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AI Cooperative
Research Laboratory

Proposal for SCM League

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NEC-AIST AI Cooperative Research Laboratory

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Proposal for SCM League

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R&D on AI in NEC

Recognition, Prediction, Control -> Negotiation

SCM League

- Concept
- Regulation
- Platform
- Schedule

Three Waves of NEC's AI Business

NEC has a technology portfolio and business track record that extends over half a century, including AI technologies that rank top around the world.

1960

1st Wave Recognition

OCR

Postal address sorter

Fingerprint Identification

No.1
2004 to 2015

Face Recognition

No.1
2009, 2010
2013, 2017

Deployed by police worldwide

Used in immigration control, etc.

2000

2nd Wave Prediction

SVM

Deep Learning

Human resource matching, etc.
(RAPID Machine Learning)

Heterogeneous Mixture learning

Demand forecasting, etc.

2010

3rd Wave Control

Autonomous and Adaptive Control

Predictive Robust Optimization Framework

NEC the WISE

AI technologies from NEC
for enriching human intellect and creativity

Deployment of AI to Social Solution Businesses

Urban Surveillance

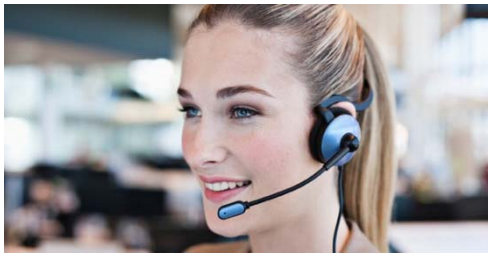
Detect potential dangers for crime prevention & solution

Reduced vehicle theft **by 80%**

Fresh Food Demand Prediction

Predict demand & order products considering factors

Reduced disposal **by 80%**



Voice of customer analysis

Support accurate answering by understanding inquiry

Reduced working hour **by 80%**

Public Safety	Infrastructure/Plant	Operation Innovation	Knowledge work
Urban Surveillance	Water Demand Prediction	Fresh Food Demand Prediction	Voice of customer analysis
Crowd Behavior Analysis	Landslide Prediction	Image/weight inspection	VIP detection
Critical Facility Management	Power Plant Failure Detection	Object Recognition for traceability	Price optimization for sale
Citizen ID / Border Control	Plant Failure Detection	Quality & performance prediction	Compliance Enhancement
Cyber Security	Power Demand Prediction	Repair parts demand prediction	Human resource matching

Three Waves of NEC's AI Business

What is the NEXT WAVE?

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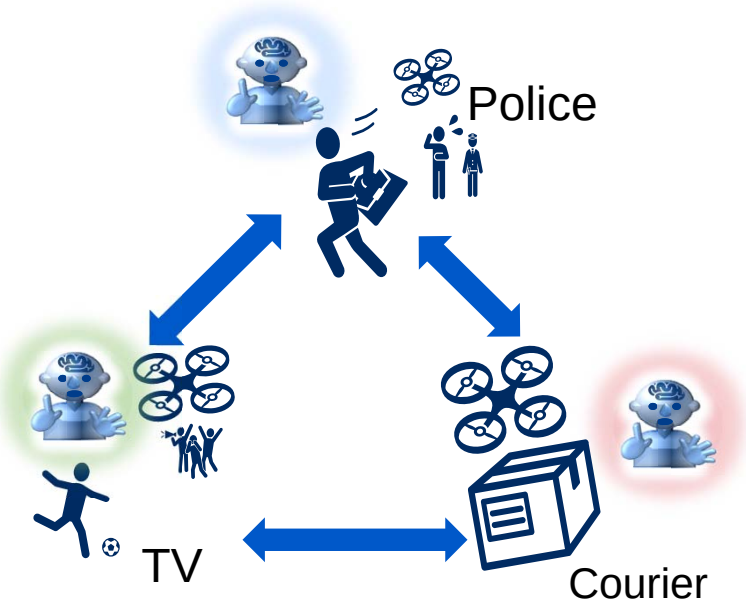
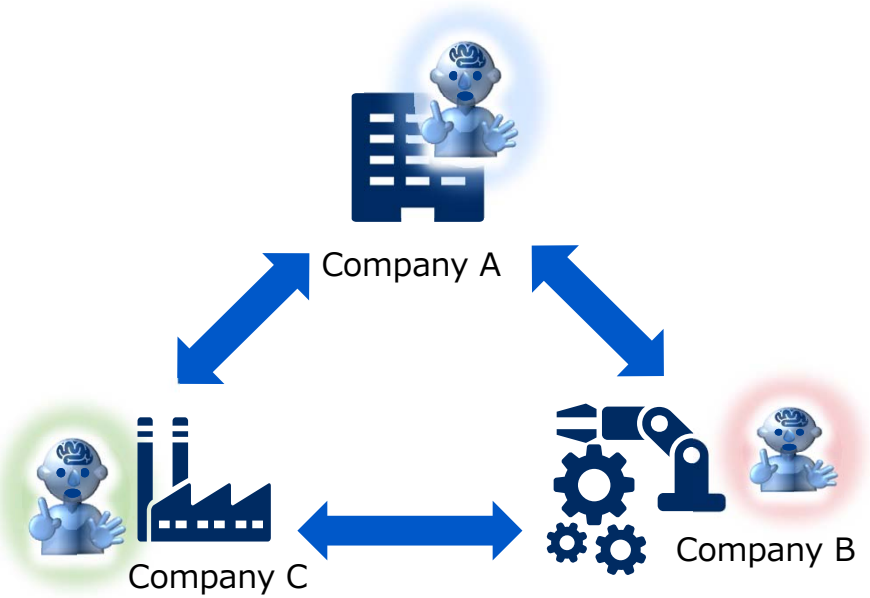
NEC's Activities on Automated Negotiation

National Projects (2017~)

Drawn Traffic Control & Supply Chain Management





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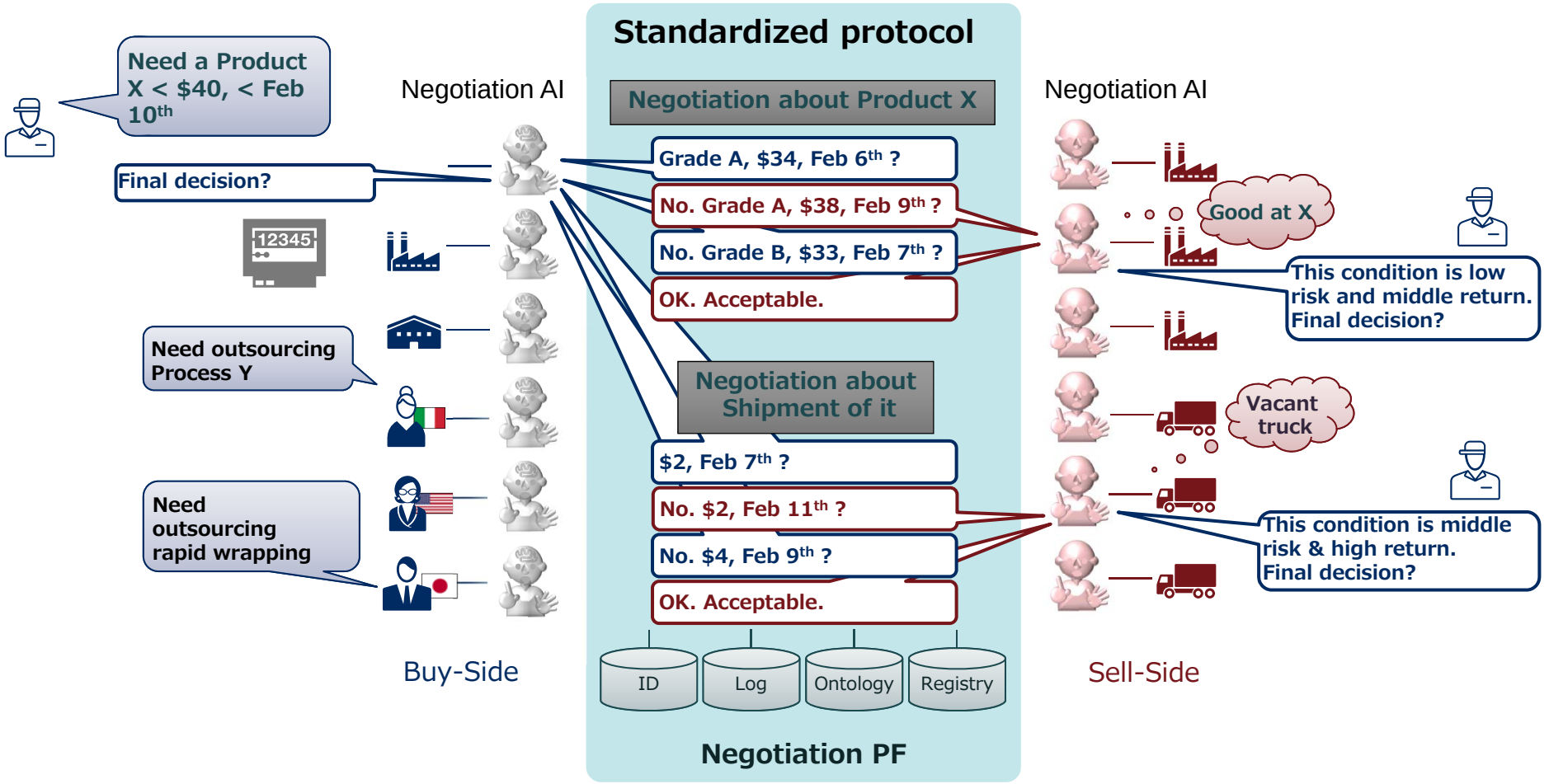
Supply Chain Management

Efficient matching of Win-Win relationships in mass customization economy



Proposal for SCM League

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SCM League

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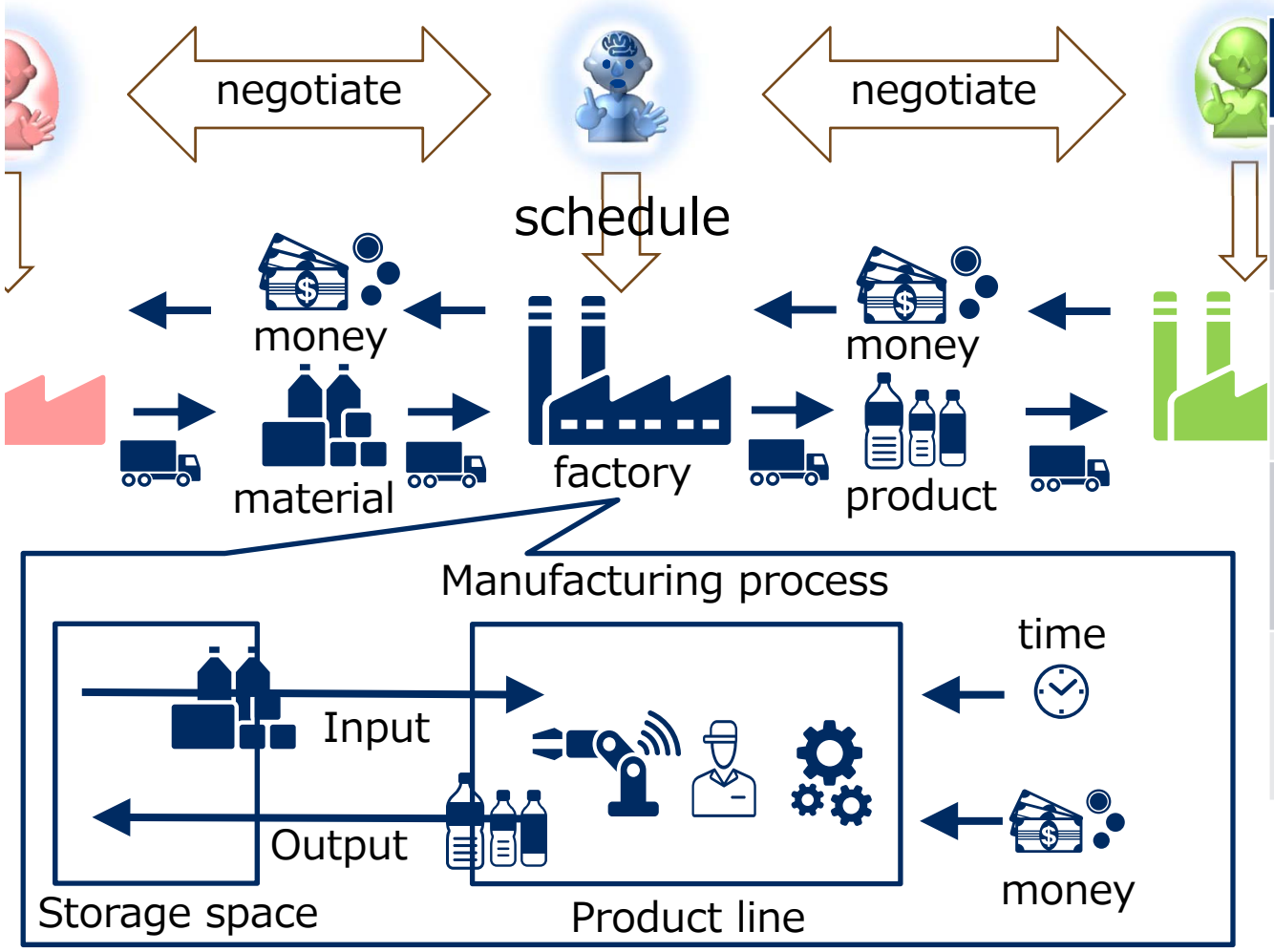
Agents of manufacturing company
buy and manufacture and sell among them.



Rank	Agent	Earned money
2		
3		
4		

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Three types of agents

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1) Manufacturing company (participant)

- has a factory (with L manufacturing lines and a storage place) and a wallet,
- can buy products from other agents through negotiation and put them in his storage place,
- can transform products in his storage place into other products using his factory with some cost of money and time under the limited capacity of the lines,
- can sell products in his storage place to other agents through negotiation.

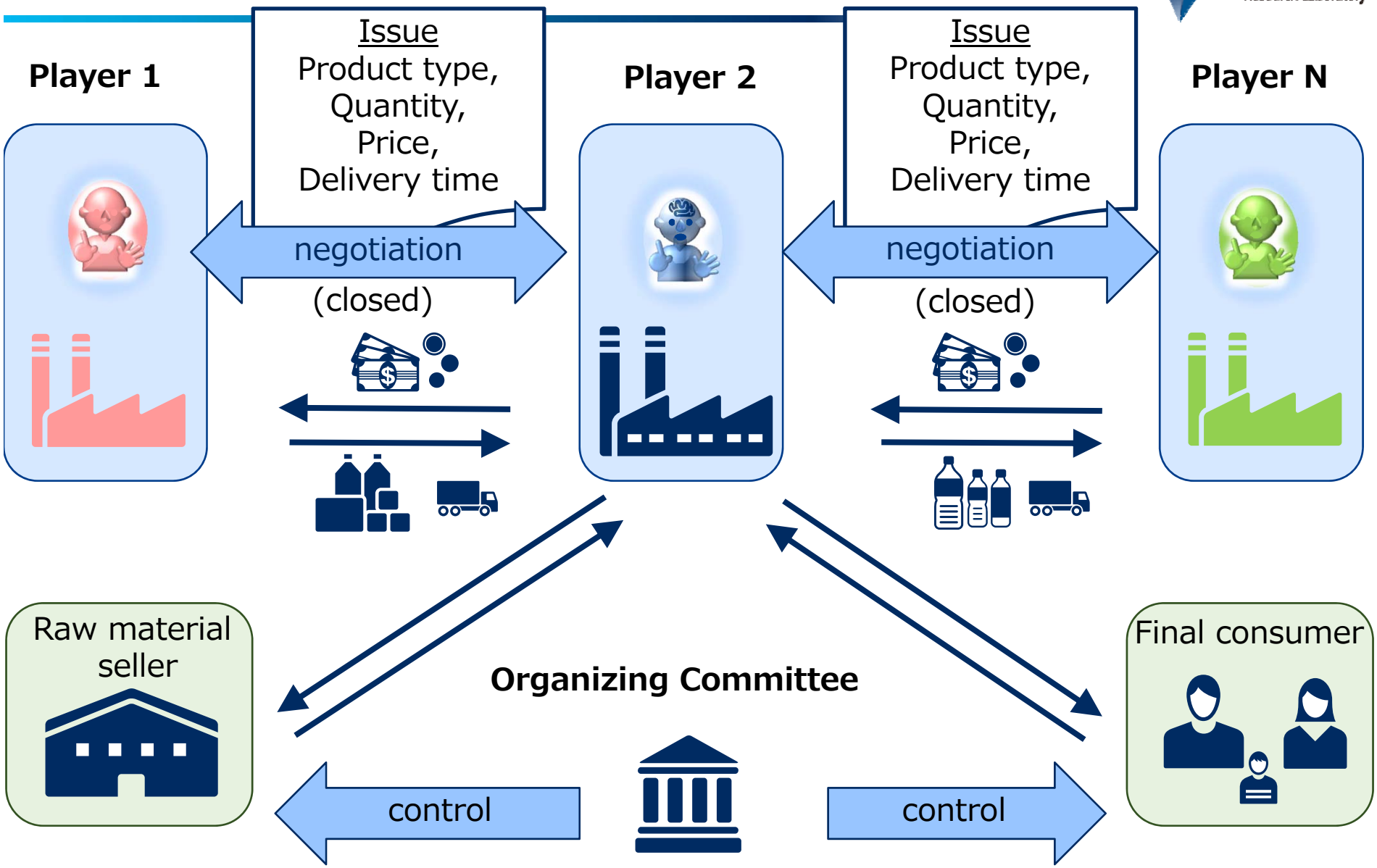
2) Raw material seller (prepared by the organizing comittee)

- sells some types of products with a certain condition, namely non-negotiable.
- The condition is fixed (or stochastically set in the future league).

3) Final product consumer (prepared by the organizing comittee)

- buys some types of products with a certain condition, namely non-negotiable.
- The condition is fixed (or stochastically set in the future league).

Bilateral, Closed, Parallel Negotiations



Factory

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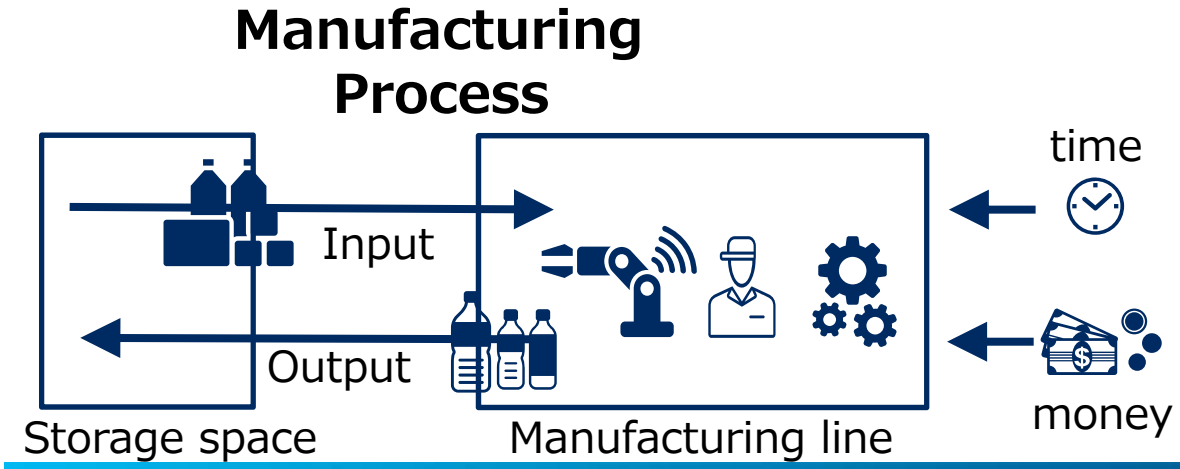
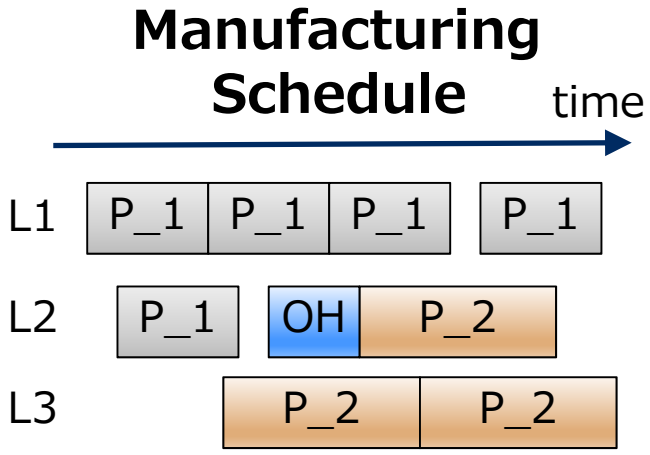
A factory has manufacturing lines and a storage place.
A line can execute several types of manufacturing process.
One process occupies one line in the factory during execution.
To switch the process type, overhead cost and overhead time is consumed.

The line executes manufacturing processes according to the schedule specified by the agent (participant).
The scheduled process starts only if the required input is available in the storage place and money in the wallet at the start time, and they are decreased at the start time.
At the end time, the output is stored in the storage place.





Profile of Factory

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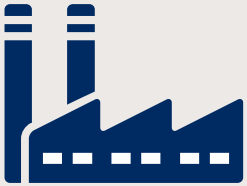
Factory Type	Process	Input	Lead Time	Cost	Output
 Has 2 lines	1	A,B	10	100	C
	2	C	500	2000	F
	3	F	3000	5000	H
 Has 3 lines	1	A	300	800	B,D
	2	C,B	80	350	G
	3	C	45	75	E
	4	C	150	200	F
	5	G	800	4000	H
 Has 1 line	1	B	4000	800	D
	2	D	200	2000	G
	3	E,F	80	100	H
	4	D,G	60	300	H

A,B: Raw Material G,H: Final Consumer Product

Best position in Ecosystem

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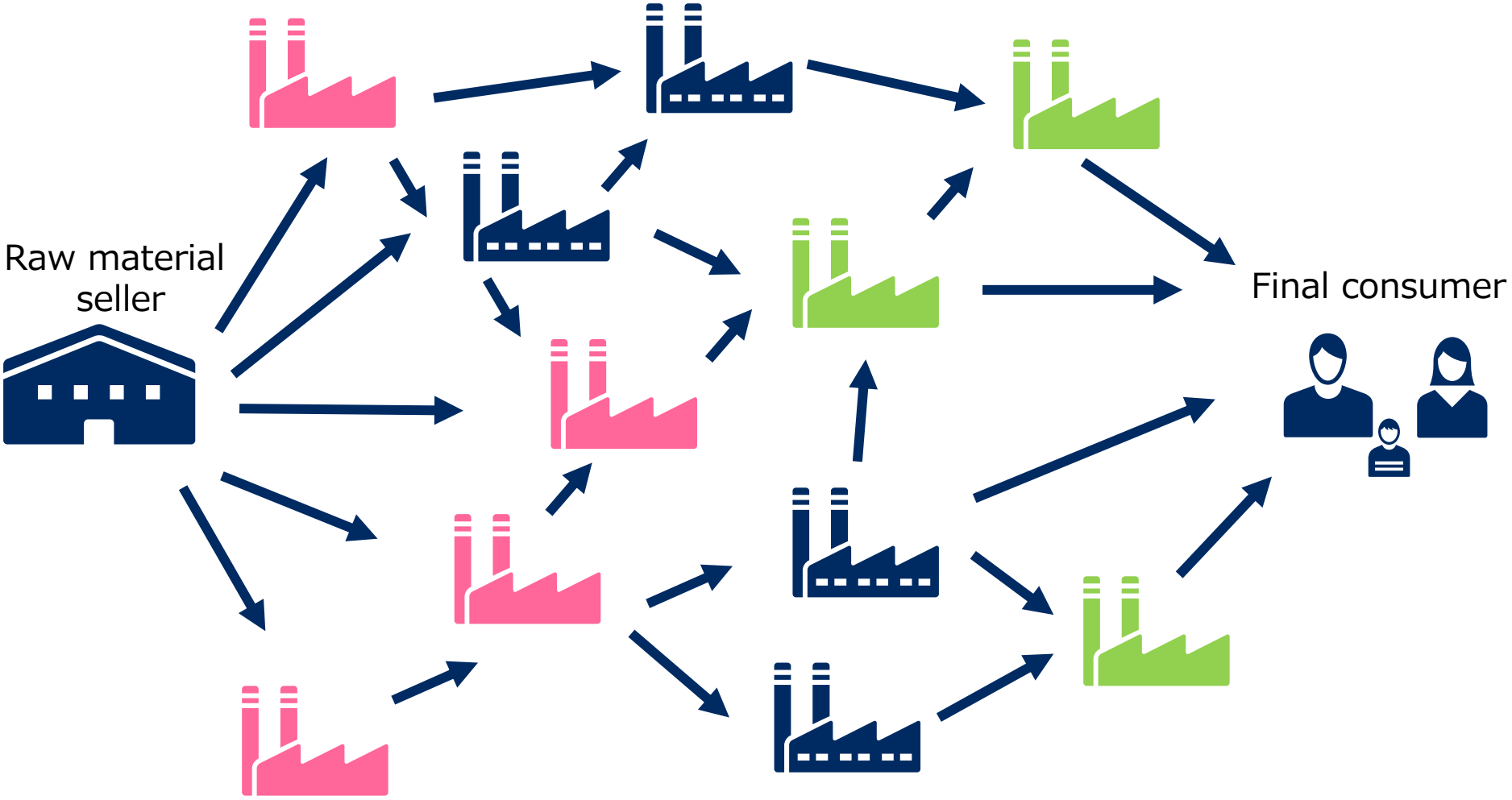

Contact Fulfillment

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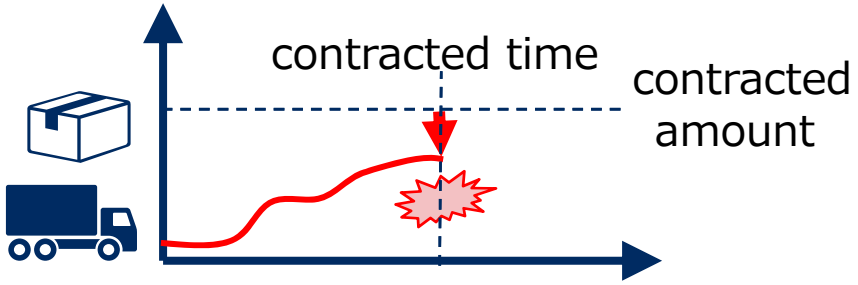
At the contracted delivery time:

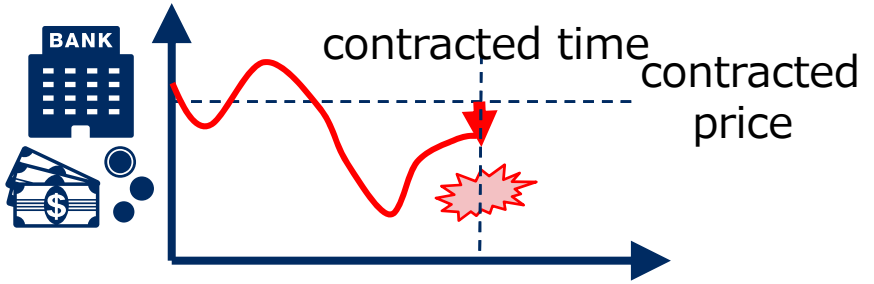
- the contracted product in the storage place of the seller-agent is moved to the storage place of the buyer-agent
- the contracted amount of money (the price) in the wallet of the buyer-agent is moved to the wallet of the seller-agent.

"Breach" occurs:

- If the quantity of the product in the storage place did not reach the contract,
- Or if the amount of money in the wallet did not reach the contract.

Then, the settlement (movement of product and/or money to the possible extent) is executed, and the agent is listed and disclosed.





Support systems: Bulletin Board

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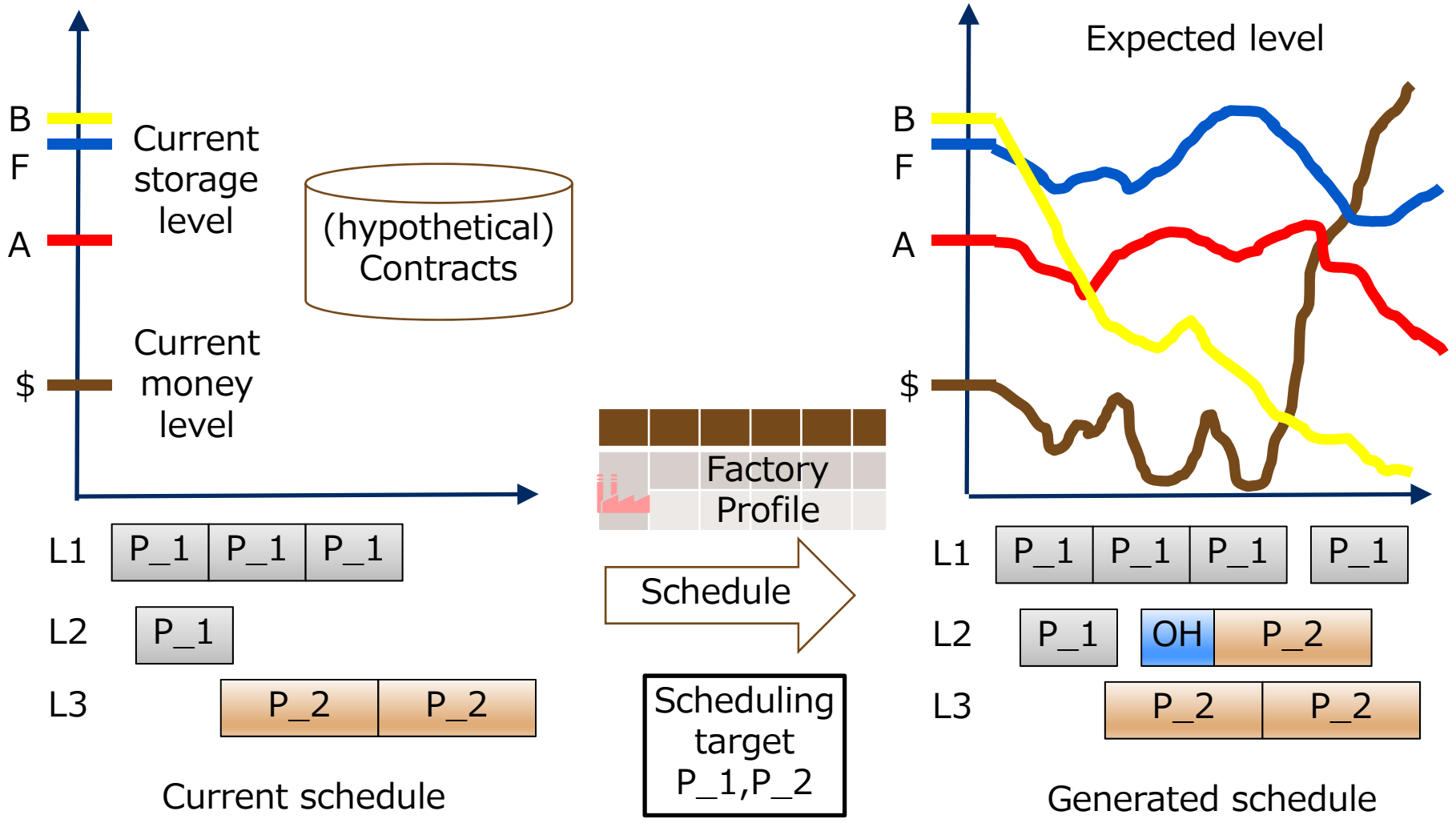
Open bulletin board is operated for finding counterparts of negotiations.

Agent can post offers specifying negotiable issue(s). Or, withdraw its own postings.

Raw material seller & Final Consumer are always offering fixed condition.

Agent				Price	Delivery Time
	sell	C	x 2	Nego.	800
	buy	C	x 3	80	Nego.
	buy	D	Ne.	Nego.	15
	sell	E	Ne.	Nego.	Nego.
	buy	F	Ne.	3000	Nego.
	sell	G	x 6	Nego.	Nego.
	sell	A	Ne.	100	Now
	buy	G	Ne.	10000	Now
	buy	H	Ne.	15000	Now

Support systems: Naïve Scheduler



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Design Philosophy of the Platform

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- Platform not only for Research
- Extendable by Researchers
- Ease of Use

Platform not only for Research

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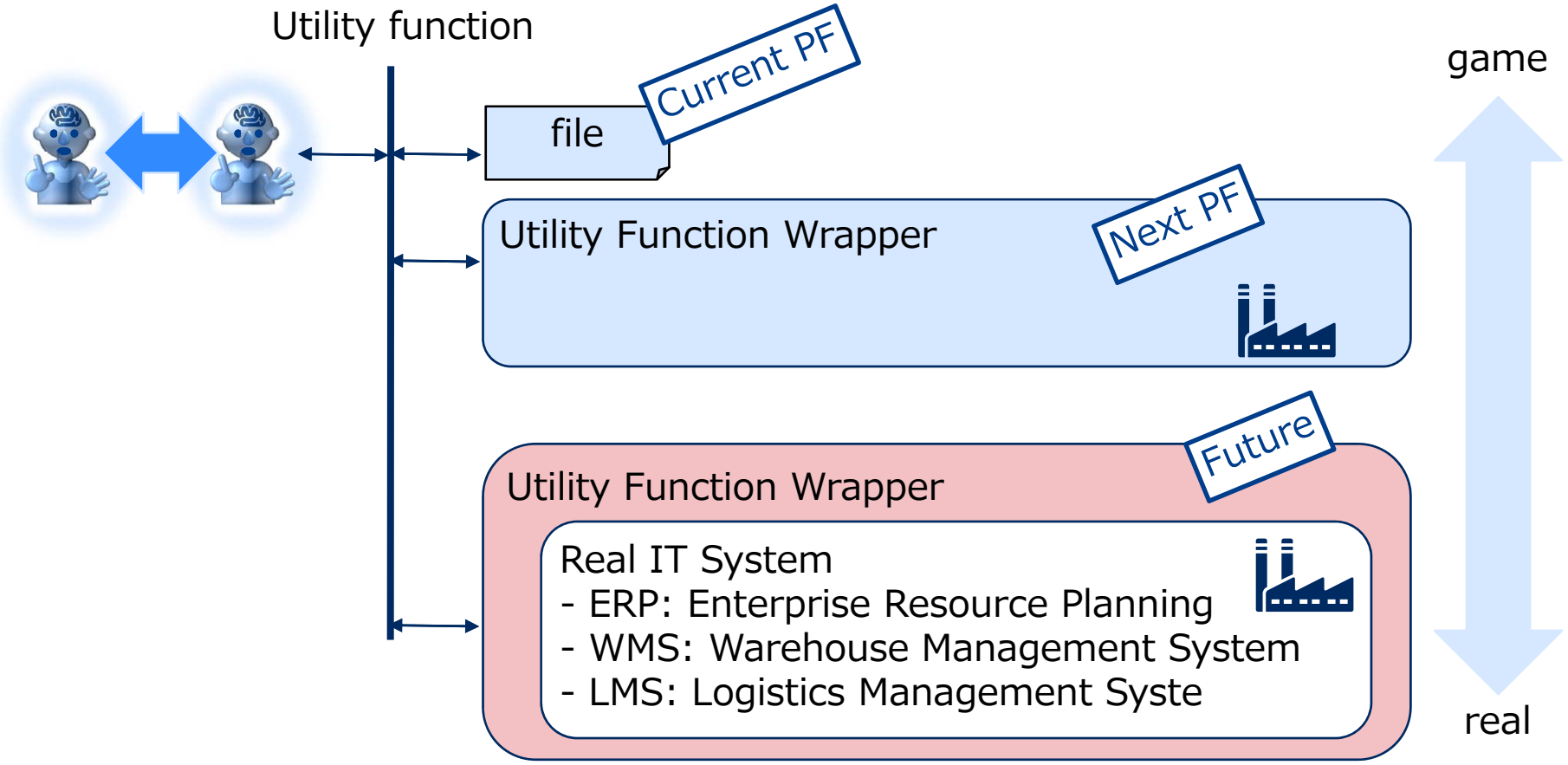
- Wrapping real IT system with Utility function
- Keeping the same interface



Extendable by Researchers

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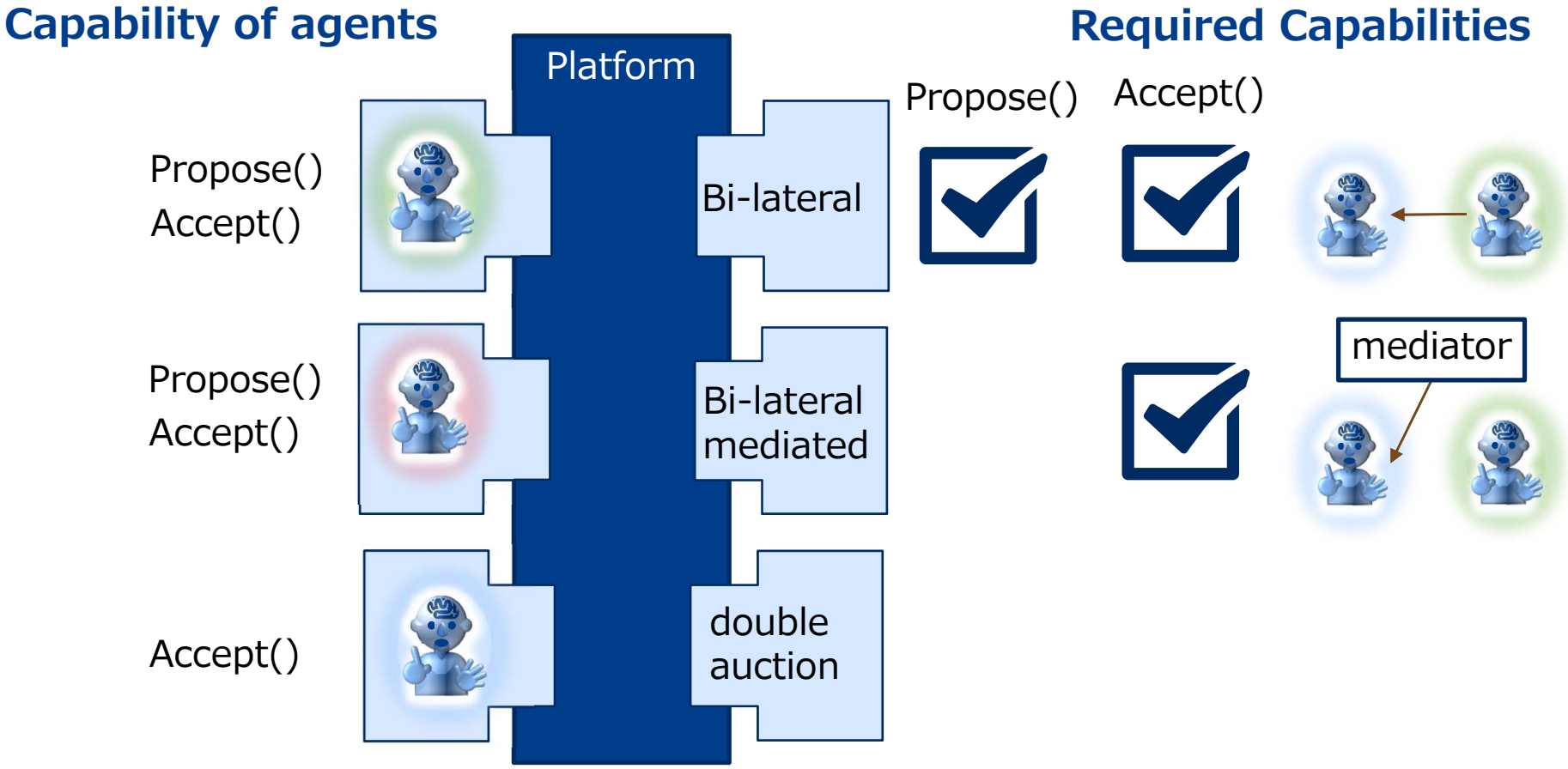
- Mechanism, Agent, and Utility Function are all plugins so that any researcher can develop own one



Ease of Use

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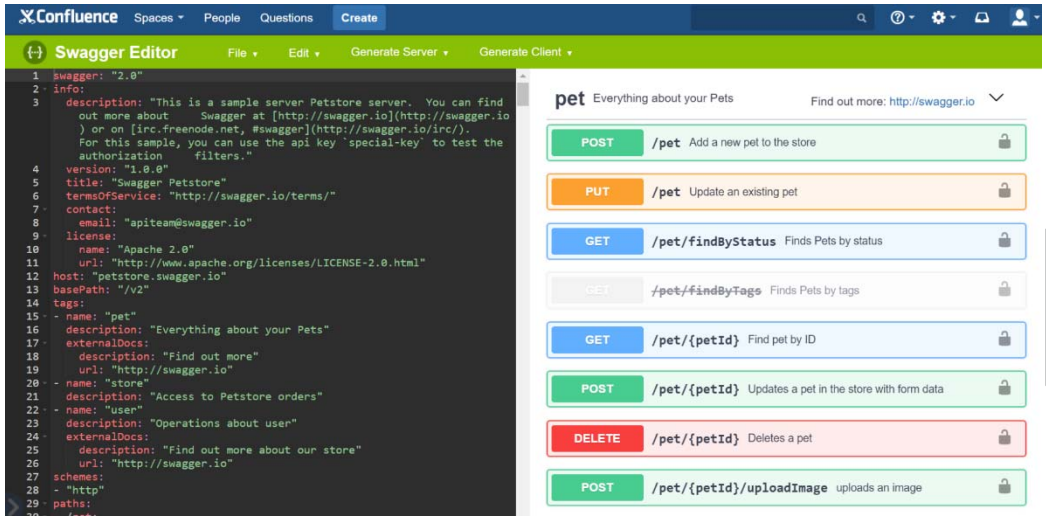
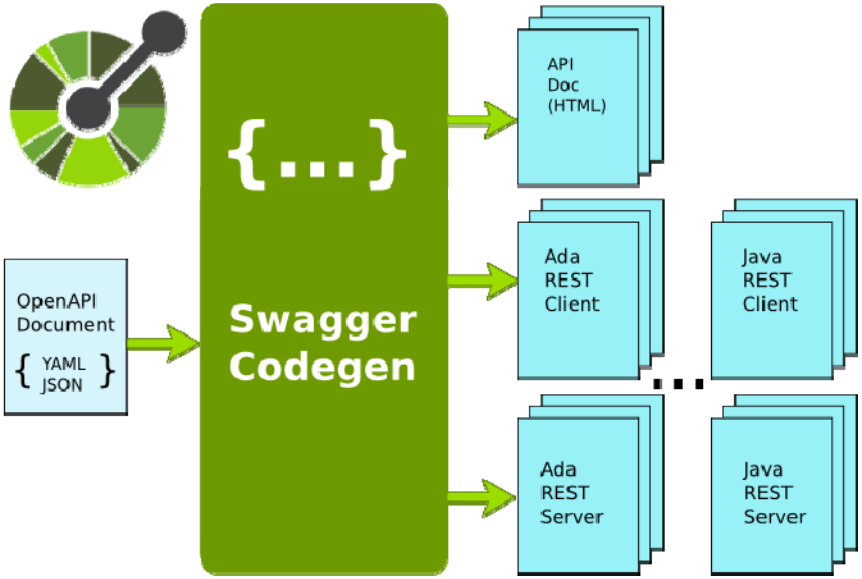
Cloud-based

- Jupyter development interface
  c.f. “Jupiter” (, 2018)
- Runnable on the cloud

Programming Language Independency

- SwaggerAPI (= OpenAPI)





Base Platform

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Conceptual Features

Situated negotiations

Negotiations run within a world

Simultaneous interdependent negotiations

Via utility functions

World driven dynamic utility functions

Based on optimization, scheduling, etc

Supports meta-negotiation

Agreeing on protocol/protocol parameters

Supports mediated and unmediated protocols

Implementation Features

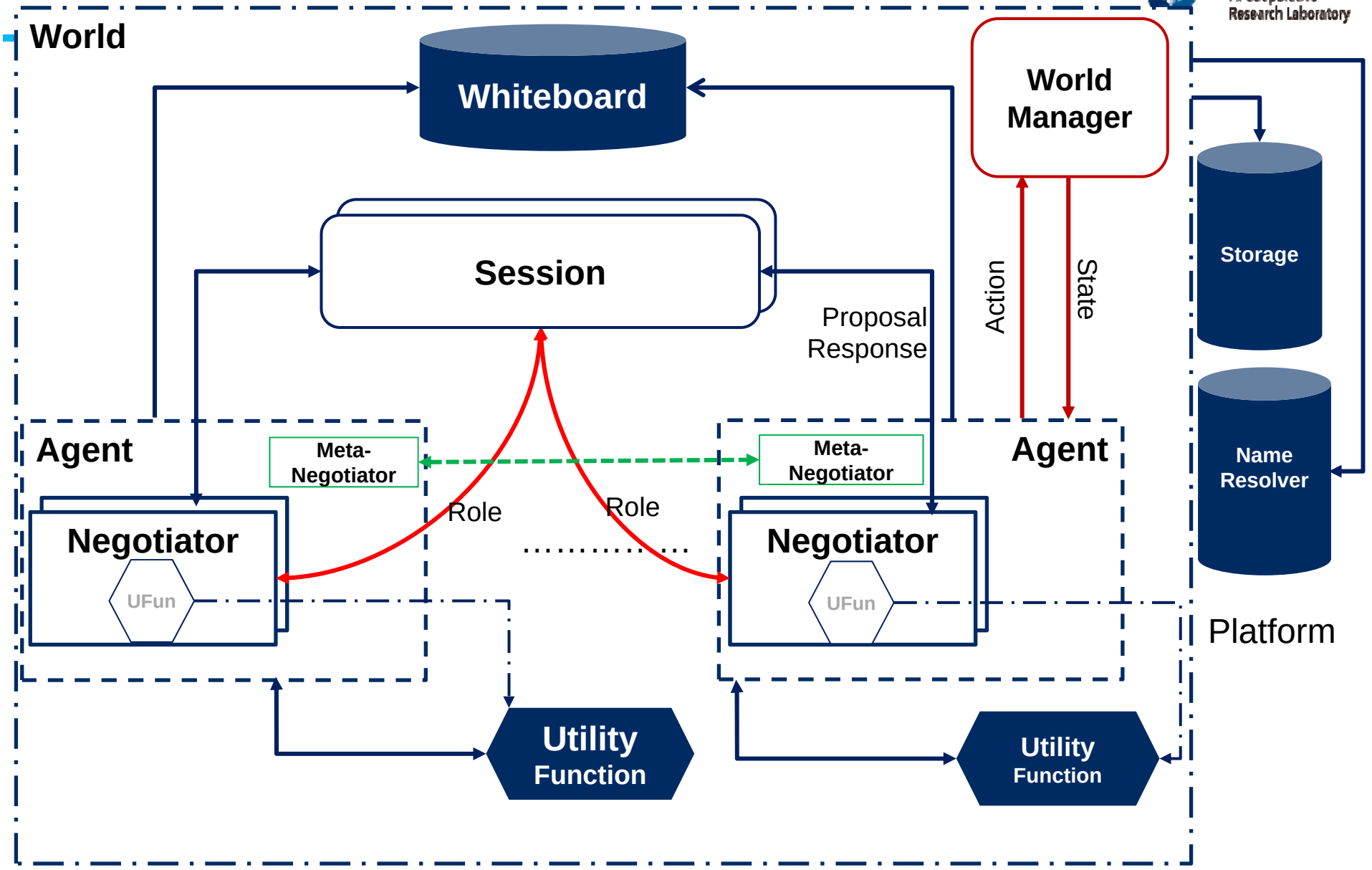
Distributed and secure via a standard-respecting web API

Language neutral (with special client libraries for Java and Python)

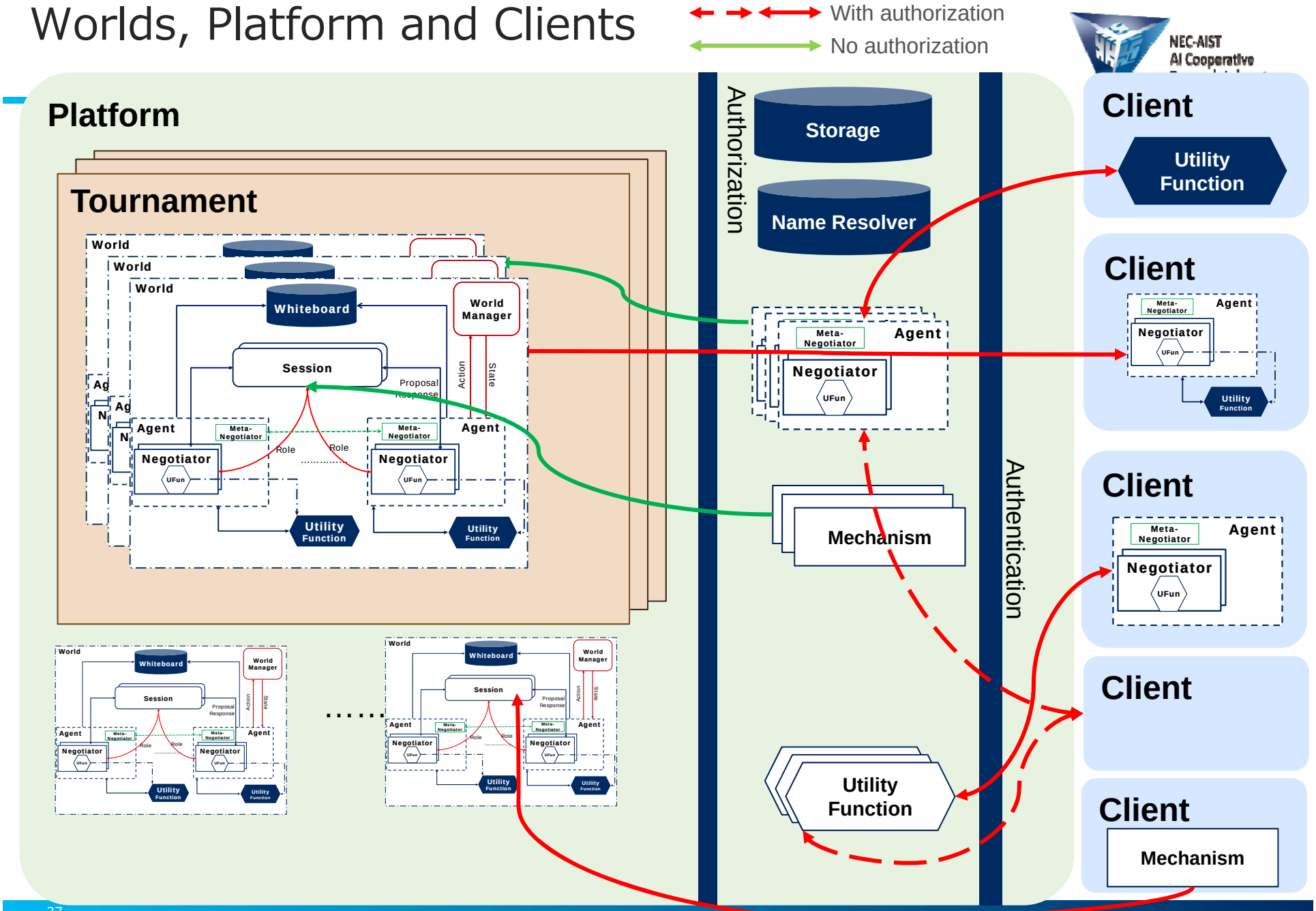
Extendible (protocols, agents, ufuns, ufun operators, etc are easily added)

Simple API

Relation between Entities within a single World



Worlds, Platform and Clients



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