Commitments for Business Processes:
Overview of Concepts, Protocols, Machines, Compliance

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Essential Properties of Business Processes

- Autonomy.
- Heterogeneity.
- Exceptions.
- Opportunism.
Agent and Multiagent Systems

- Agents cover a wide range of behavior and functionality.
- An agent is an active computational entity that
  - Has a persistent identity.
  - Perceives, reasons about, and initiates activities in its environment.
  - Communicates with other agents.
  - Enters into complex relationships with other agents.
- These features enable agents to participate in open systems as service providers and consumers.
Commitments

- An agent’s commitment to another agent:
  - Is a directed obligation.
  - Arises within a well-defined scope or context, which is itself a MAS.
  - Manipulable (including revocable) with restrictions.

- Enable coherent agent interactions by capturing the meaning behind the interactions.

- Claim: 90% of all business data reflects commitments [statistics made up J].
Outline

- History, briefly:
  - AI, communication, mentalism.
  - Introduced 1991, applied late 1990s.
- Commitments and spheres thereof.
- Contracts.
- Commitment protocols and machines.
- Compliance.
- Directions.
Dynamic Organizations

Whenever agents come together dynamically and have structure to their interactions.

Abstractly, organizations

- Consist of roles
  - Requiring certain capabilities and commitments.
  - Offering certain authorities.
- Require commitments among the roles.
- Support commitments among the roles.

Concretely, organizations

- Consist of agents.
- Acting coherently.
Sphere of Commitments

SoCom: an organization that provides the context or scope of commitments among agents.

- Conceptually, the SoCom
  - Serves as a witness or adjudicator for the commitment.
  - Helps validate commitments and test for compliance.
  - Offers compensations to undo members’ actions.
Manipulating Commitments

- Operations on commitments:
  - Create.
  - Discharge (satisfy).
  - Cancel.
  - Release (eliminate).
  - Delegate (change debtor).
  - Assign (change creditor).

- Metacommitments:
  - Constrain the manipulation of commitments.
  - Fall into a small number (dozen) of patterns for common business process scenarios.
Applying SoComs

- Example: buyer and seller roles with appropriate
  - Capabilities, e.g., requests they can honor.
  - Commitments, e.g., validity of their price quotes.
- To adopt a role, an agent must have the capabilities and adopt the commitments.
- System needs are architecture and tools for
  - Discovery.
  - Compliance.
  - Designing the right agents.
SoComs provide the context for concepts represented & communicated.
Virtual Enterprises (VE)

- Two sellers come together into a SoCom called VE (implemented, e.g., with a new proxy agent).

Example of VE’s commitments:
- Notify on change.
- Update orders.
- Guarantee the price.
- Guarantee delivery date.
A Selling VE

Customer as Buyer

Do you sell valves and hoses?

Yes

1 need a valve with input dia of 43 and two matching hoses.
1 authorize up to $50,000

Order placed:
1 valve idia=43 odia=43
2 hoses dia=43
Charge = $14,414

Order revised:
1 valve idia=43 odia=21
2 hoses dia=43, and dia=21
Charge = $14,414

Order processed:
1 valve idia=43 odia=21
2 hoses dia=43, and dia=21
Charge = $14,414

represents events; events with the same sequence numbers are concurrent events.
Patterns

- Common patterns of commitments emerge, e.g.,
  - Policies to notify and renotify.
  - Policies to entertain requests, updates, from other roles.
- Patterns help design good systems.
- Agent skeletons can be generated from selected patterns that a role is expected to follow.
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Hohfeld discovered that “right” is used ambiguously and proposed a uniform terminology to distinguish its various uses.

- Sixteen concepts result:
  - Four main concepts.
  - Their correlates.
  - Their negations.
  - Their negations’ correlates.
- All two-party notions.
Claim-duty: the claims a party has on another.

Privilege-exposure: freedom from the claims of another agent – dual of claim.

Power-liability: when an agent can change the claim-duty relationship of another agent – ability to create and manipulate commitments involving others.

Immunity-disability: freedom from the power of another agent – dual of power.
Commitments for Contracts

Commitments express the Hohfeldian concepts. Importantly, commitments are:

- Public (unlike beliefs and intentions).
- Can be used as the basis for compliance.
- Contracts apply between parties, in a context.
- Other approaches are:
  - Single-agent focused, e.g., deontic logic.
  - Don’t handle organizational aspects of contracts.
  - Don’t accommodate manipulation of contracts.
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Commitment Protocols

- Protocols enable open systems to be constructed.
- Interaction protocols expressed in terms of
  - Participants’ commitments.
  - Actions for performing operations on commitments (to create and manipulate them).
  - Constraints on the above captured in temporal logic.
Example: NetBill

Some variations:
- The merchant may start the protocol by sending a quote.
- The customer may send an accept prior to offer.
- The merchant may send the goods prior to accept.

*These variations are not allowed by the FSM.*
Capturing Meaning

Atomic propositions:
- request: the customer has requested a quote.
- goods: the merchant has delivered the goods.
- pay: the customer has paid the agreed amount.
- receipt: the merchant has delivered the receipt.

Metacommitments:
- promiseGoods: $C_m(accept \Rightarrow goods)$
- accept: $C_c(goods \Rightarrow pay)$
- promiseReceipt: $C_m(pay \Rightarrow receipt)$
- offer: promiseGoods $\land$ promiseReceipt
When we represent meaning, we can reason about how an agent should act given the protocols in which it is participating.

- **Planning**: generate protocol runs that satisfy the given protocols
- **Opportunism**: Skip unnecessary states.
- **Composition**: Combine protocols through common commitment states.
- **Factoring**: Substitute a subprotocol for another (e.g., a sophisticated negotiation protocol for accepting quote) as long as both protocols produce semantically equivalent computations.
NetBill Enhanced by CMs

Meanings:
1. true
2. request
3. offer
4. $C_m \text{goods} \land \text{accept} \land \text{promiseReceipt}$
5. $\text{goods} \land C_c \text{pay} \land \text{promiseReceipt}$
6. $\text{goods} \land \text{pay} \land C_m \text{receipt}$
7. $\text{goods} \land \text{pay} \land \text{receipt}$
8. $\text{goods} \land \text{promiseReceipt}$
9. accept

Final state: No open commitments remain.
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Commitment machines deal with designing agents to obey protocols flexibly.

But in open multiagent systems, agents are contributed by different vendors and serve different interests.

How can we check if the agents comply with the specified protocols?

- Coordination aspects: traditional techniques.
- Commitment aspects: representations of the agents’ commitments in TL.
Verifying Compliance

- Specification of commitment protocols:
  - Models based on potential causality.
  - Protocol:
    - Commitments based on branching-time TL.
    - Domain-specific propositions and actions
    - Skeletons of roles essential for coordination

- Run-time verification:
  - Respects design autonomy.
  - Uses TL model-checking.
  - Local verification based on observed messages.
Fish-Market Sample Execution

Diagram showing interactions between Auctioneer A and Bidders B1 and B2.
Fish-Market Local Observations
Message Patterns for Commitment Operations

Ensure that information about commitment operations flows to the right parties, to enable local decisions.
Run-Time Compliance Checking

- An agent can keep track of
  - Its pending commitments.
  - Commitments made by others that are not satisfied.
- It uses this local model to see if a commitment has been violated.
- An agent who benefits from a commitment can always determine if it was violated.
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Directions

- Concepts and design:
  - Simplified commitment and policy capture.
  - Manipulation of commitments based on varying context groups.

- Protocols and machines:
  - Richer models of inference about commitments.

- Compliance:
  - Determination of compliance under different cases of system architecture and information flow.
  - Relationship to trust among participants.

Influence industry practice and standards.
Evaluation

- Control Flow: Excellent graph primitives, some with iteration
- Organizational abstraction: Not supported
- Conversations: Modeled as scripts (graphs), but not flexible
- Cooperation: Not supported
- Exception handling: Only low level, not semantic