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A Normative Agent-based Model for Sharing Data in Secure Trustworthy Digital Market Places

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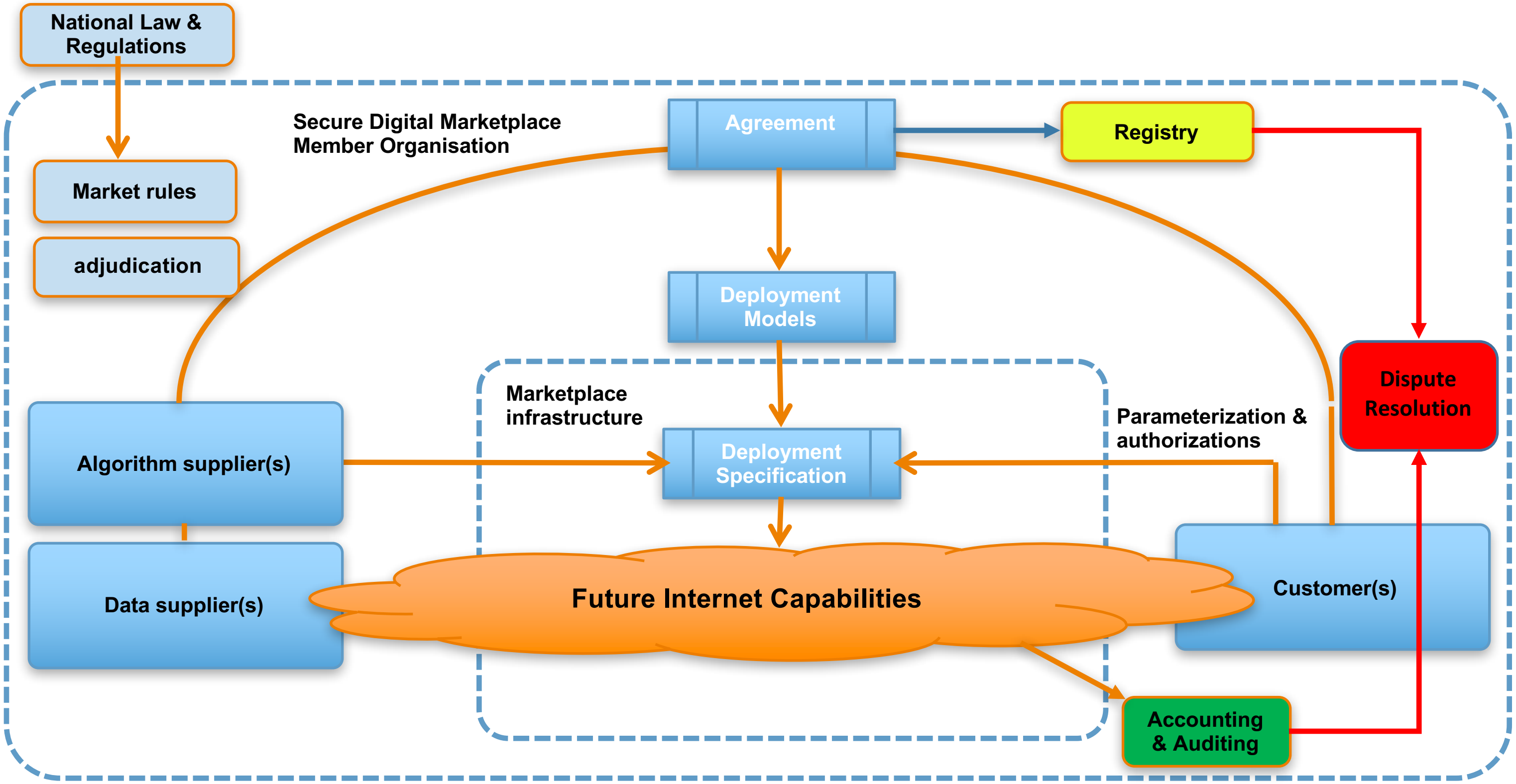
COMMIT/ NWO AIRFRANCE KLM TNO

Secure Digital Market Place architectural sketch



The needs for STDMPs..

- Bring competitors together to share data to achieve a common goal.
- Use shared data for different purposes.
- Create a trusted infrastructure to process data.

Motivation

1. How do the rules that express the social system’s policy impact the different members’ behavior and what is the emergent behavior of the regulated systems?

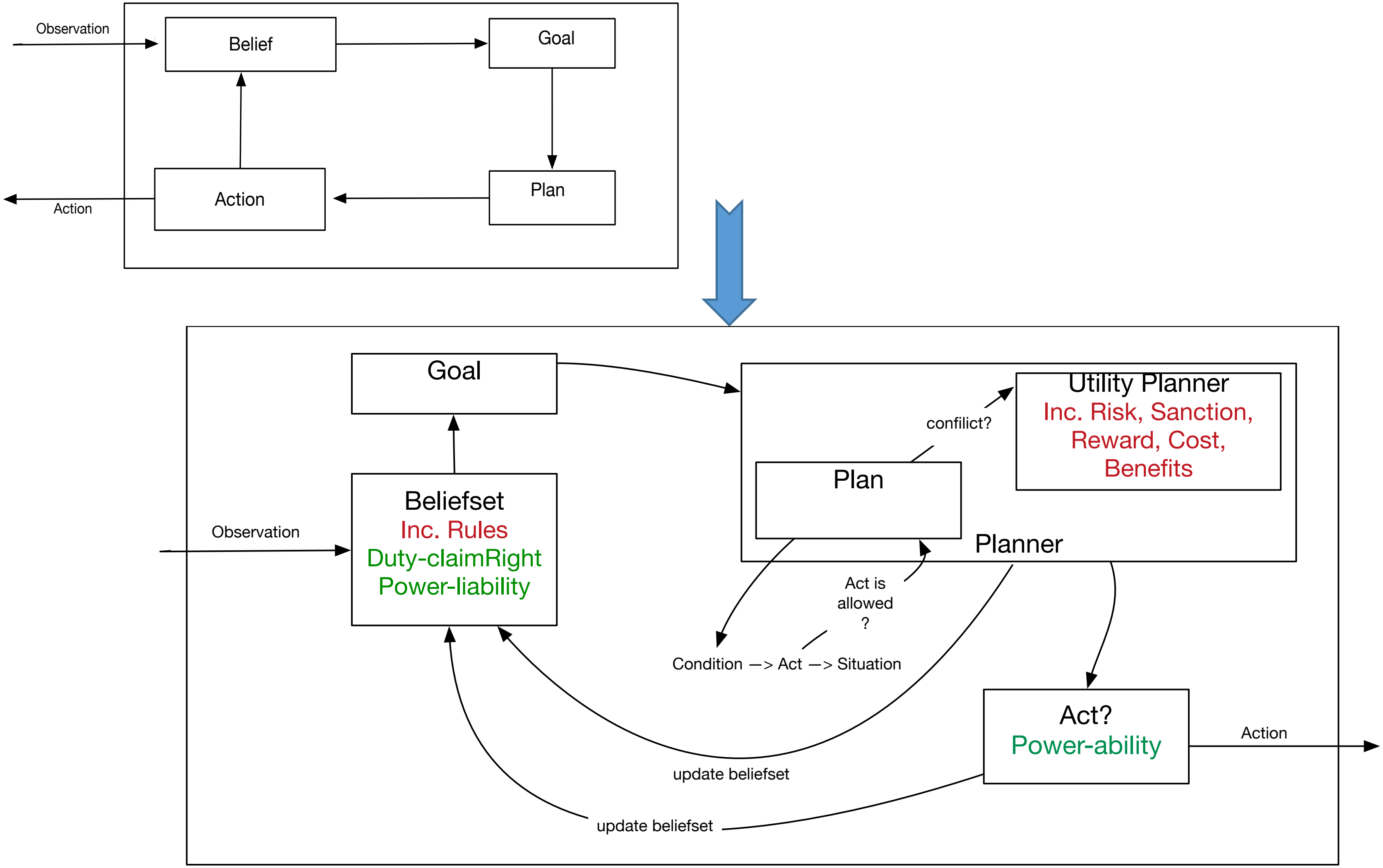
2. How can agents identify non-compliant society members and respond to them by adapting their behavior?

Goal

- Development of an extended version of the BDI agent model (N-BDI*)
- Extension of the BDI control loop
- Enabling us to study how norms can be used to create STDMPs.

N-BDI*

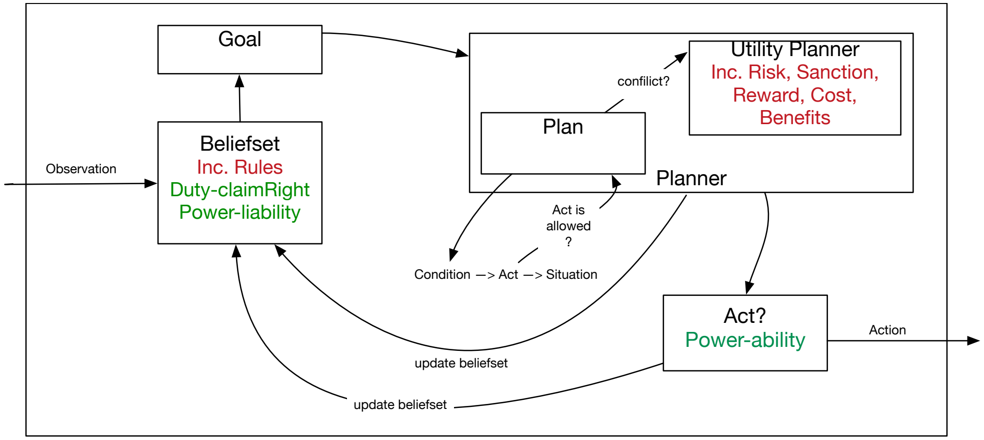
N-BDI* architecture

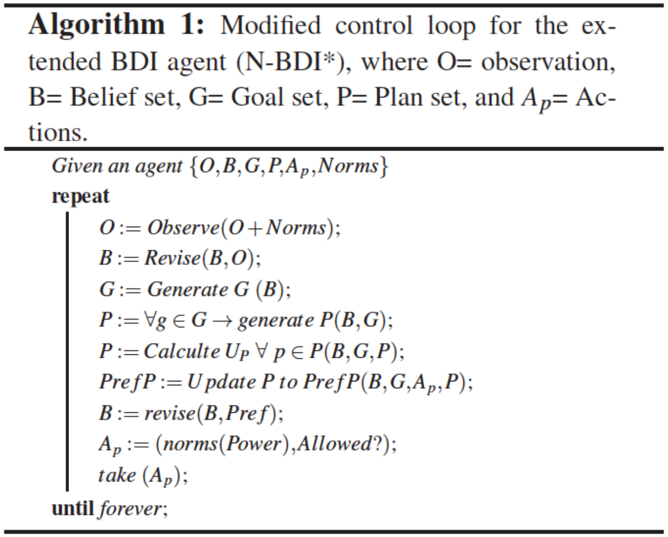


*Rao, Anand S., and Michael P. Georgeff. "BDI Agents: From Theory to Practice." *ICMAS*. Vol. 95. 1995.

Modified Control Loop

- Divided an agent planner component in two sub-components:
  1. Planner to generate plans based on the agent preferences
  2. Select the most appropriate plan based on the plan utility[1]
- Include norms to the agent's belief-set





Algorithm 1: Modified control loop for the extended BDI agent (N-BDI*), where O= observation, B= Belief set, G= Goal set, P= Plan set, and A_p= Actions.

```
Given an agent $\{O, B, G, P, A_p, Norms\}$
repeat
    $O := Observe(O + Norms)$;
    $B := Revise(B, O)$;
    $G := Generate\ G\ (B)$;
    $P := \forall g \in G \rightarrow generate\ P(B, G)$;
    $P := Calculte\ U_P\ \forall\ p \in P(B, G, P)$;
    $PrefP := Update\ P\ to\ PrefP(B, G, A_p, P)$;
    $B := revise(B, Pref)$;
    $A_p := (norms(Power), Allowed?)$;
    $take\ (A_p)$;
until forever;
```

[1] Deljoo, A., Gommans, L., van Engers, T., and de Laat, C. (2017). What is going on: Utility based plan selection in bdi agents. In The AAAI-17 Workshop on Knowledge-Based Techniques for Problem Solving and Reasoning WS-17-12 .

Norm

- A norm[1] is defined as a tuple

$$n = (role, normtype, conditions, action)$$

- Role: indicates the organizational position;
- Norm: type is one of the four modal verbs “can” (power), “can not” (disability), “must” (duty) and “must not” (the obligation to not do something!);
- Condition[2] : describes when and where the norm holds;
- Action: action specifies the particular action to which the normative relation is assigned (norm adoption);

[1] Oren et al., 2009

[2] Pre-condition and Post-condition have been extracted from the GDPR.

From GDPR to Normative Expression(Example)

- **NormCollectData** that describes the **permission** to **collect personal data** from the **data subject**, where the **collector** is the **LH agent** consisting of two sub-agents (**LH’s controller, LH’s processor**).

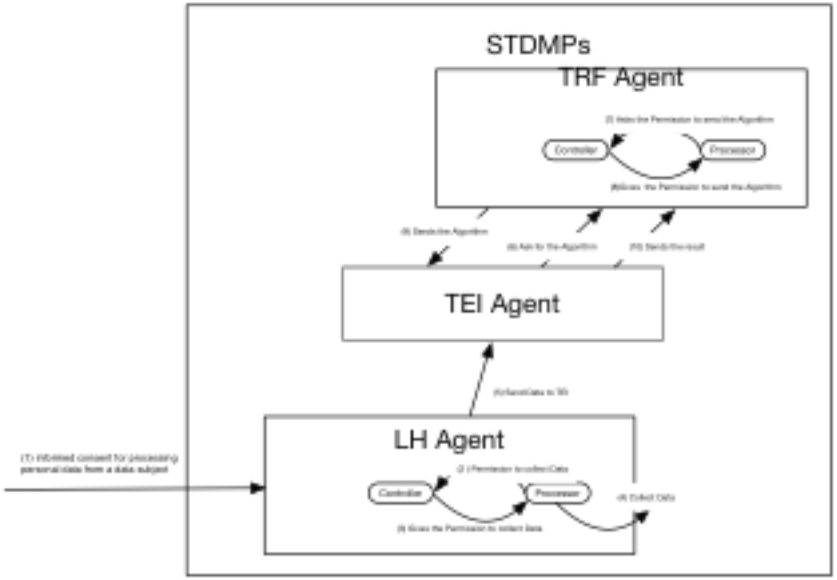
Agent	Role	Normative Relation	Condition	Action
LH Agent	LH’s Controller	Power	“iff” **legitimate** purpose of collecting data is **specified explicit** “AND” the LH’s controller has provided the data subject with the information on the **collecting** of his personal data’	Collecting Data
	LH’s Processor	Power	“iff” **processing** of data is **compatible** with the purposes for which data was collected “AND” controller took appropriate measures to provide information relating to processing to the data **subject** “AND” the **LH’s controller** has provided the data subject with the information on the processing of his personal data”	Processing Data

Assumption

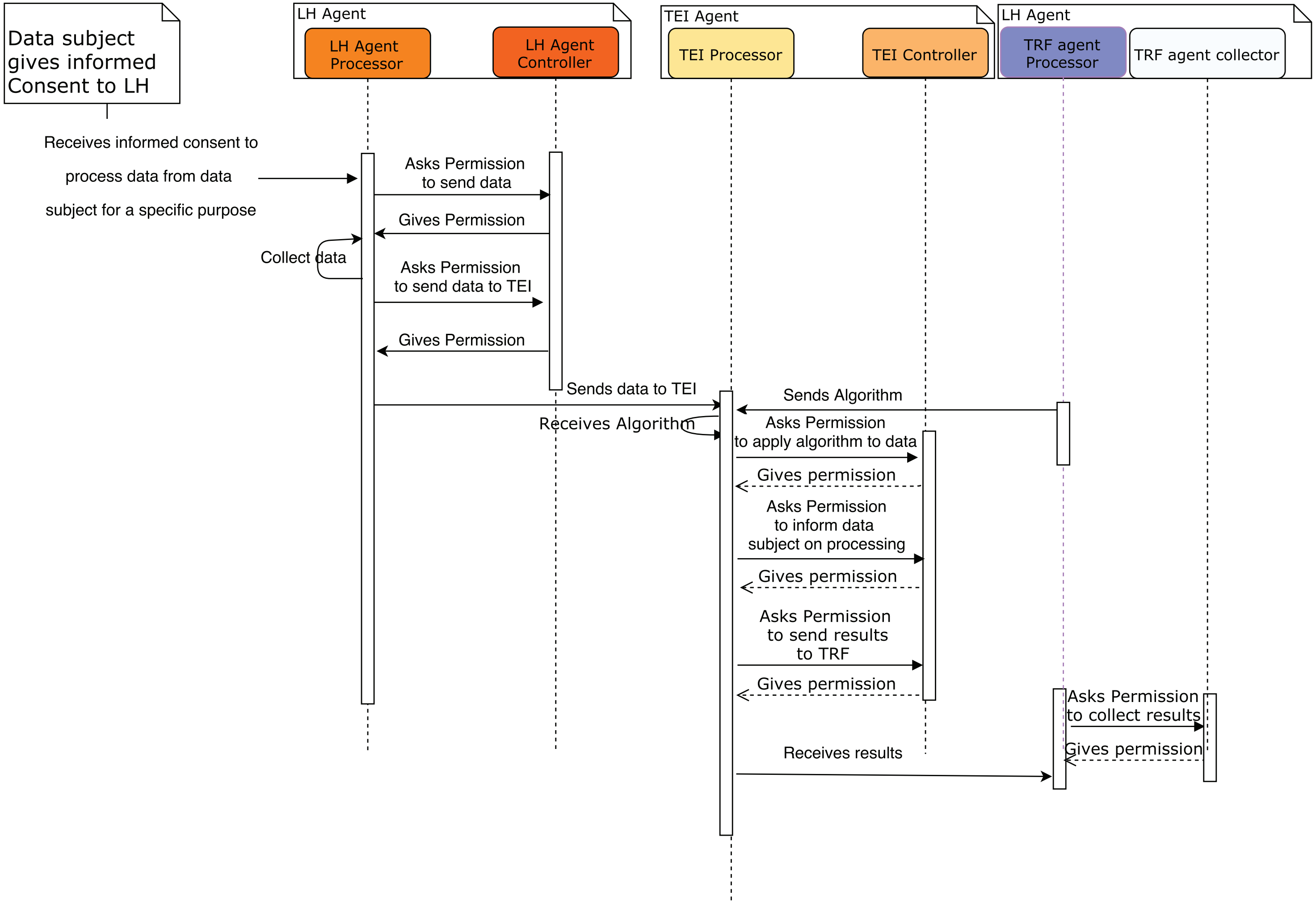
- Each agent consists of two subagents of Collector and Processor.
- Contract are a set of **Permissions**.
- LH’s controller defined the set of **licenses**.
- Licenses have a defined a set of conditions on using data.

STDMPs

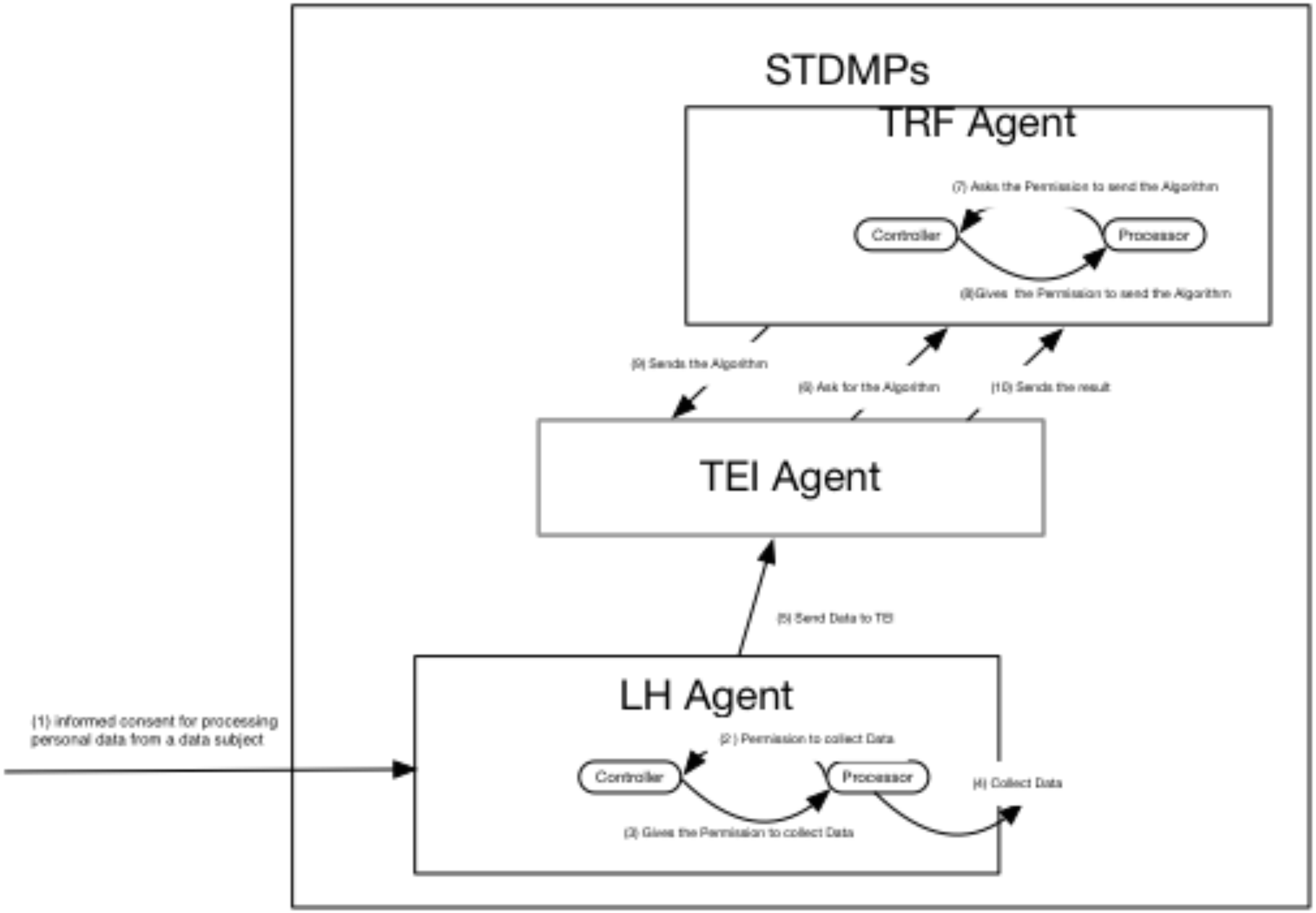
- LH: license holding agents who hold data and can provide data to the market (the STDMPs);
- TEI: agents who monitor the members’ behavior;
- TRF: Transformation agents who hold the algorithms, have a need for the LH’s data that can be provide through the STDMPs.


STDMPs
TRF Agent
(7) Asks the Permission to send the Algorithm
Controller
Processor
(8)Gives the Permission to send the Algorithm
(9) Sends the Algorithm
(6) Asks for the Algorithm
(10) Sends the result
TEI Agent
(5) Send Data to TEI
LH Agent
(1) Informed consent for processing personal data from a data subject
(2) Permission to collect Data
Controller
Processor
(4) Collect Data
(3) Gives the Permission to collect Data

SDTMP


Data subject gives informed Consent to LH
LH Agent
LH Agent Processor
LH Agent Controller
TEI Agent
TEI Processor
TEI Controller
LH Agent
TRF agent Processor
TRF agent collector
Receives informed consent to process data from data subject for a specific purpose
Asks Permission to send data
Gives Permission
Collect data
Asks Permission to send data to TEI
Gives Permission
Sends data to TEI
Receives Algorithm
Sends Algorithm
Asks Permission to apply algorithm to data
Gives permission
Asks Permission to inform data subject on processing
Gives permission
Asks Permission to send results to TRF
Gives permission
Asks Permission to collect results
Gives permission
Receives results

Scenario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Simulation

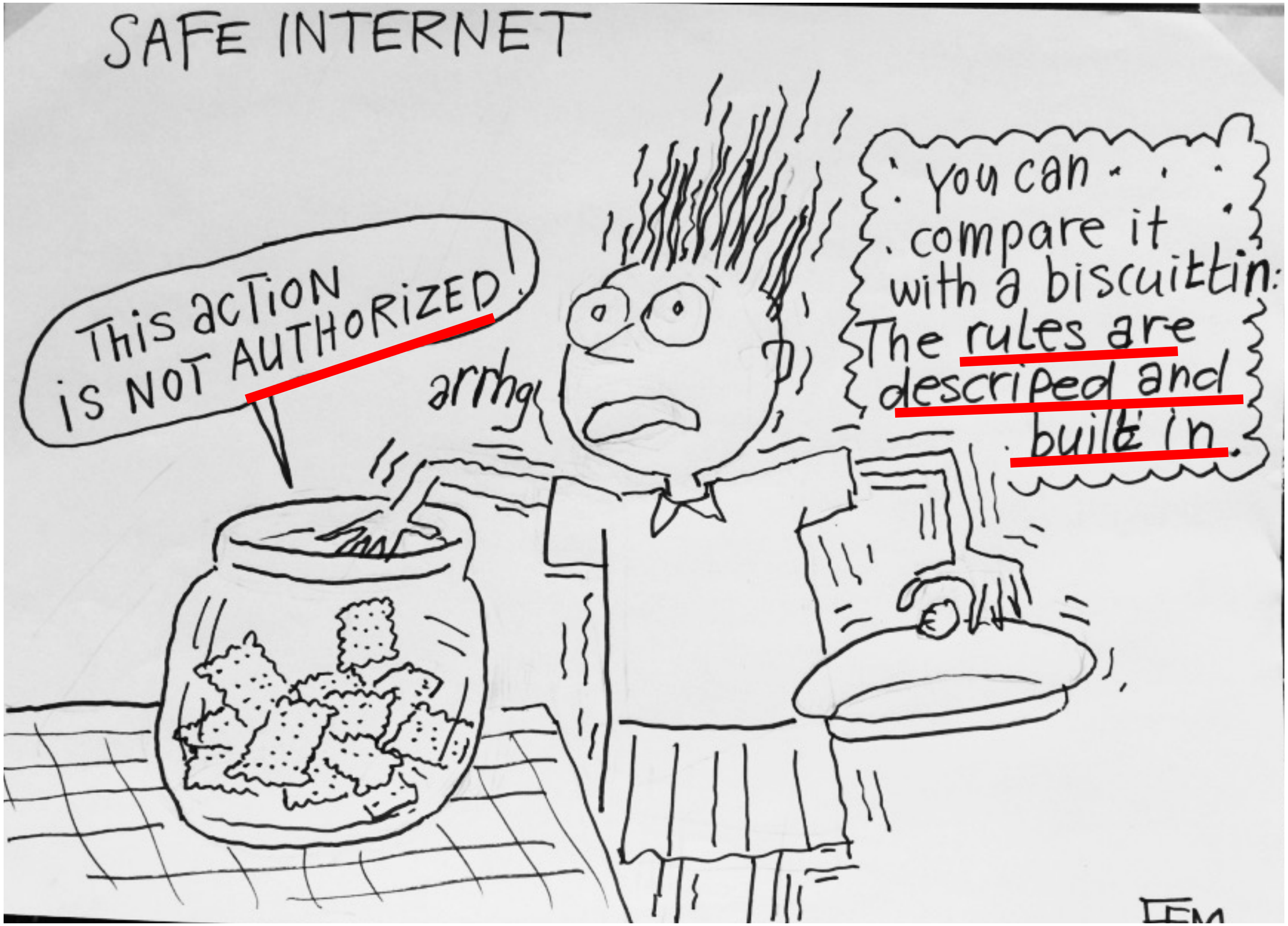

SAFE INTERNET
This action is NOT AUTHORIZED!
arrhg
you can compare it with a biscuittin: The rules are descriped and built in.
FEM

Illustration credit: FEM

Simulation

Setup

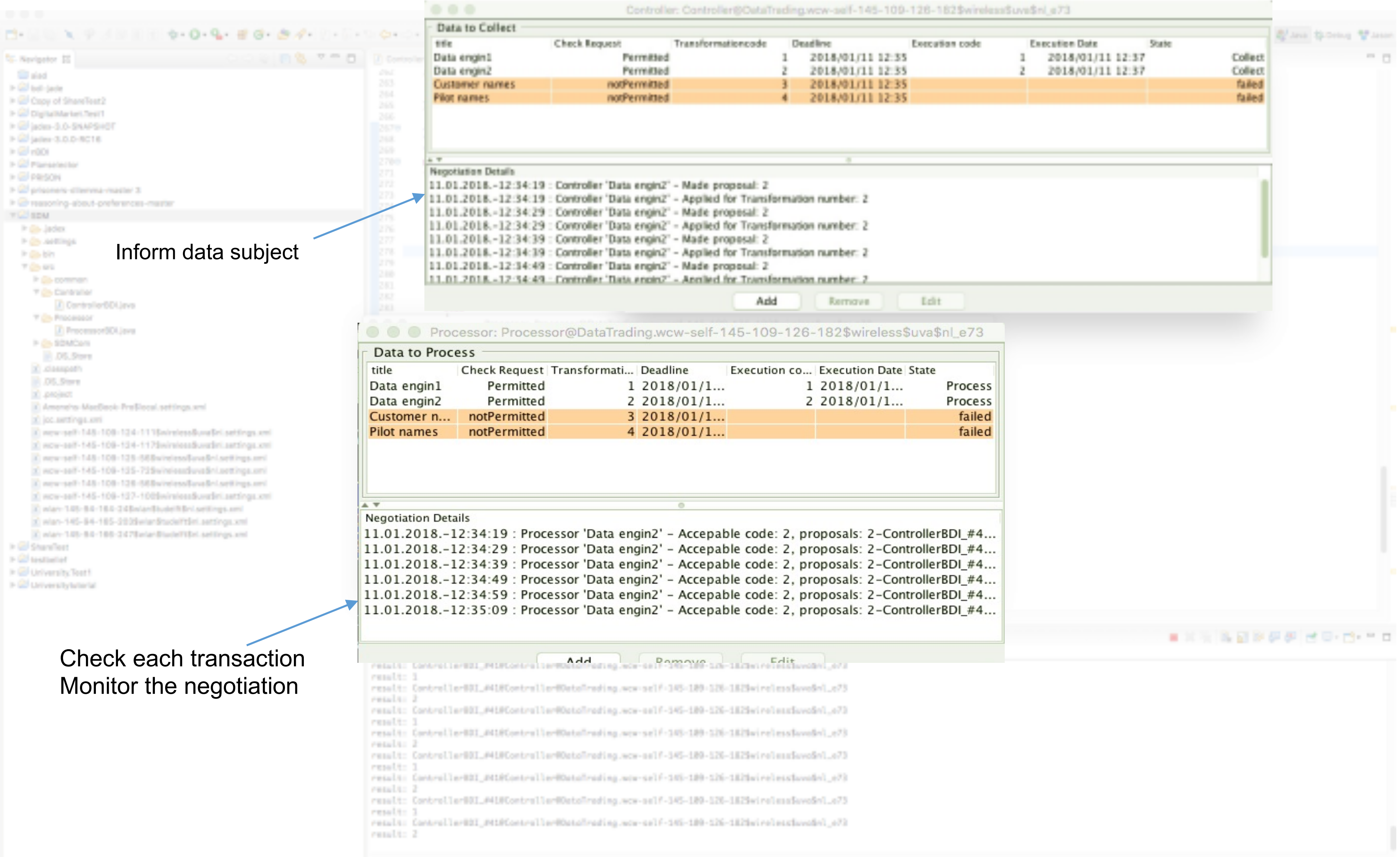
- Implement the STDMP's agent with BDI agent in Jadex.
- Two BDI agents as the Controller and Processor.
- Norm engine has been implemented as a part of the belief-set.
- STDMP formed by different airlines companies.

Aim

- Monitor the negotiation process between the agents.
- Check each requested transaction against the GDPR.

[1] Braubach, Lars, Winfried Lamersdorf, and Alexander Pokahr. "Jadex: Implementing a BDI-infrastructure for JADE agents." (2003).

Simulation



Inform data subject

Check each transaction
Monitor the negotiation

Controller: Controller@DataTrading.wcw-self-145-109-126-182$wireless$uva$nl_e73

Data to Collect

title	Check Request	Transformationcode	Deadline	Execution code	Execution Date	State
Data engin1	Permitted	1	2018/01/11 12:35	1	2018/01/11 12:37	Collect
Data engin2	Permitted	2	2018/01/11 12:35	2	2018/01/11 12:37	Collect
Customer names	notPermitted	3	2018/01/11 12:35			failed
Pilot names	notPermitted	4	2018/01/11 12:35			failed

Negotiation Details

```
11.01.2018.-12:34:19 : Controller 'Data engin2' - Made proposal: 2
11.01.2018.-12:34:19 : Controller 'Data engin2' - Applied for Transformation number: 2
11.01.2018.-12:34:29 : Controller 'Data engin2' - Made proposal: 2
11.01.2018.-12:34:29 : Controller 'Data engin2' - Applied for Transformation number: 2
11.01.2018.-12:34:39 : Controller 'Data engin2' - Made proposal: 2
11.01.2018.-12:34:39 : Controller 'Data engin2' - Applied for Transformation number: 2
11.01.2018.-12:34:49 : Controller 'Data engin2' - Made proposal: 2
11.01.2018.-12:34:49 : Controller 'Data engin2' - Applied for Transformation number: 2
```

Processor: Processor@DataTrading.wcw-self-145-109-126-182$wireless$uva$nl_e73

Data to Process

title	Check Request	Transformati...	Deadline	Execution co...	Execution Date	State
Data engin1	Permitted	1	2018/01/1...	1	2018/01/1...	Process
Data engin2	Permitted	2	2018/01/1...	2	2018/01/1...	Process
Customer n...	notPermitted	3	2018/01/1...			failed
Pilot names	notPermitted	4	2018/01/1...			failed

Negotiation Details

```
11.01.2018.-12:34:19 : Processor 'Data engin2' - Accepable code: 2, proposals: 2-ControllerBDI_#4...
11.01.2018.-12:34:29 : Processor 'Data engin2' - Accepable code: 2, proposals: 2-ControllerBDI_#4...
11.01.2018.-12:34:39 : Processor 'Data engin2' - Accepable code: 2, proposals: 2-ControllerBDI_#4...
11.01.2018.-12:34:49 : Processor 'Data engin2' - Accepable code: 2, proposals: 2-ControllerBDI_#4...
11.01.2018.-12:34:59 : Processor 'Data engin2' - Accepable code: 2, proposals: 2-ControllerBDI_#4...
11.01.2018.-12:35:09 : Processor 'Data engin2' - Accepable code: 2, proposals: 2-ControllerBDI_#4...
```

```
result: ControllerBDI_#41@Controller@DataTrading.wcw-self-145-109-126-182$wireless$uva$nl_e73
result: 1
result: ControllerBDI_#41@Controller@DataTrading.wcw-self-145-109-126-182$wireless$uva$nl_e73
result: 2
result: ControllerBDI_#41@Controller@DataTrading.wcw-self-145-109-126-182$wireless$uva$nl_e73
result: 1
result: ControllerBDI_#41@Controller@DataTrading.wcw-self-145-109-126-182$wireless$uva$nl_e73
result: 2
result: ControllerBDI_#41@Controller@DataTrading.wcw-self-145-109-126-182$wireless$uva$nl_e73
result: 1
result: ControllerBDI_#41@Controller@DataTrading.wcw-self-145-109-126-182$wireless$uva$nl_e73
result: 2
result: ControllerBDI_#41@Controller@DataTrading.wcw-self-145-109-126-182$wireless$uva$nl_e73
result: 1
result: ControllerBDI_#41@Controller@DataTrading.wcw-self-145-109-126-182$wireless$uva$nl_e73
result: 2
```

Future work

- Design and implement the rule engine as an external component.
- Monitor activities to detect of (non-)compliance in networked societies
- Define enforcement activities would enhance compliance.
- Study the flipping point of the society.

Questions?

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http://delaat.net/sarnet/index.html

Illustration credit: FEM