

# ATHOS: A PILOT PROJECT TOWARDS COMPUTATIONAL ACCOUNTABILITY

 Accountable Trustworthy Organizations and Systems

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M. Baldoni, C. Baroglio, [R. Micalizio](#)

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Università degli Studi di Torino, Dipartimento di Informatica



# WHAT ATHOS IS

## ACCOUNTABLE TRUSTWORTHY ORGANIZATIONS AND SYSTEMS

- is a two-year, local project
- is a pilot project for investigating the topic of **accountability** in business processes
- has involved
  - three faculty members
  - three granted students
  - five Bachelor Theses
  - two M. Sc. Theses

# THE QUEST FOR COMPUTATIONAL ACCOUNTABILITY

- Human society strongly relies on **relationships**
  - between two individuals
  - between an individual and an organization
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  - between two individuals
  - between an individual and an organization
  - between two organizations
- **relationships set up expectations** about parties' good conduct
- when expectations are violated one of the parties is **held to account** for her conduct

- Accountability can be defined as:  
*“ [A] social relationships in which an actor feels an obligation to explain and to justify his or her conduct to some significant other.”*

Day & Klein, 1987

# THE QUEST FOR COMPUTATIONAL ACCOUNTABILITY

- Accountability can be defined as:  
*“ [A] social relationships in which an actor feels an obligation to explain and to justify his or her conduct to some significant other.”*  
Day & Klein, 1987
- How to support an actor in her activities so as not to violate expectations, or to provide an account of her conduct when asked to?

# THE QUEST FOR COMPUTATIONAL ACCOUNTABILITY

- Thanks to technological advances the paradigm of *Socio-technical Systems* (STSs) is rapidly spreading in many everyday human tasks
- The mere availability of an ICT infrastructure does not support the interacting parties to **be aware of the expectations** that are put on them
- Even more critical when **cross-organizational relationships** have to be established and maintained

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- **Procedural** (e.g., BPMN, YAML, Activity Diagrams)
  - parties are required to adhere to procedures: no deviations for taking advantages from opportunities
  - **activity-centric perspective overlooks the relationship dimension**
- **Declarative** (e.g., DECLARE, BALSAs, GSM-CMNN)
  - interaction among parties is modeled by *choreographies*
  - the focus is on the exchange of messages
  - no proper abstraction to model explicitly relationships
  - parties involved in an interaction **cannot create expectations** about the behaviors of others

# THE QUEST FOR COMPUTATIONAL ACCOUNTABILITY

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How to proceed:

- **Methodologically:**
  - **paradigm shift from procedural processes to declarative agents**
  - modeling framework for STSs based on *Multi-Agent Systems*:
    - focus moves from procedural workflows to *declarative and explicit representation of interactions and social relationships*

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  - modeling framework for STSs based on *Multi-Agent Systems*:
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- **Practically:**
  - an **agent programming environment**
    - *supporting and monitoring* on-going interactions (and processes),
    - *enforcing accountability*, when possible, or detecting violations

# PRINCIPLES OF ACCOUNTABILITY BY DESIGN

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## The Research Question

*Is it possible to develop STSs that show accountability as a design property?*

In other terms, how to develop an STS such that in every state of interest the accountable parties are clearly identifiable?

- AThOS focuses on **accountability in organizational settings**
- the organization's functioning is assumed to be supported by an STS
- AThOS aims at realizing accountability as **computational process within a specific organization**
  - the accountability process activates when a state of interest is reached, and an authoritative entity wishes parties behind that state to hold account

## Paradigm shift: from process to agents

- Agents as abstractions for (business) processes
  - BDI architecture enables direct manipulation of **goals**
  - usage of MAS notions such as **norms, commitments, organizations** and **roles** ⇒ **Relationships**
- Multi-agent programming is concerned with realizing **multiple, concurrent control flows**: perfect for capturing business processes, even cross-organizational ones

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4. An agent is only accountable, towards the organization or another agent, **for those goals it has explicitly accepted to bring about**
5. An agent must have the leeway for putting before the organization the **provisions it needs for achieving the goal to which it is committing**. The organization has the capability of reasoning about the requested provisions and can accept or reject them.

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- ADOPT: ACCOUNTABILITY-DRIVEN ORGANIZATION PROGRAMMING TECHNIQUE

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- ADOPT: ACCOUNTABILITY-DRIVEN ORGANIZATION PROGRAMMING TECHNIQUE
- Regulates how an agent gets into an organization (*role enactment*)
  - when an agent enacts a role is made aware of the *powers* it will be asked to use inside the organization

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## ADOPT Protocol [PRIMA 2017, AIXIA 2017]

- ADOPT: ACCOUNTABILITY-DRIVEN ORGANIZATION PROGRAMMING TECHNIQUE
- Regulates how an agent gets into an organization (*role enactment*)
  - when an agent enacts a role is made aware of the *powers* it will be asked to use inside the organization
- Regulates how an organization can assign goals to an agent
  - an agent accepts to carry out a task by *committing* to it, but it can also ask the organization to supply proper *provisions*

- ADOPT involves an agent and the organization it has enrolled to.
- how to address accountability between agents sharing data?

Business artifacts (initially proposed in [Nigam and Caswell, 2003]) are:

- identifiable, self-describing chunks of information by which business models and operations are described
- they are created and evolve as they pass through business operations

# BUSINESS ARTIFACTS

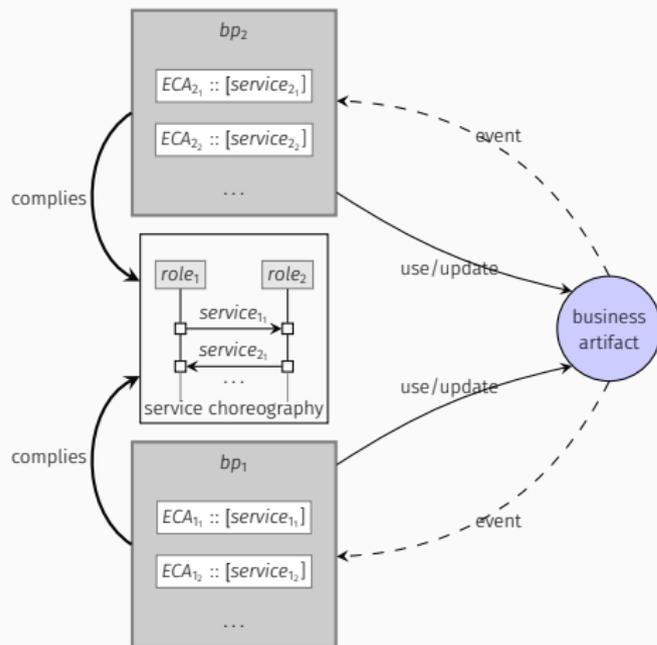
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Business Artifacts (BA) include:

- an **information model** of the data
- a **lifecycle model**, used both at design time and at run-time

# BUSINESS ARTIFACTS AND COORDINATION



- Coordination relies on **choreography** and **choreography languages**
- BAs are **not devised** as natural means of coordination in their own right, although they have the potential to be a coordination media

**Claim: BAs themselves can be a means for realizing coordination**  
[BPAI2017, CAiSE2017]

## Business Artifact as Coordination Medium

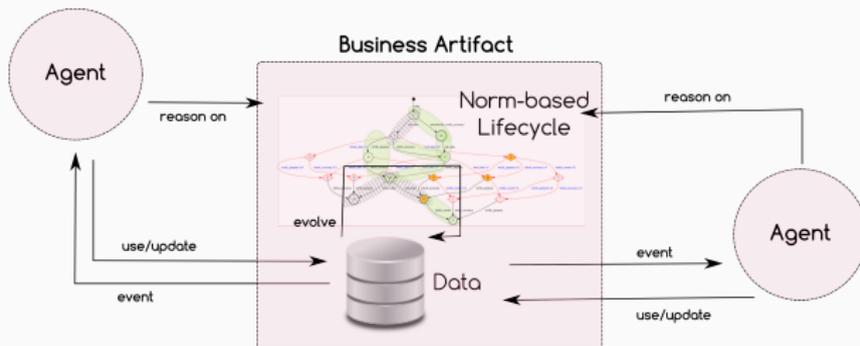
We propose to enrich business artifacts with a **normative layer** to account for the social engagements of the parties which interact by using them

## Multiagent Systems Approach

A **MAS approach**, that exploits **commitments** to represent **social engagements**.

1. **representing the BA lifecycle** (how data evolve)
  - agents will be capable of **reasoning** on the BA and decide if and how to use it for their own purposes
2. **capturing the engagements between the agents**
  - agents will be able to create **expectations** on each other's behavior and coordinate

# ATHOS'S NORMATIVE BUSINESS ARTIFACTS



- Services operating on business artifacts should be encapsulated and organized into **goal-oriented containers**
- Need for a **normative layer** to capture the behaviors that are expected of the parties

Information model:

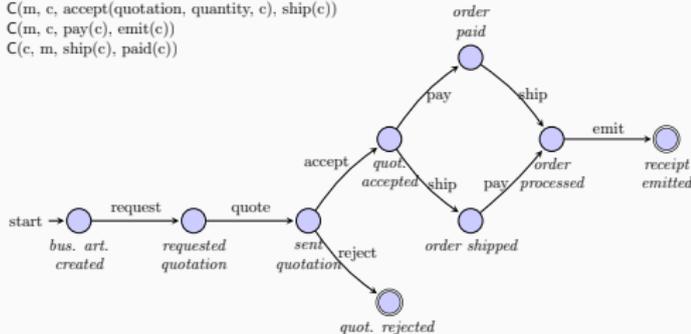
merchant	customer	item	max_avail	quantity	quotation	order
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Normative layer:

ShipGoods:  $C(m, c, \text{accept}(\text{quotation}, \text{quantity}, c), \text{ship}(c))$

EmitReceipt:  $C(m, c, \text{pay}(c), \text{emit}(c))$

PayForGoods:  $C(c, m, \text{ship}(c), \text{paid}(c))$



- Agents aware of current state of the lifecycle, **obligations**, **prohibitions**, **commitments**, **permissions** put on them.
- Agents aware of the **task expected** of them and of their parties
- Normative business artifacts induce a form of **objective coordination**
- Coordination is **addressed outside** the interacting agents

## ATHOS IMPLEMENTATION

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- Use social commitments [Singh, 1999] to realize the normative layer and in particular engagements
- Use 2COMM [Baldoni et al., 2017] to create normative BAs
- Use JaCaMo+ [Baldoni et al., 2017] to program agents

# COMMITMENT SPECIFICATION

Commitments associated with a BA in Cupid Syntax [Chopra and Singh, 2015]

**commitment** ShipGoods merchant to customer

**create** quote(quantity, customer)

**detach** accept(quotation, quantity, customer)

**discharge** ship(customer)

**release** reject(price, quantity, customer)

**commitment** EmitReceipt merchant to customer

**create** quote(quantity, customer)

**detach** paid(customer)

**discharge** emit(customer)

**release** reject(price, quantity, customer)

**commitment** PayForGoods customer to merchant

**create** accept(quotation, quantity, customer)

**detach** ship(customer)

**discharge** paid(customer)

Jason agents have plans for addressing commitment state changes

```
+requestedQuotation(Quantity, Customer_Id)
  < – quote(UnitPrice*Quantity, Quantity, Customer_Id).

+cc(My_Role_Id, Customer_Role_Id,
  accept(Price, Quantity, Customer_Role_Id), ship(Customer_Role_Id),
  "DETACHED")
: enactment_id(My_Role_Id)
< – ship(Customer_Role_Id, Quantity).

+cc(My_Role_Id, Customer_Role_Id, paid(Customer_Role_Id),
  emitReceipt(Customer_Role_Id), "DETACHED")
: enactment_id(My_Role_Id)
< – emitReceipt(Customer_Role_Id).
```

## Example

```
+cc(My_Role_Id, Customer_Role_Id,  
    accept(Price, Quantity, Customer_Role_Id), ship(Customer_Role_Id),  
    "DETACHED")  
: enactment_id(My_Role_Id)  
< – ship(Customer_Role_Id, Quantity).
```

- Merchant side:
  - If a customer accepts my quotation, then it expects me to ship the items
  - The commitment lies within the BA
  - I am aware of actual commitments of this kind
  - In my program I tackle the situation when one is detached (e.g., price is accepted), and enact a plan to actually achieve what expected of me

## CONCLUSIONS

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- Computational Accountability is a challenging task:
  - requires to set a **context**
  - not all the process can always be automatized
  - a (human) **forum** can be supported by computational accountability
    - ADOPT and Normative Business Artifacts (NoBAs) are a first step towards this direction

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## Future directions:

- Formal verification techniques based on ADOPT and NoBAs
- Agent programming methodology for business processes
- Declarative agent abstraction points towards automated reasoning (i.e., **planning**): e.g., when to join into an engagement, how to satisfy a commitments, ...

QUESTIONS?

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