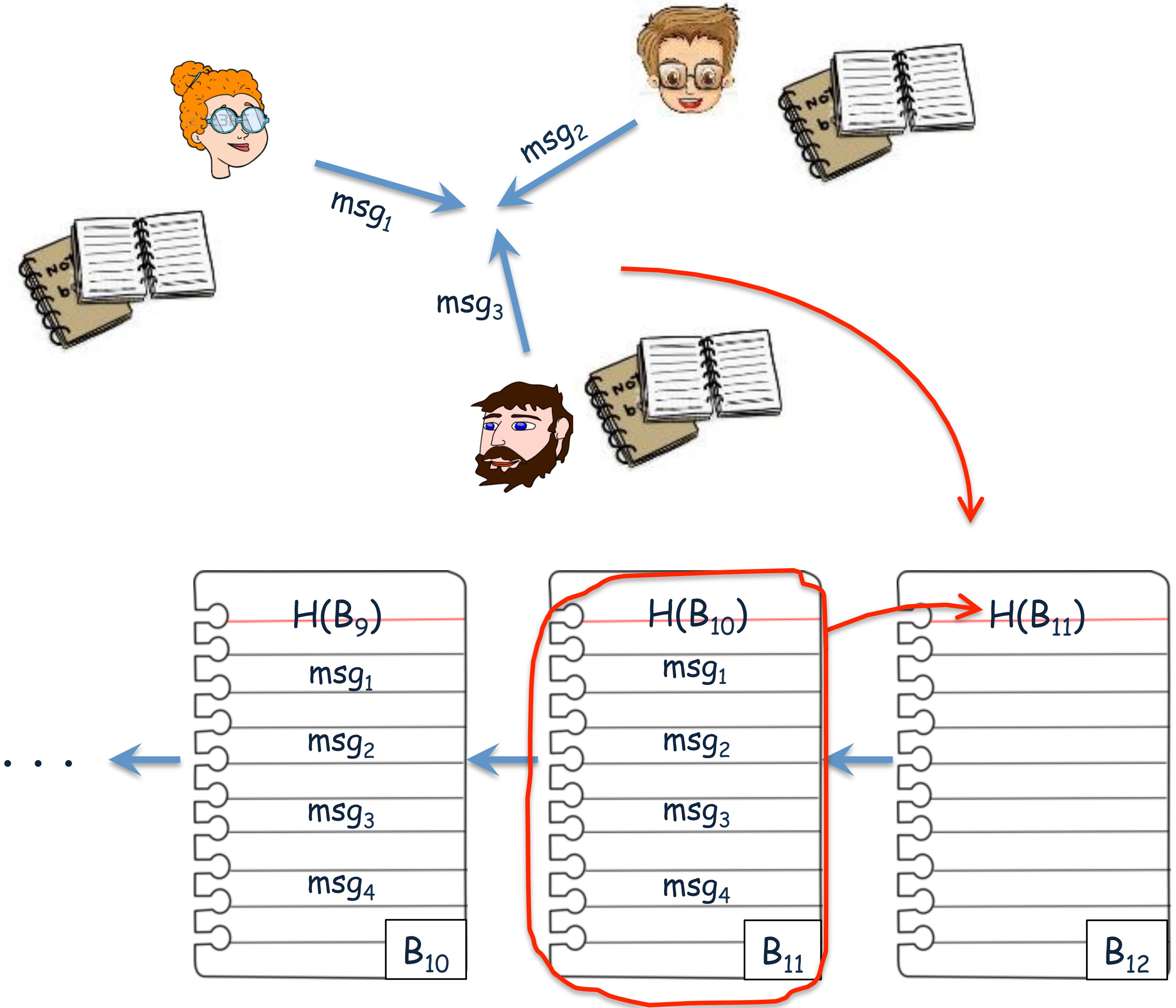

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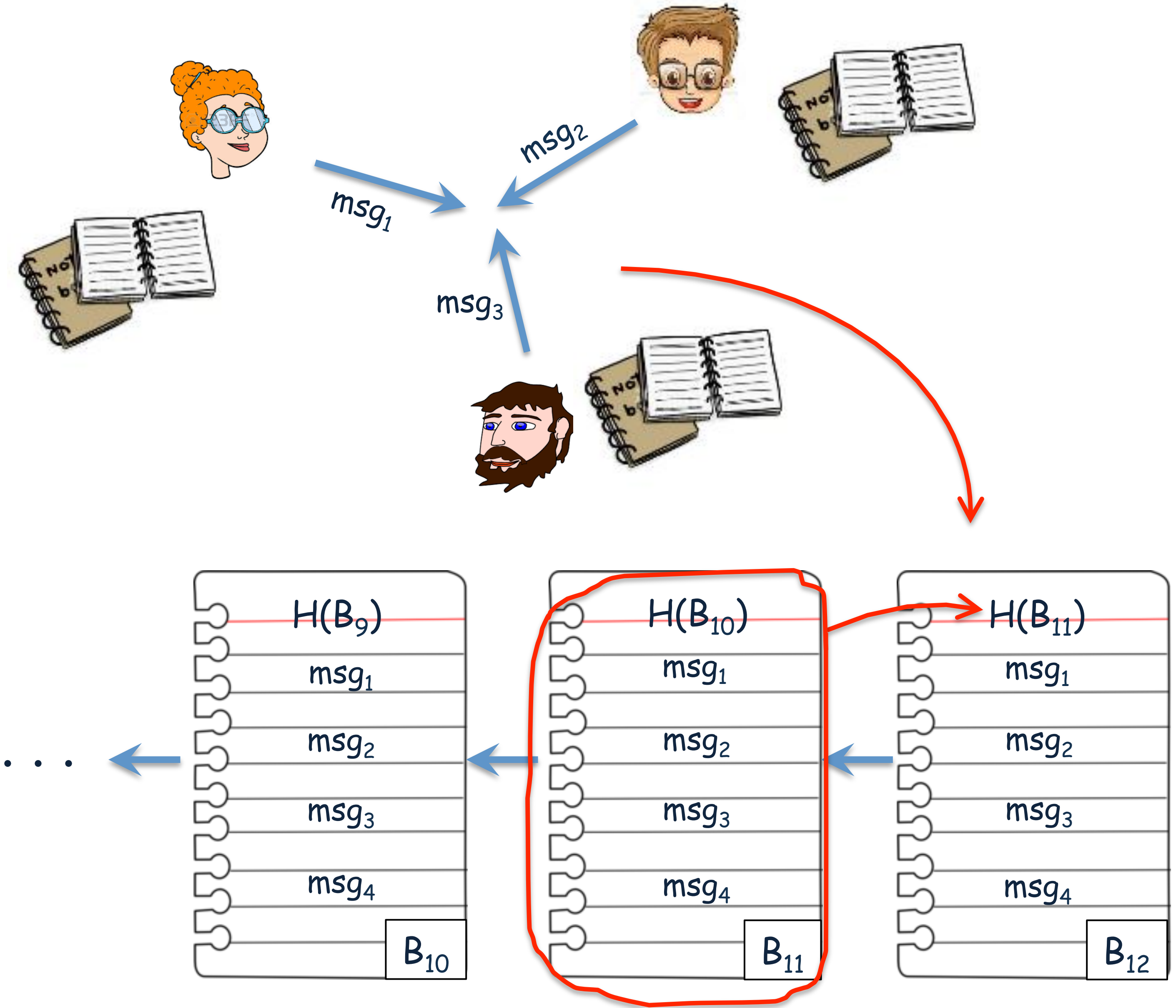

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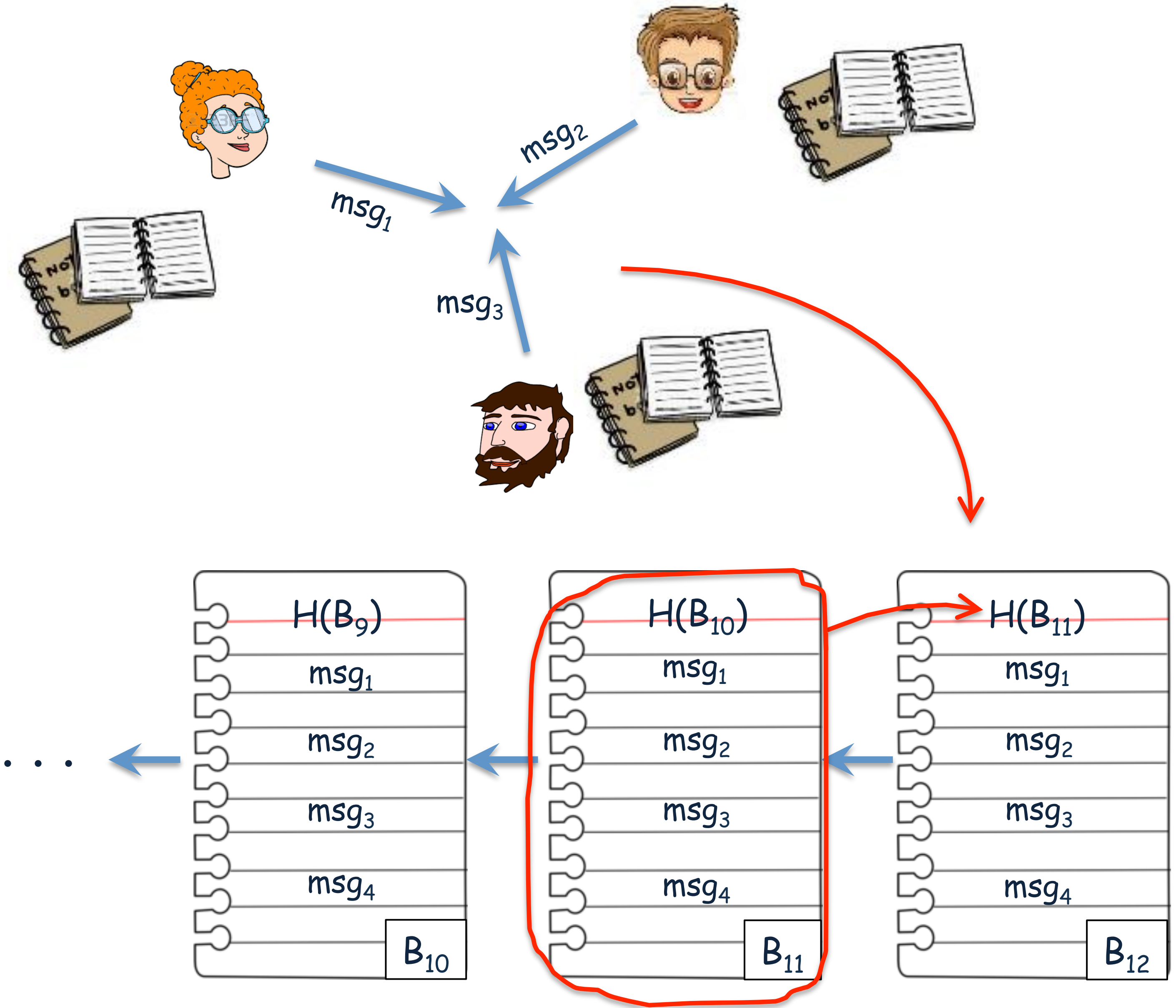

Construction

Farmers

- the natural players who own a farmland and raise crops that correspond to the region of the land
- they support two roles: producer and auditor.
- they have to get a certificate from the agriculture authority of their region in order to register in the system

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Administrators

- the officers that represent the agriculture authority of different regions
- they will be the registration authority and they maintain the platform
- they have to possess a well-established identity

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Registration of Administrators

- we start with a set of administrators, i.e. their identifiers $(A_{i_1}, \ldots, A_{i_m})$ will be specified at the genesis block B_0

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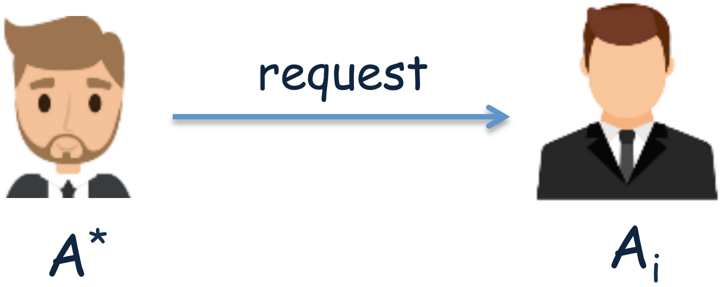

request

A^*

A_i

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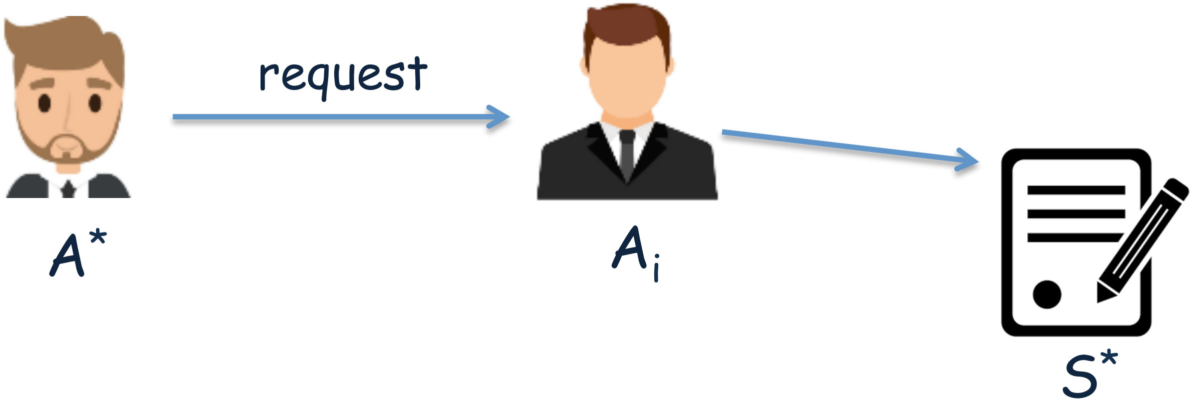

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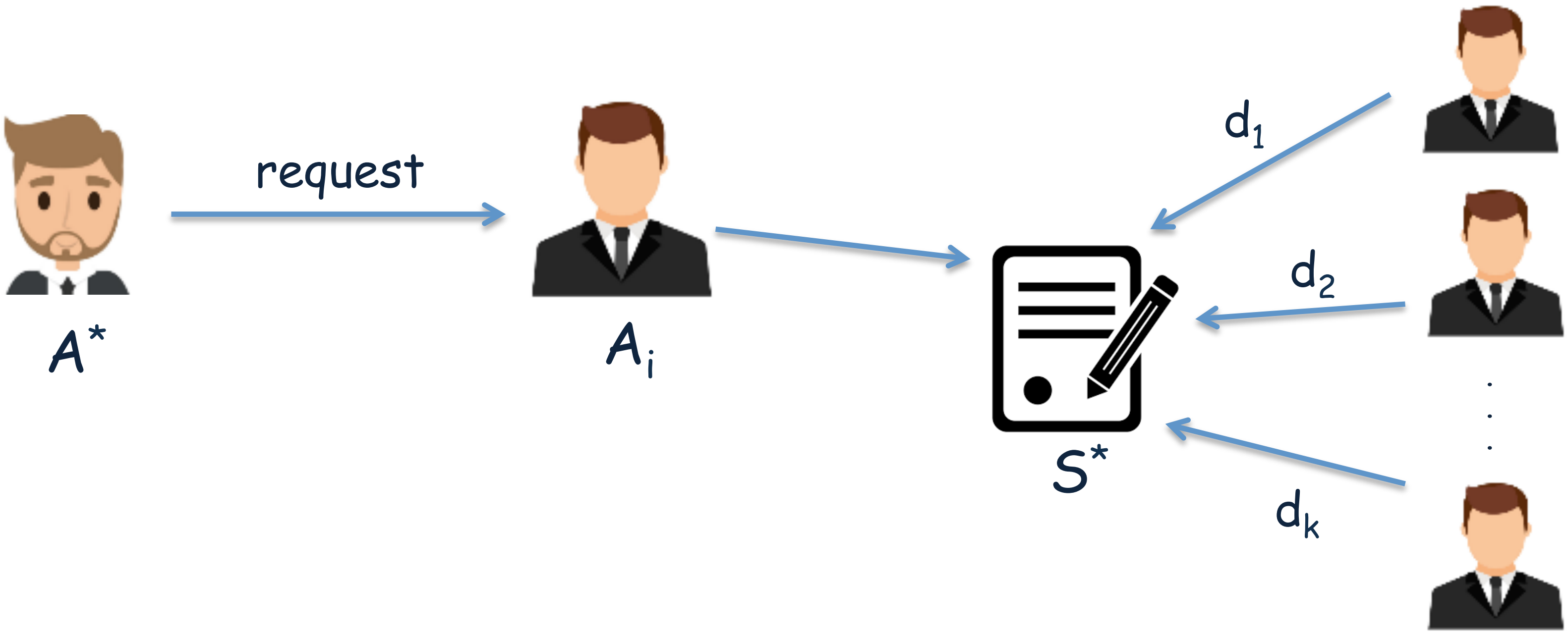

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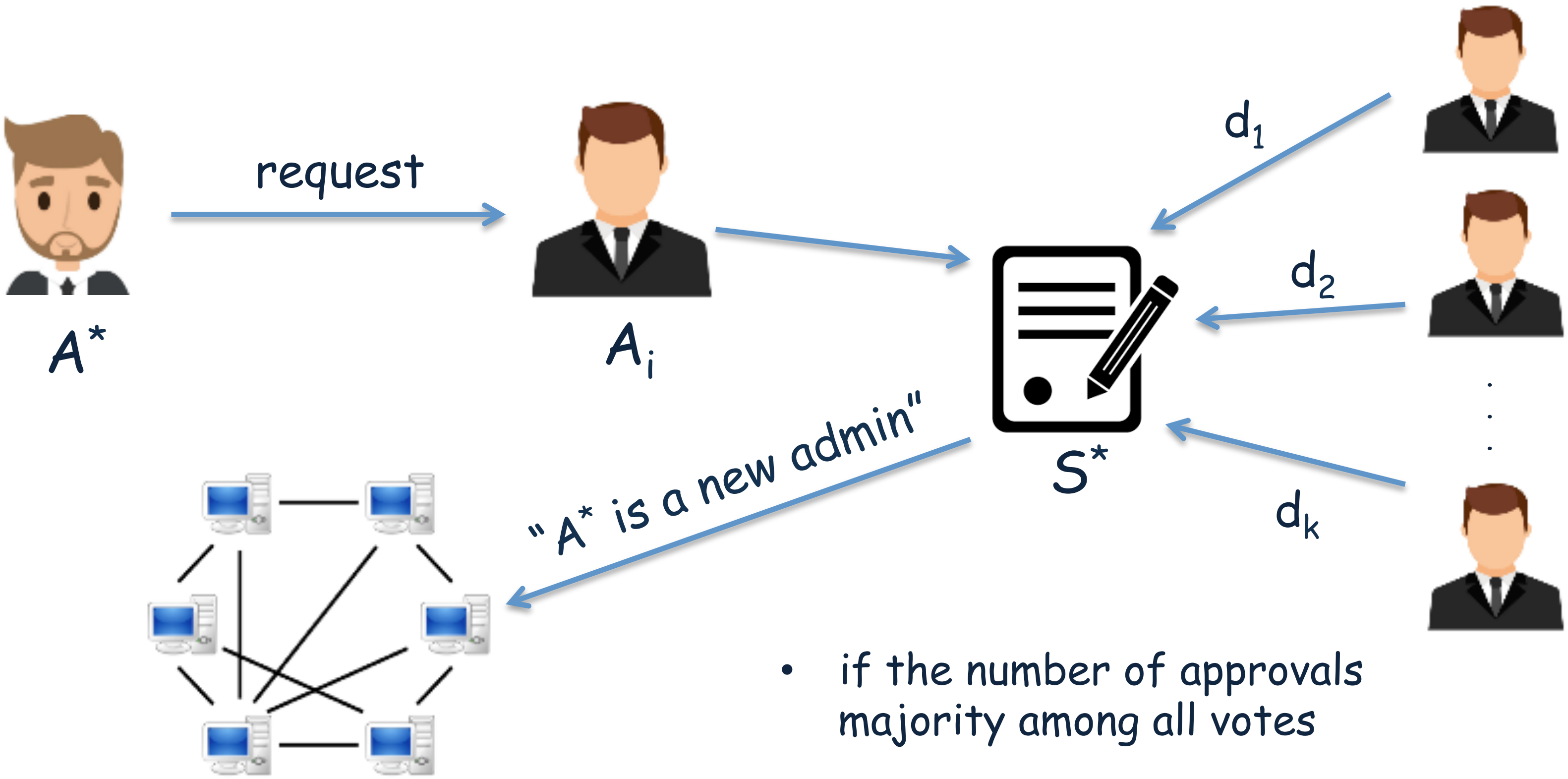

- if the number of approvals majority among all votes

Construction

Registration of Farmer

F_u

Construction

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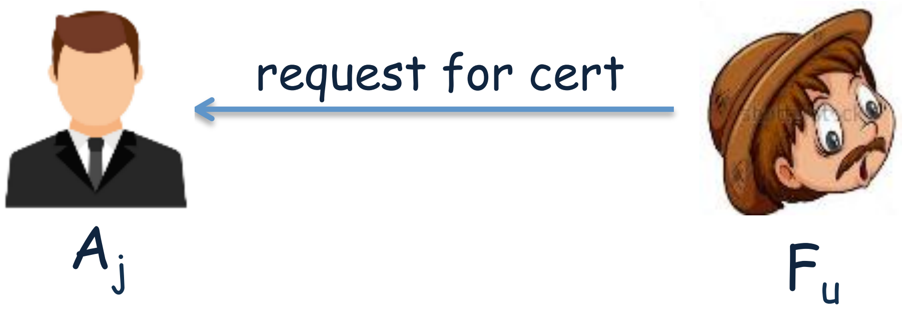

request for cert

A_j

F_u

Construction

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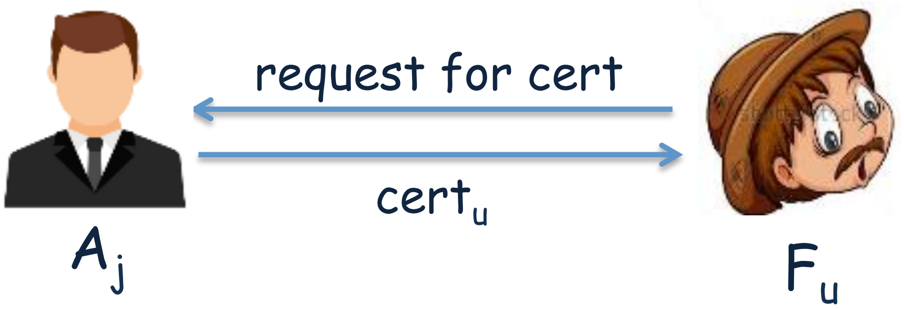

request for cert

$cert_u$

A_j

F_u

Construction

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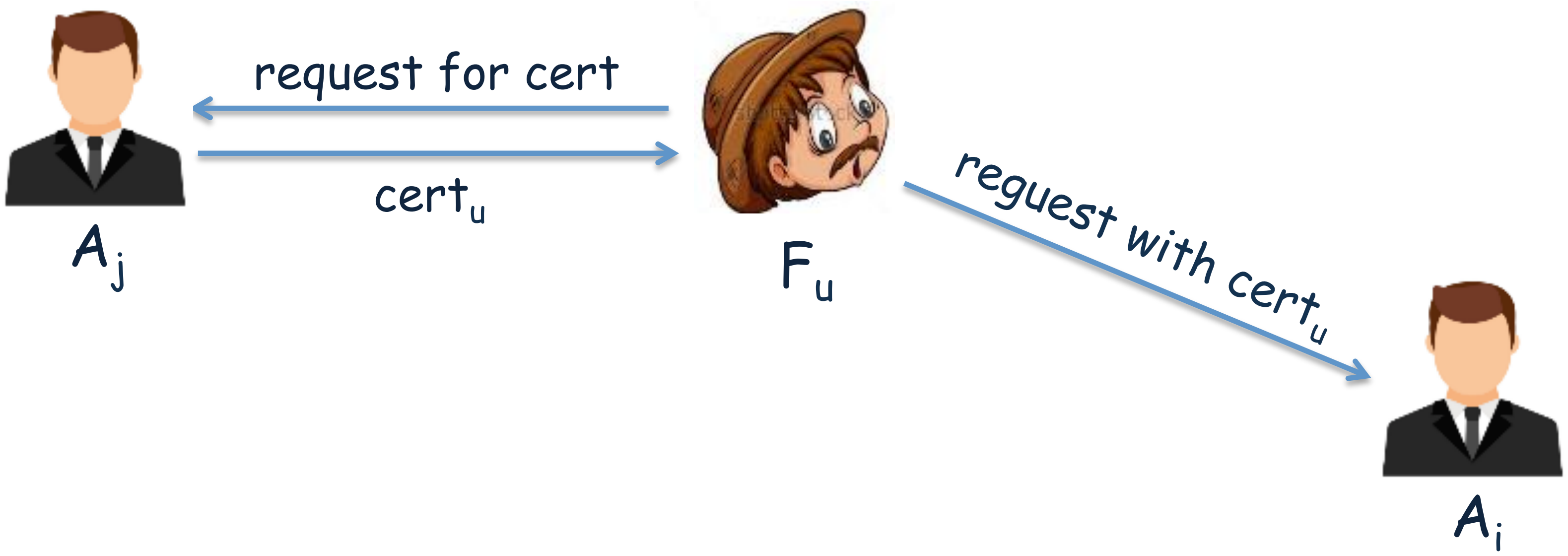

request for cert

cert$_u$

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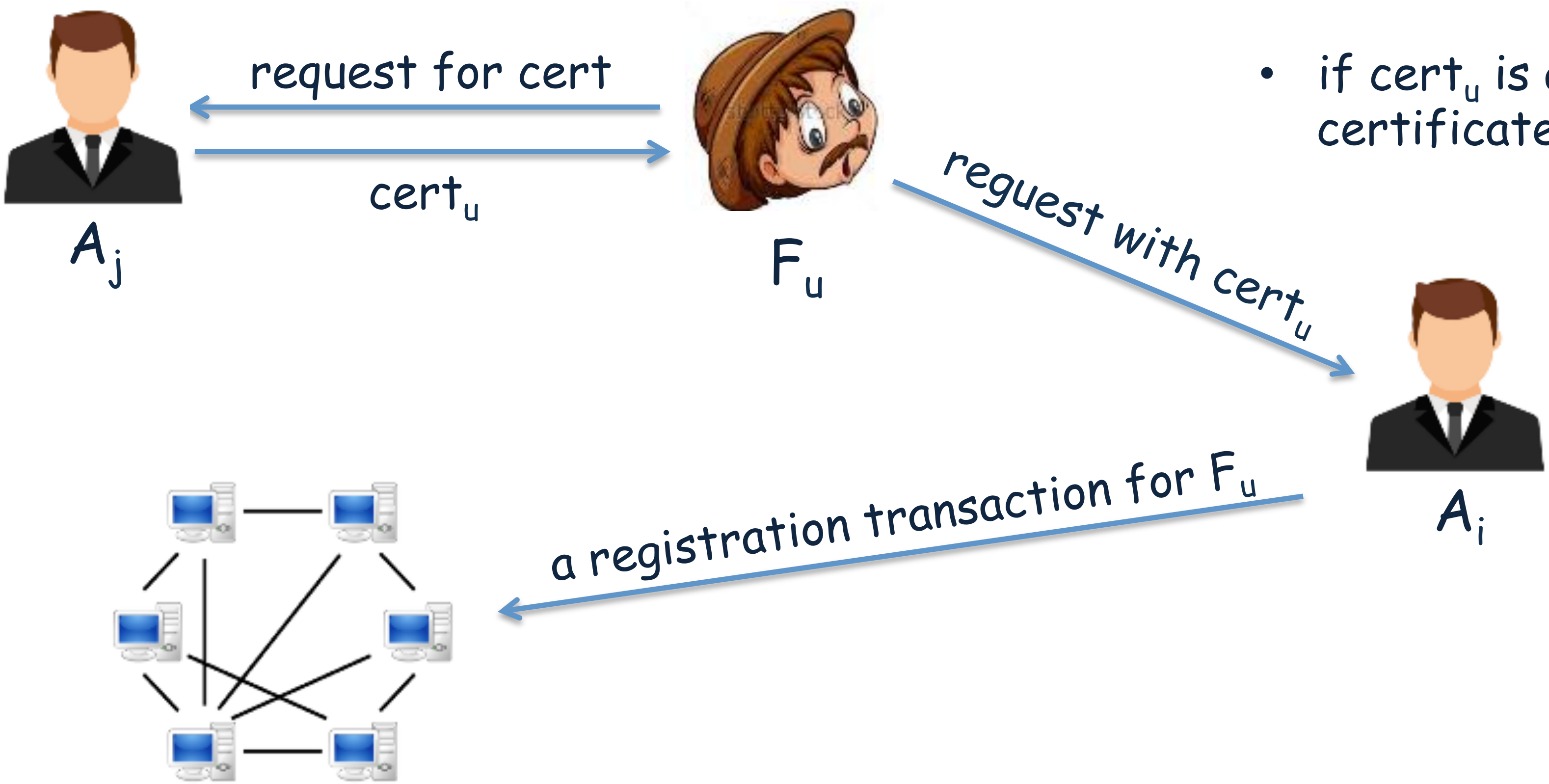

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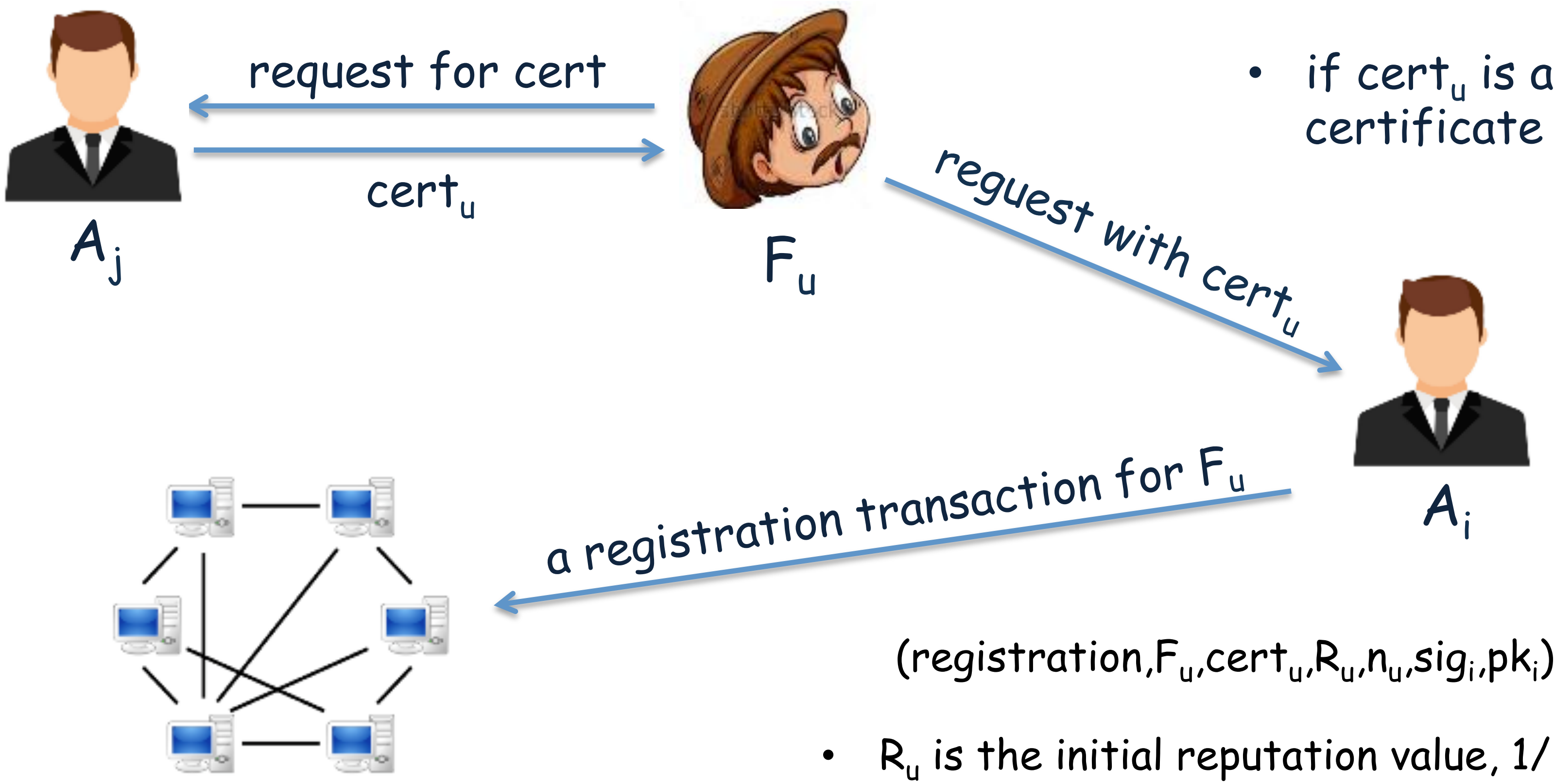

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$(registration, F_u, cert_u, R_u, n_u, sig_i, pk_i)$

- R_u is the initial reputation value, 1/2
- n_u is the positive integer that helps us to count the number of farmers, and to efficiently choose random auditors

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Block Format

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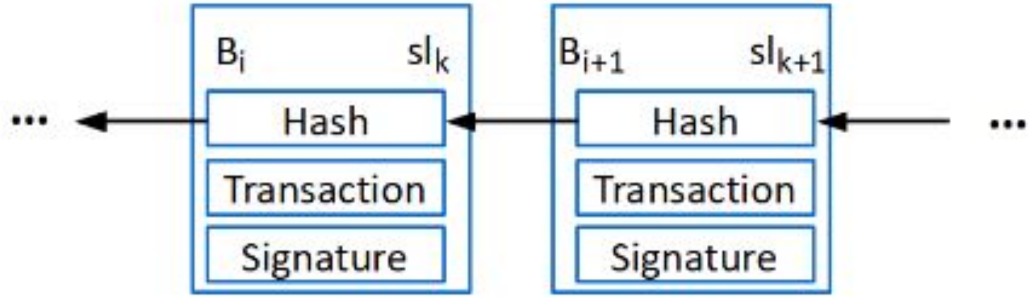

Construction

Declaring a Yield Commitment

F_u

Construction

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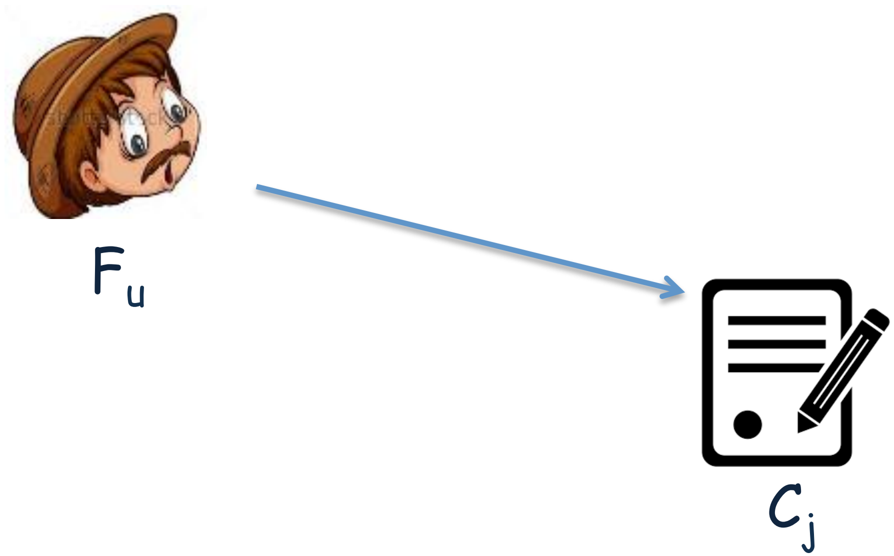

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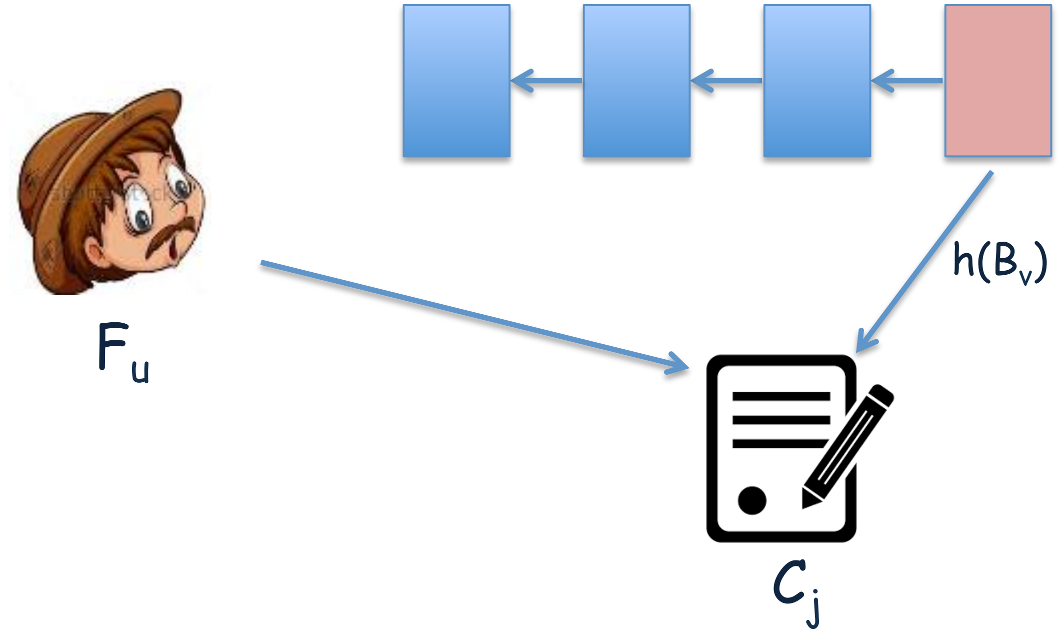

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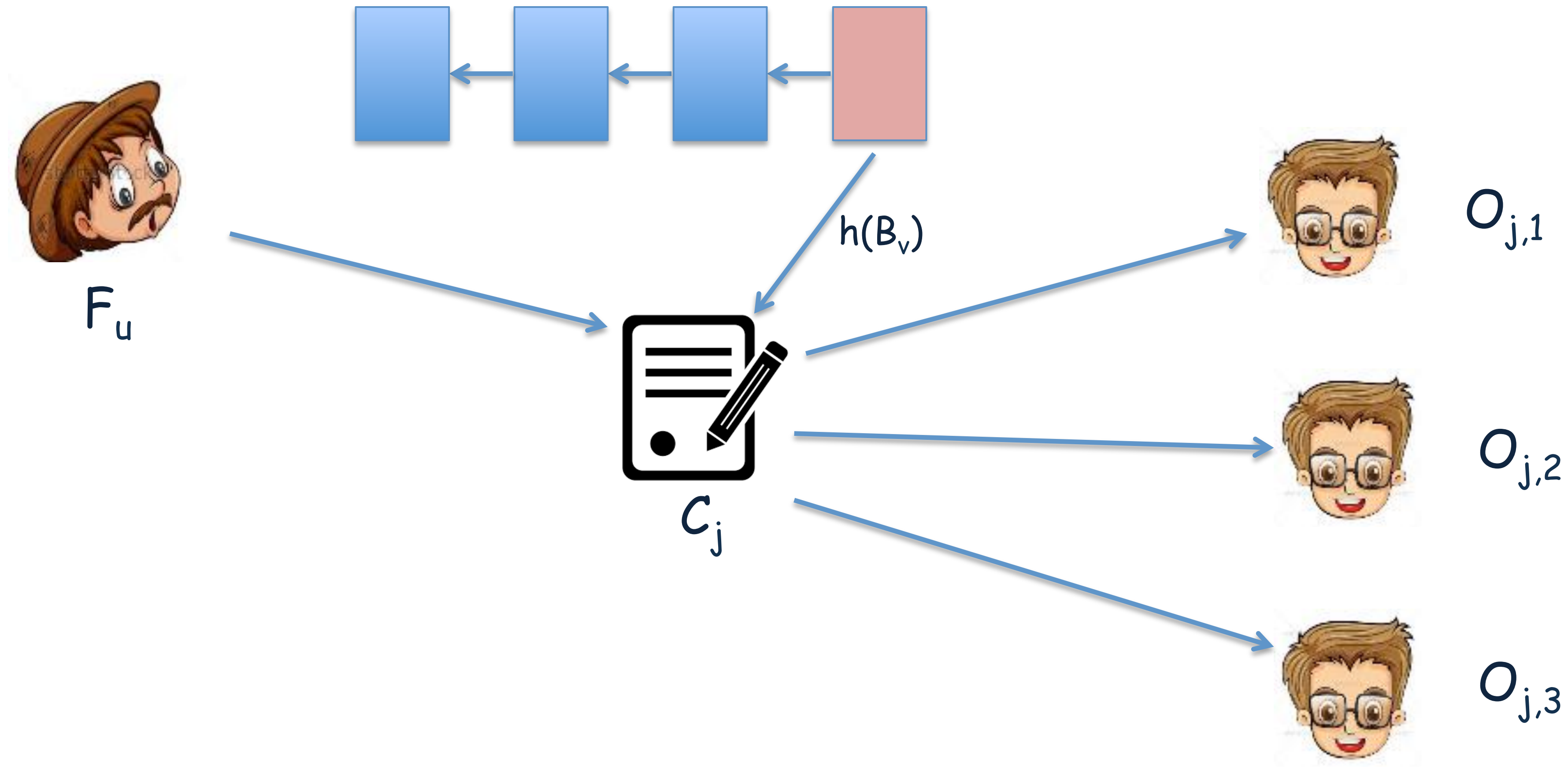

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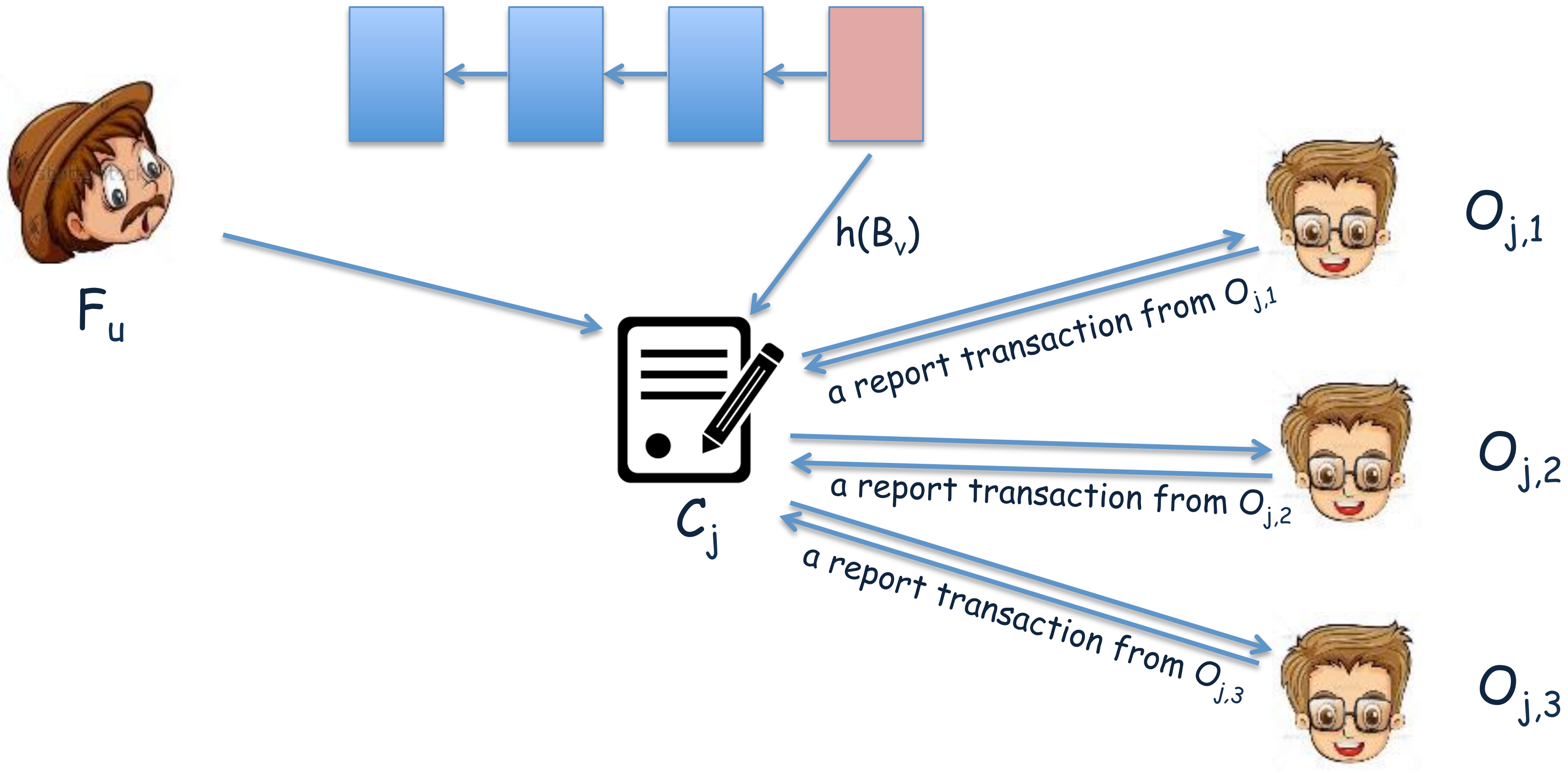

h(B_v)
F_u
C_j
$O_{j,1}$
$O_{j,2}$
$O_{j,3}$
a report transaction from $O_{j,1}$
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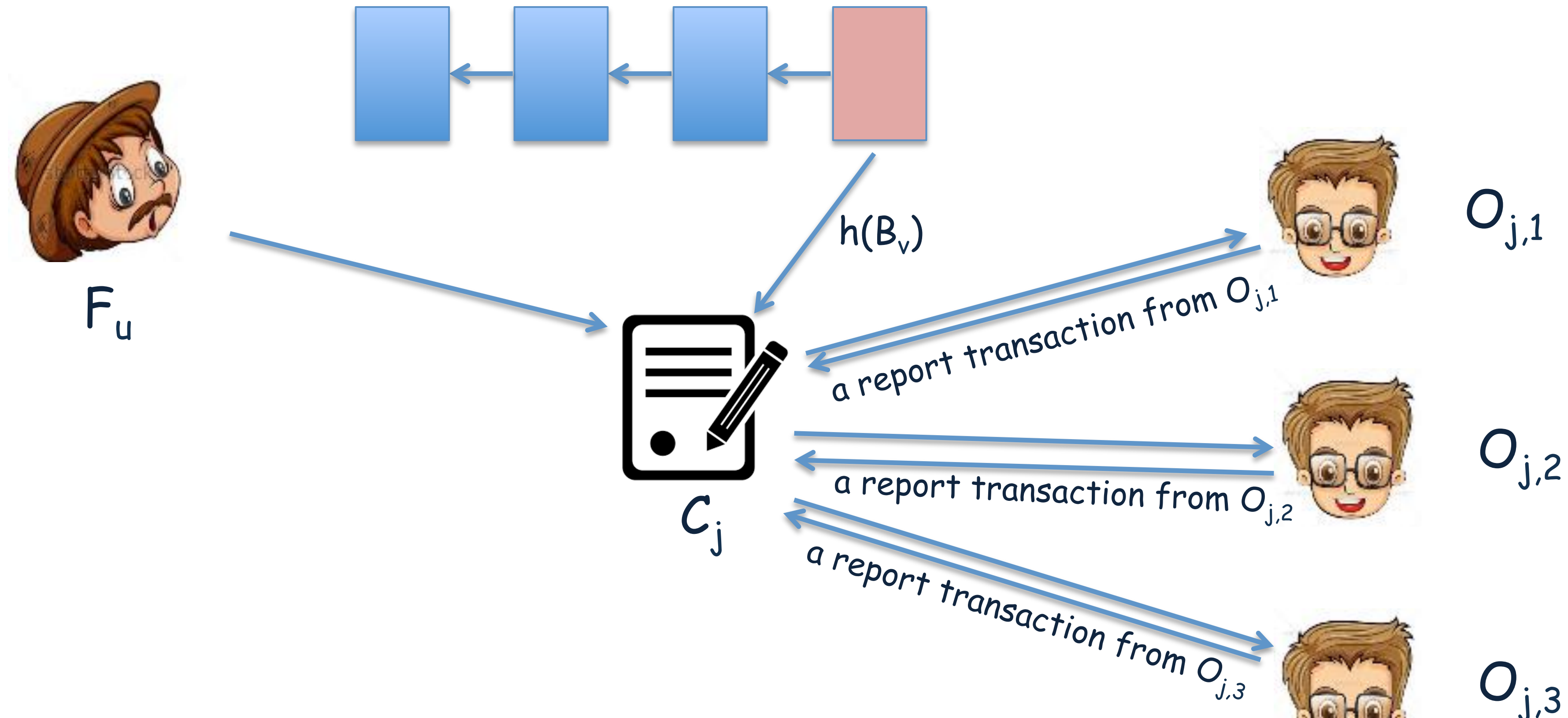
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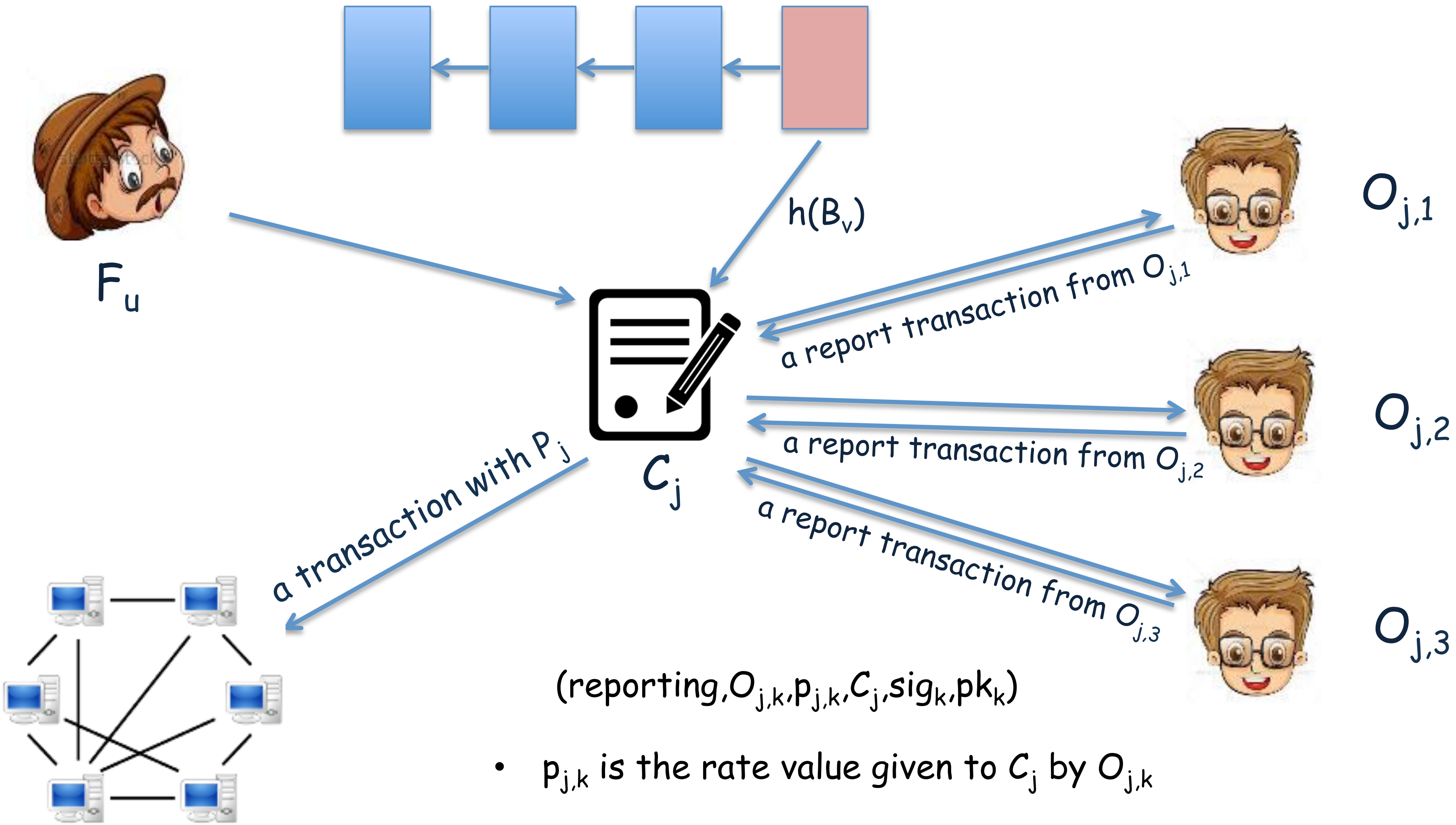
$(reporting, O_{j,k}, p_{j,k}, C_j, sig_k, pk_k)$

- $p_{j,k}$ is the rate value given to C_j by $O_{j,k}$

Construction

Declaring a Yield Commitment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- c is the counter indicating the number of consecutive commitments in which the reputation of F_u stays below a certain threshold

Construction

Updating Reputation

- if an administrator A_i detects a farmer F_u that has not declared a yield commitment in a certain time period, he creates an upgrading reputation transaction

$$(\text{update}, F_u, c, R_u/2, \text{sig}_i, \text{pk}_i)$$

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- if an administrator A_i detects an auditor $O_{j,k}$ that has not reported a rate for the corresponding commitment in a certain time period, he creates an upgrading-reputation transaction

$$(update, O_{j,k}, c, R_u/2, sig_i, pk_i)$$

Construction

Revocation

- administrators revoke farmers that have not performed well in their recent commitments by creating a revocation transaction. It has the following form:

$$(\text{revocation}, F_u, sig_i, pk_i)$$

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- this transaction is only created if the counter in the last upgrading reputation transaction of F_u is equal to the threshold t and F_u fails on the last commitment

Instantiation

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- Tendermint BFT consensus engine (Tendermint core)

  it is a BFT consensus mechanism, i.e. it assumes that no more than 1/3 of the administrators in the network can be byzantine

  BFT assumption is predicated on the weight (stake) of each validator rather than 1/3 of the total nodes participating

Future Works

- The system may require auditors to prove that they have indeed visited the corresponding farmland and made enough observations.

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- Reputation can also be used to even enforce the administrators to follow the protocol

Future Works

- The system may require auditors to prove that they have indeed visited the corresponding farmland and made enough observations.

  auditors may attach a location proof to their reports

- Reputation can be used outside of the platform in order to incentivize farmers to act honestly in the platform

- Reputation can also be used to even enforce the administrators to follow the protocol

- Yield commitment can be extended in a way that it also determines the amount of crop the farmers planning to harvest

Thanks!