

Trust-based Resource Sharing in Distributed Manufacturing

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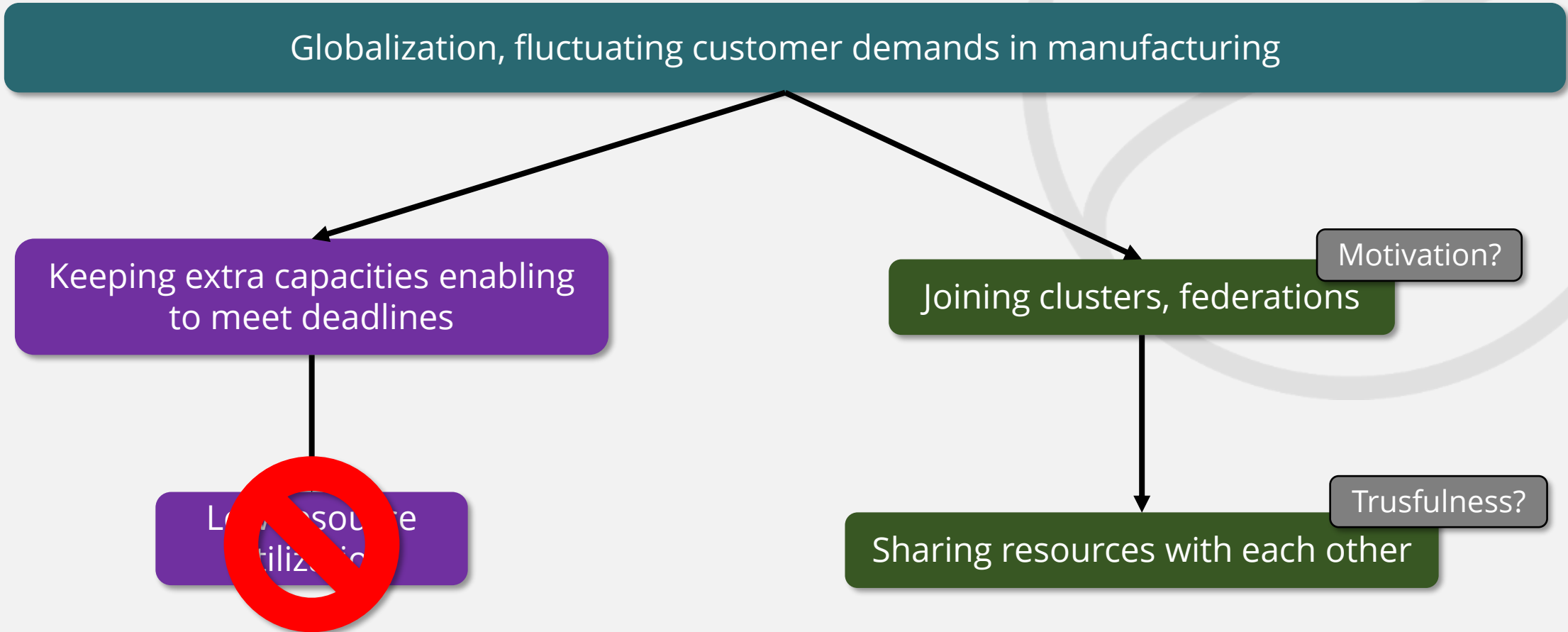
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Problem description



Why AnyLogic?

Goal of research:

- To create and test *resource sharing mechanisms* between manufacturing companies
- To consider *trustfulness* of companies in decision-making

Simulation model requirements:

- Model autonomous entities, communication on an easy way
 - ✓ Agent-based modelling
- Possibility to customize and define complex structures
 - ✓ Java programming, using pre-defined libraries
- More or less realistic model
 - ✓ GIS map, modelling real logistic routes
- Easy experimentation, handling high number of agents effectively



Platform-based resource sharing I.

Companies are members of a **federation** → receiving **order stream** from outside

- Lack of resources (type or amount) → requests
 - Free resources → offers
- } sent to the Federation Centre to find a **match**

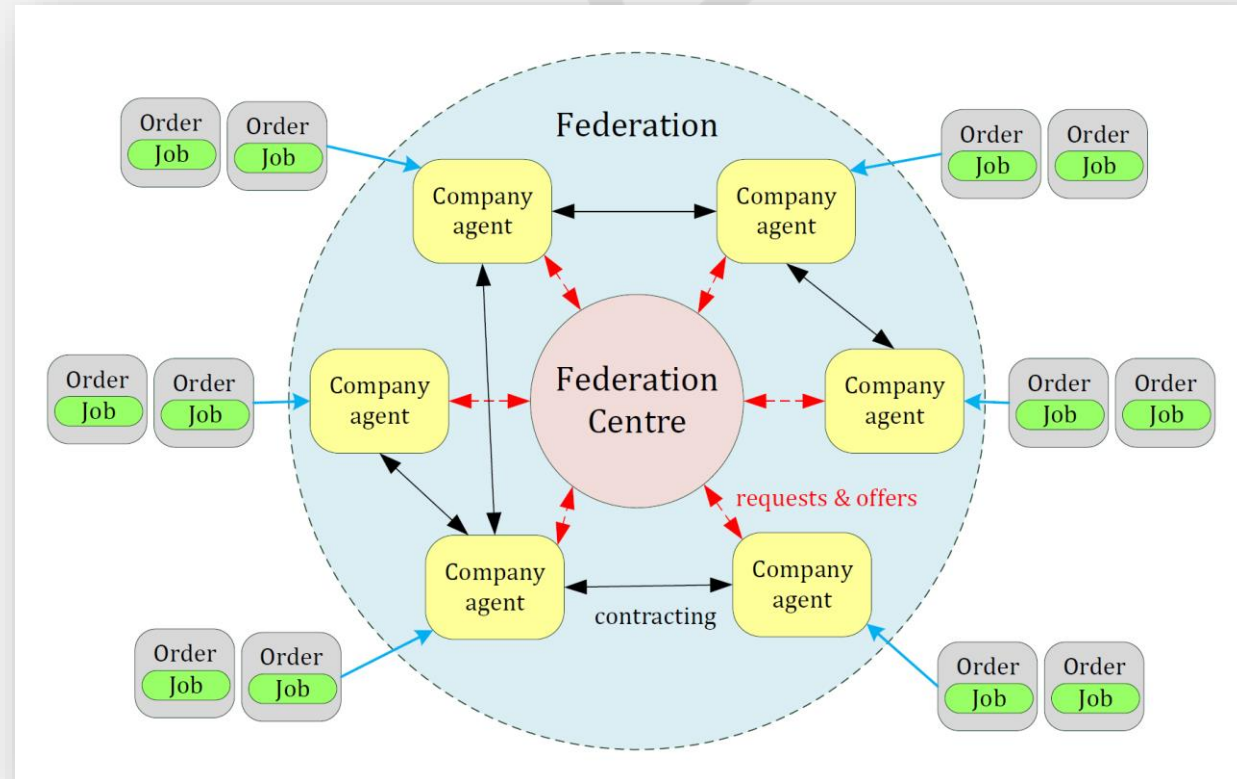
In case of a match → **contracting**

Promises from offeror side:

1. Complete (do not cancel) the job
2. Complete it on time, and
3. in the expected quality.



Bases of **rating** given after each contract → **trustfulness**



Platform-based resource sharing II.

- A request can be fulfilled by a combination of offers
- Offers from previously unknown companies
- Access to reputation values

companies have to be **motivated** to join and share capacity information

Aim of the platform: ~~find the best solution?~~

provide some good alternatives

Novelty:

- trustfulness has not been included in resource sharing mechanisms
- in manufacturing cases, rating suppliers → not competitor, different level of value creation
- neglecting capacity constraints is frequent → a reliable partner may become overloaded

Results are published in high-impact journals and conferences



Source: <https://www.ovocreatives.com/>

Considering trustfulness

Motivating companies to keep their promises → rating each other (0..100)

- **trust** → internal value, based on **direct interactions** (~ own opinion)
- **reputation** → public value, influenced by **all the interactions** of a company (~ Google reviews)

Rating given by the **requester about the offeror**, after each contract:

The diagram illustrates the formula for the rating given by company m to company n about job i . The formula is:

$$rating_i^{m,n} = \left(100 - \frac{L_i \cdot 100}{t_d - t_e} \right) \cdot \alpha \cdot \mu$$

Callouts in dashed boxes point to the components of the formula:

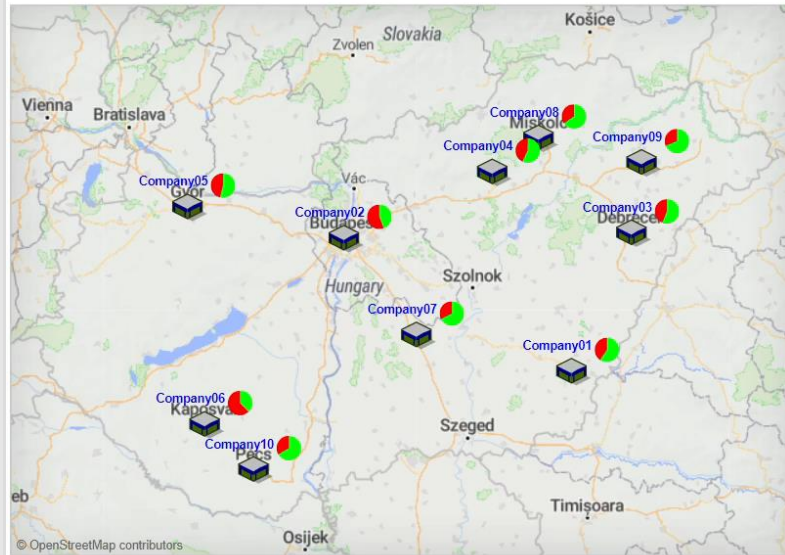
- rating given by company m to company n about job i** points to the entire formula.
- lateness** points to L_i .
- due date** points to t_d .
- earliest start time** points to t_e .
- penalty factor** points to α .
- quality** points to μ .

Base of decision between offers:

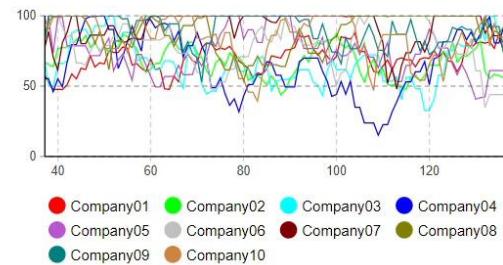
Weighted average of previous ratings + applying modified **exponential smoothing** to assign smaller weights to older ratings

Simulation model

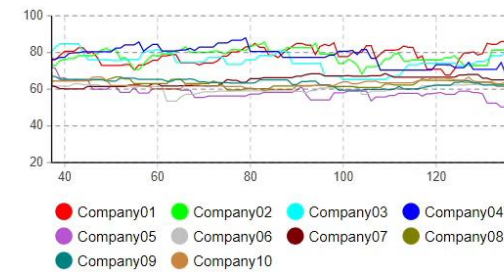
OMF : Simulation - AnyLogic Personal Learning Edition



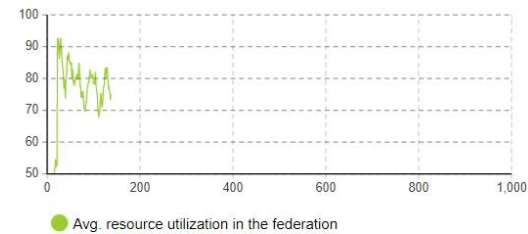
Resource utilization



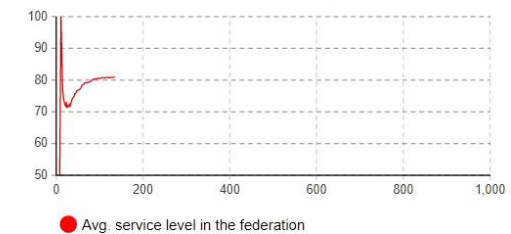
Reputation



Average resource utilization

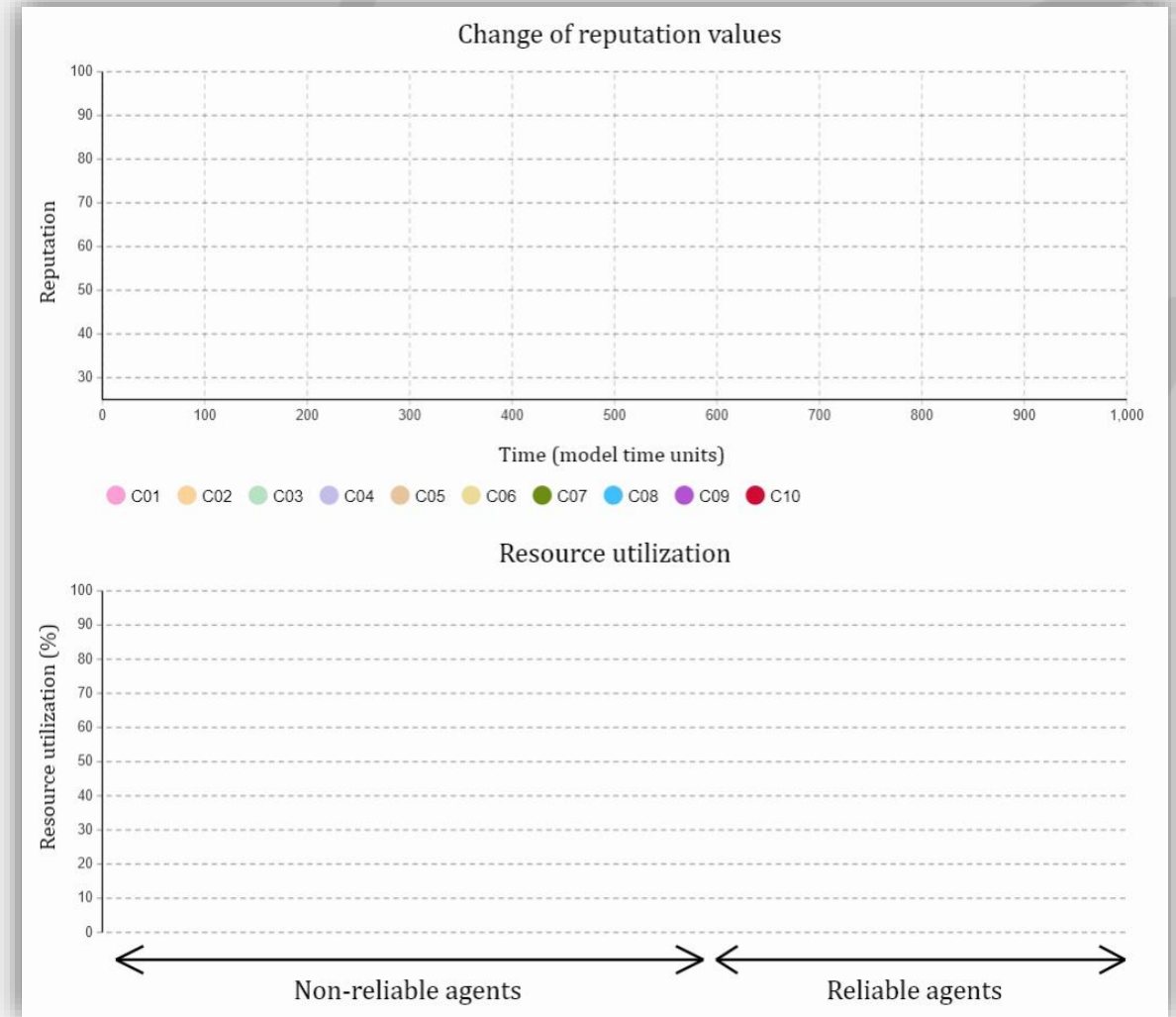
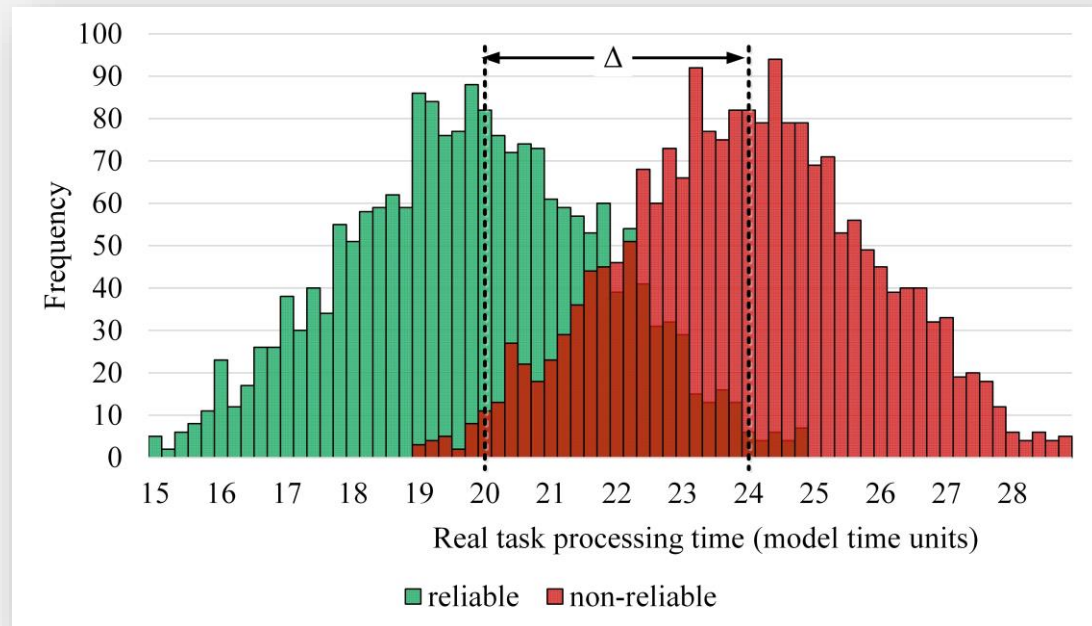


Average service level



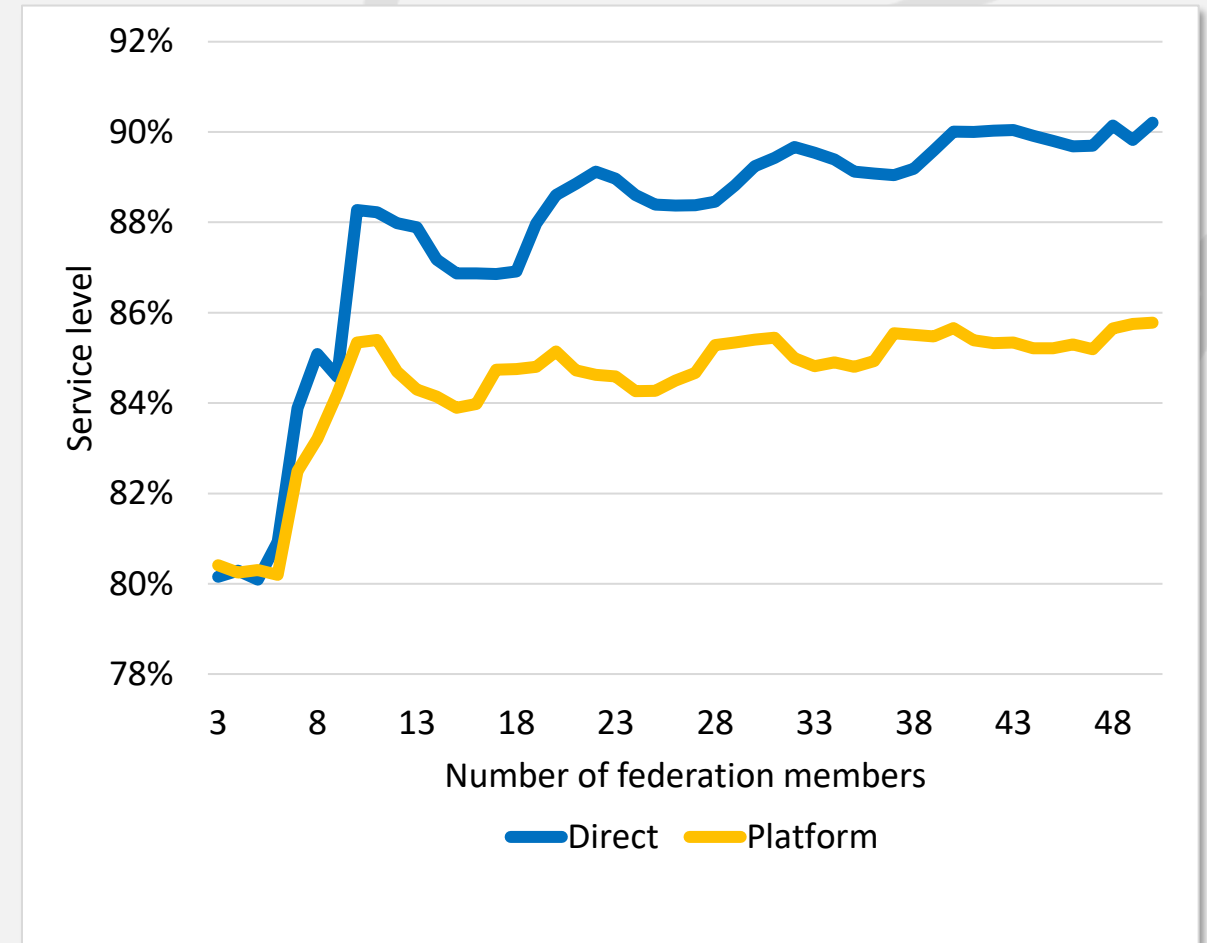
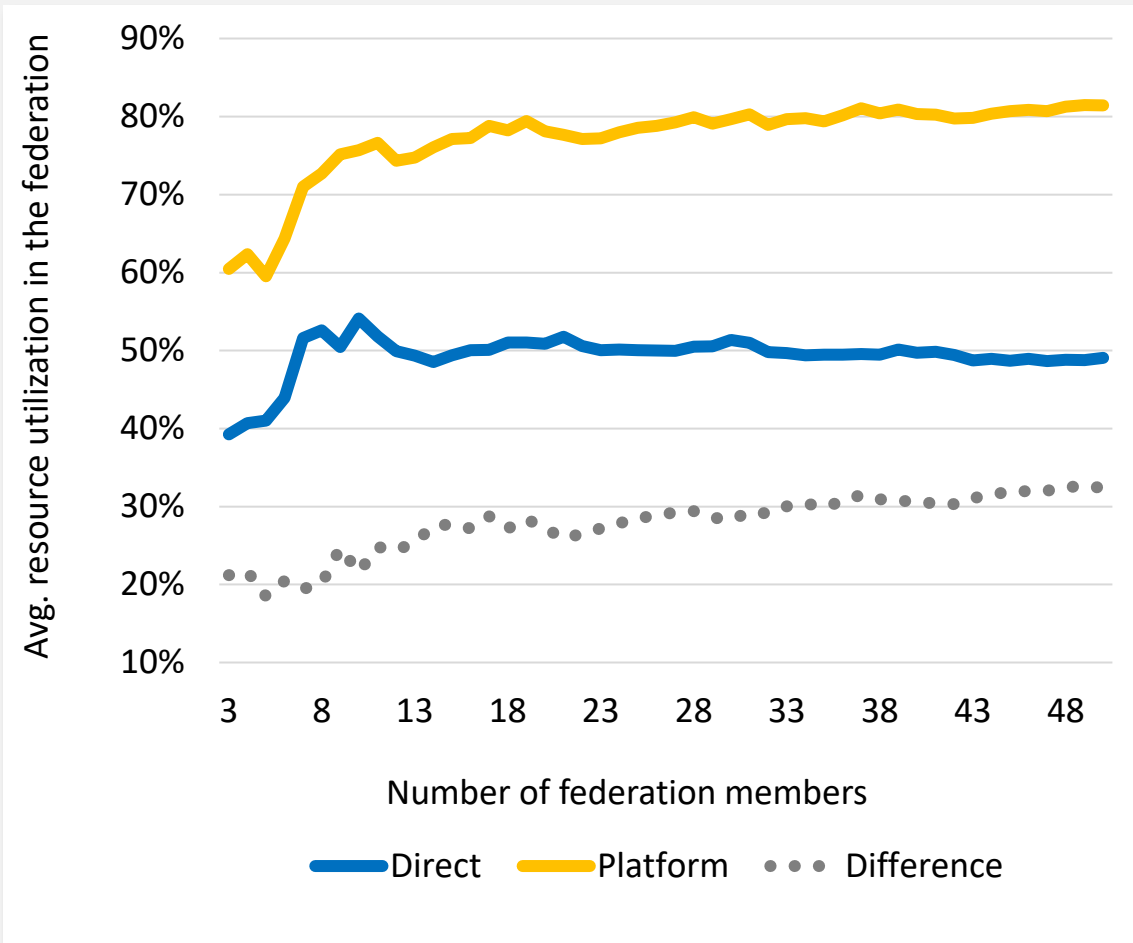
Reliable vs. non-reliable companies

- „real“ completion times in the model are generated from normal distributions
- the chance for reliable agents to finish the job in time is higher than in case of non-reliable ones

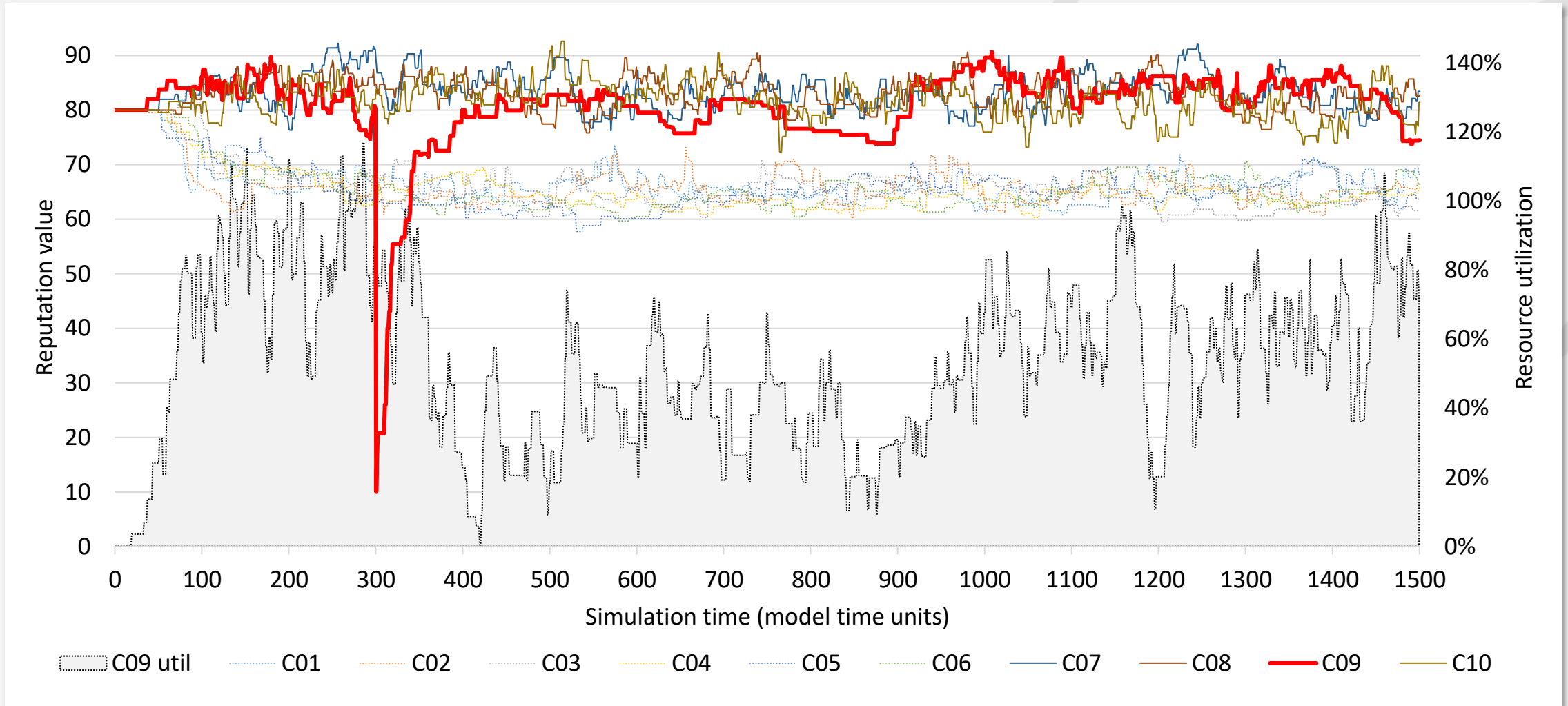


Experiments

Platform vs. direct exchange-based resource sharing



Effect of a negative event that affects trustfulness



Summary

1. Agent-based simulation model in AnyLogic for trust-based resource sharing
2. Goal of experiments
 - creating an effective mechanism that can be applied in real life
 - testing effect of realistic scenarios

Future plans:

1. Multi-criteria **decision making** algorithm
 - preferences: price / trustfulness / sustainability?
2. Extend the company agents with DES **factory model**
 - possible to combine ABM and DES in AnyLogic
3. Run more **experiments**
 - the platform has a global view on the system → optimization
 - reliable partners have higher prices, critical mass



Thank you for your attention!

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