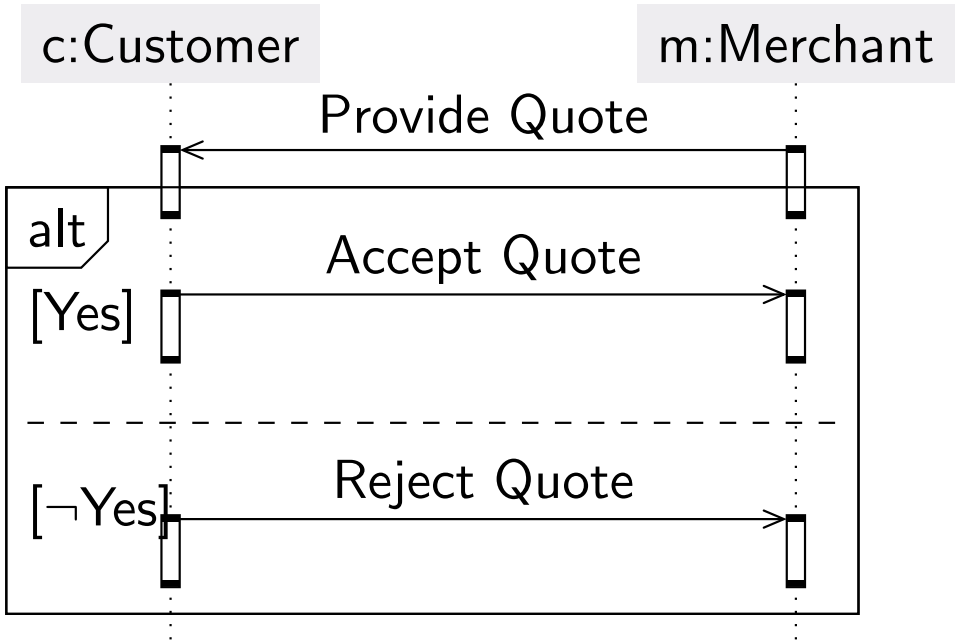
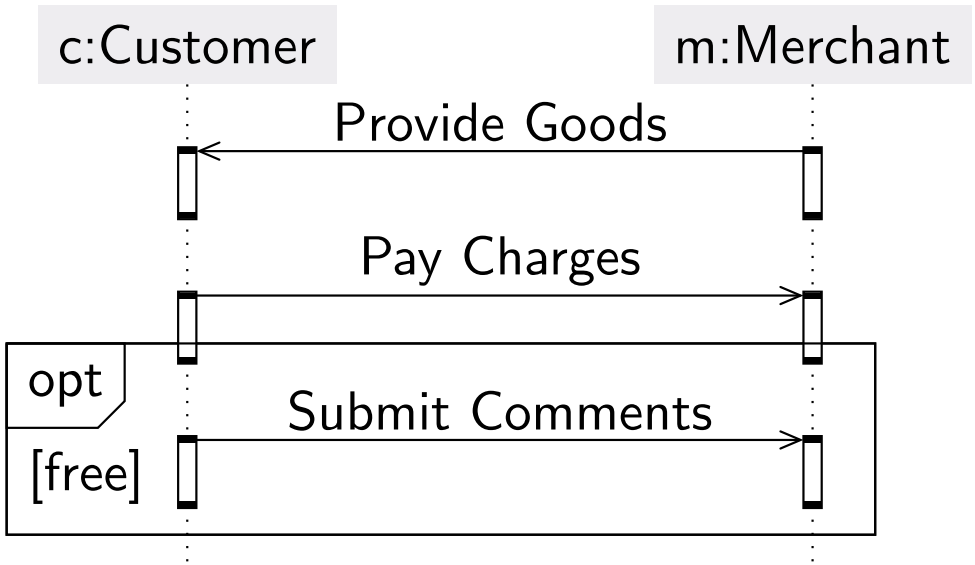
The Alternative Block

Nondeterministially choose and execute any fragment whose guard is true



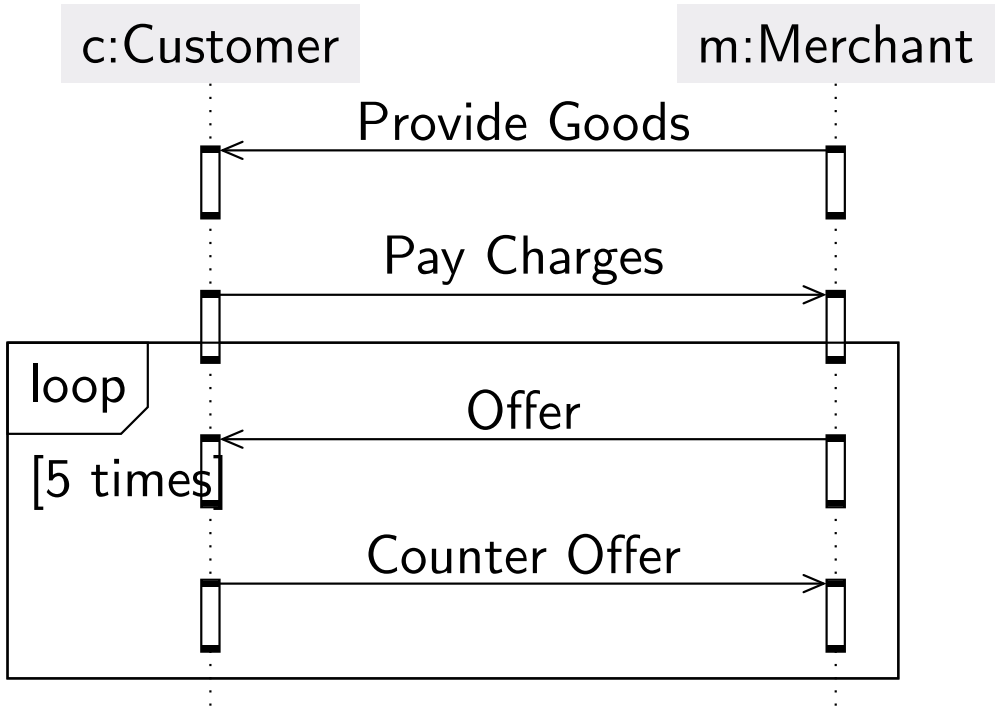
The Optional Block

Modeling error here: Showing internal detail (free (spare time)) in a protocol



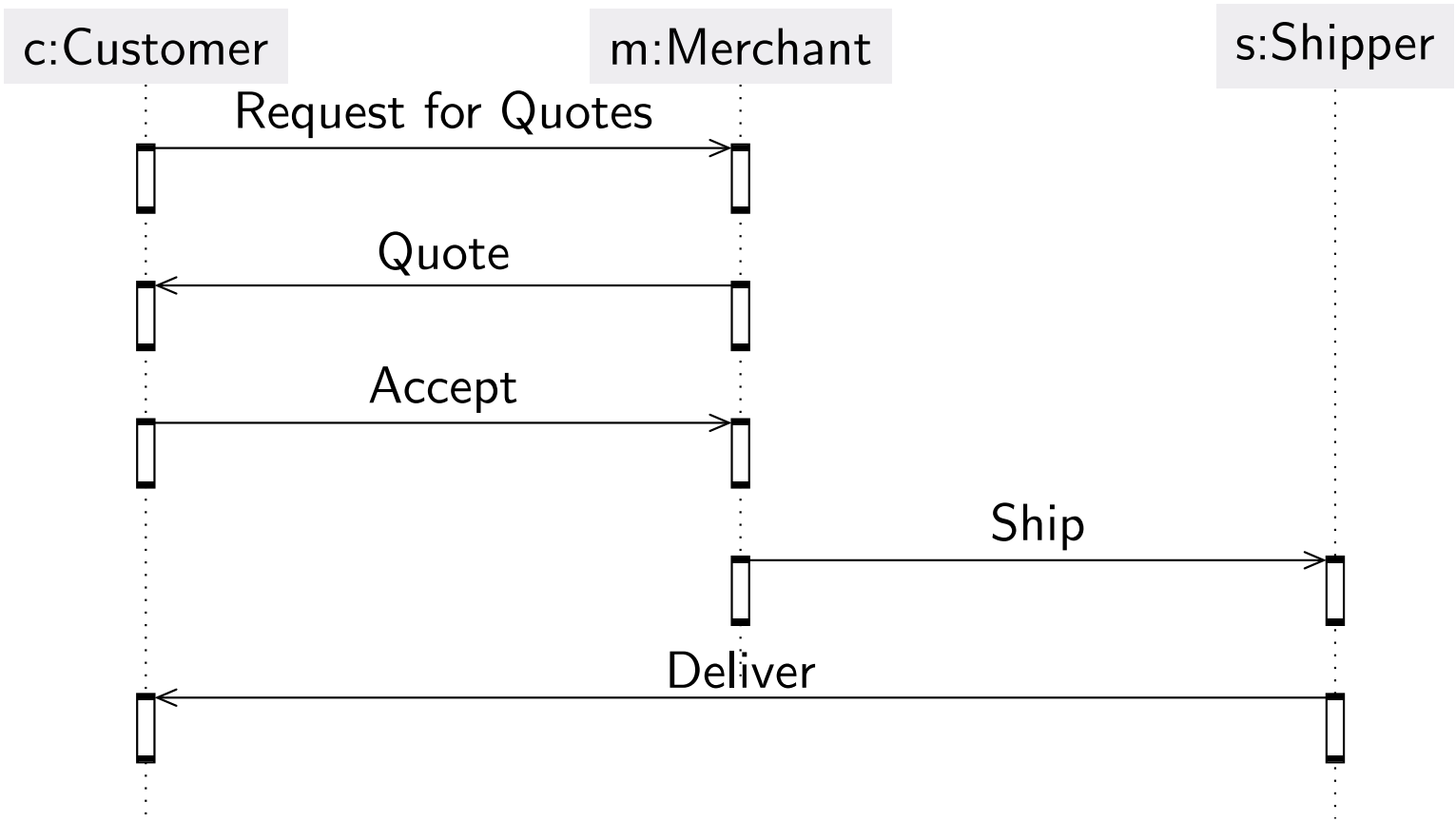
The Loop Block

Usually bounded in our examples

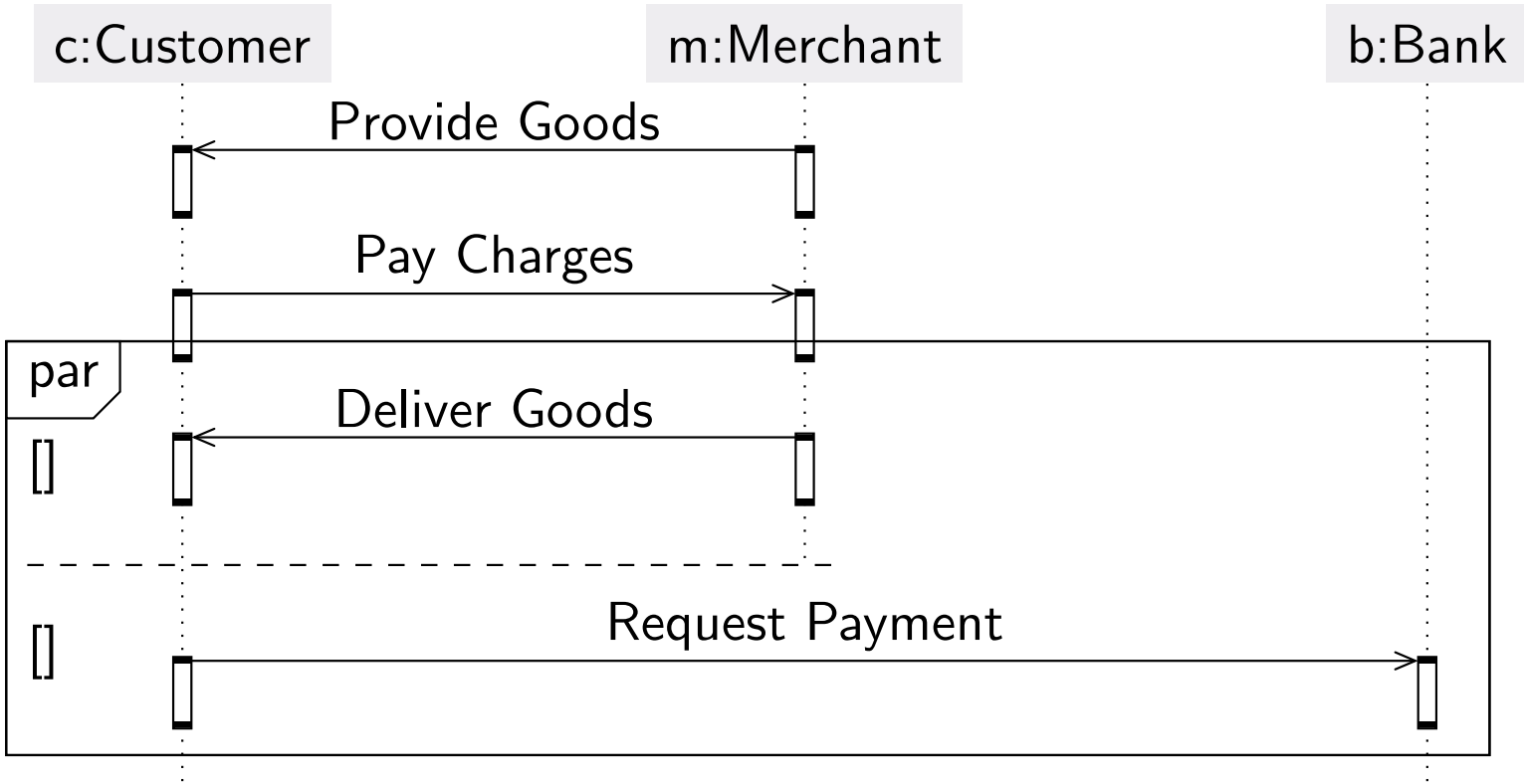


Purchase (Just the Happy Path)

Notice the hand off pattern, indicative of delegation



The Parallel Block

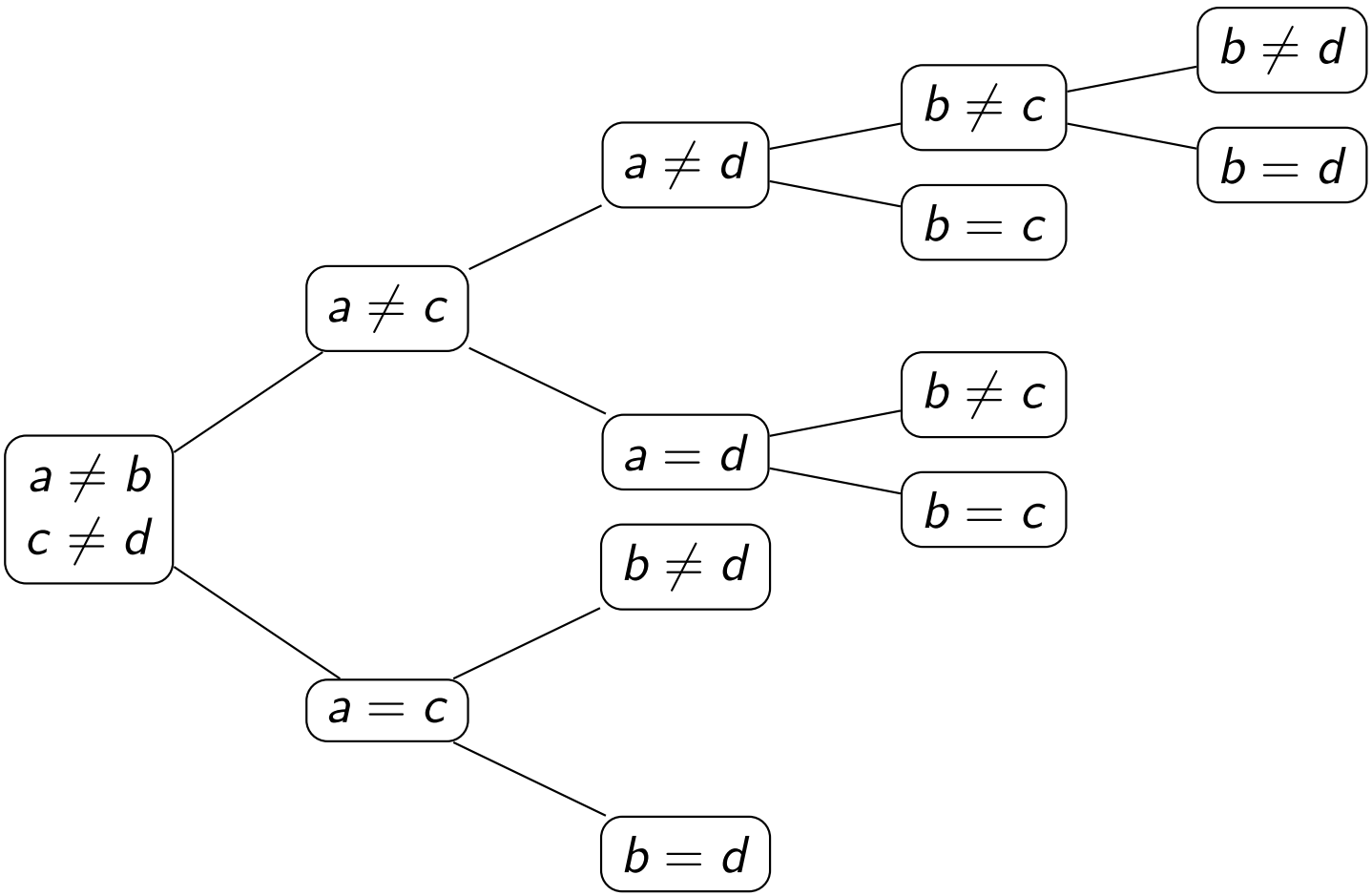


Exercise: Diagramming Precedence

- Four roles: A, B, C, D (could map to the same parties)
- Two messages: m_{AB} and m_{CD} (sender to receiver: distinct parties)
- We would like to assert that m_{AB} precedes m_{CD}

All Possible Sequence Diagrams

Given messages from a to b and from c to d



Exercise: Which of the Sequence Diagrams for Precedence are Compatible with Asynchrony?

Invariant outcomes regardless of relative execution speed, communication delays, and no global clock

Exercise: Diagramming Occurrence and Exclusion

Use guards that refer to message occurrence

If $[m_{AB}]$ occurs then so does $[m_{CD}]$

- Four roles: A, B, C, D (could map to the same parties)
- Two messages: m_{AB} and m_{CD} (sender to receiver)
- We would like to assert that
  - m_{AB} excludes m_{CD}
  - m_{AB} and m_{CD} mutually exclude each other
  - m_{AB} requires m_{CD}

Properties of a (Point-to-Point) Message Channel

Can we take a system snapshot that violates any of these properties?
How can we achieve each property?

Noncreative: Must a message that is received have been sent by someone?

- Will a channel create messages?

Reliable: Must a message that is sent be received?

- Will a channel drop messages?

Ordered: Must the messages received from the same sender be received in the order in which they were sent?

- In which direction does the information flow?

Global: Must the messages received from different senders be received in the order in which they were sent?

- Called "causal" ordering in the literature but that term refers to potential causality

Challenges to Correctness of Protocols

Not specific to sequence diagrams

Distribution: different parties observe different messages, i.e., each lacks remote knowledge

Asynchrony: different parties observe messages in inconsistent orders

- Despite FIFO channels

- Intuitions about correctness
  - If each party interacts correctly, is the overall behavior correct?
  - If not, our sequence diagram is not *realizable* or *enactable*
  - Is the design of each party obvious?
  - Does the design of the parties preclude some legal enactments?

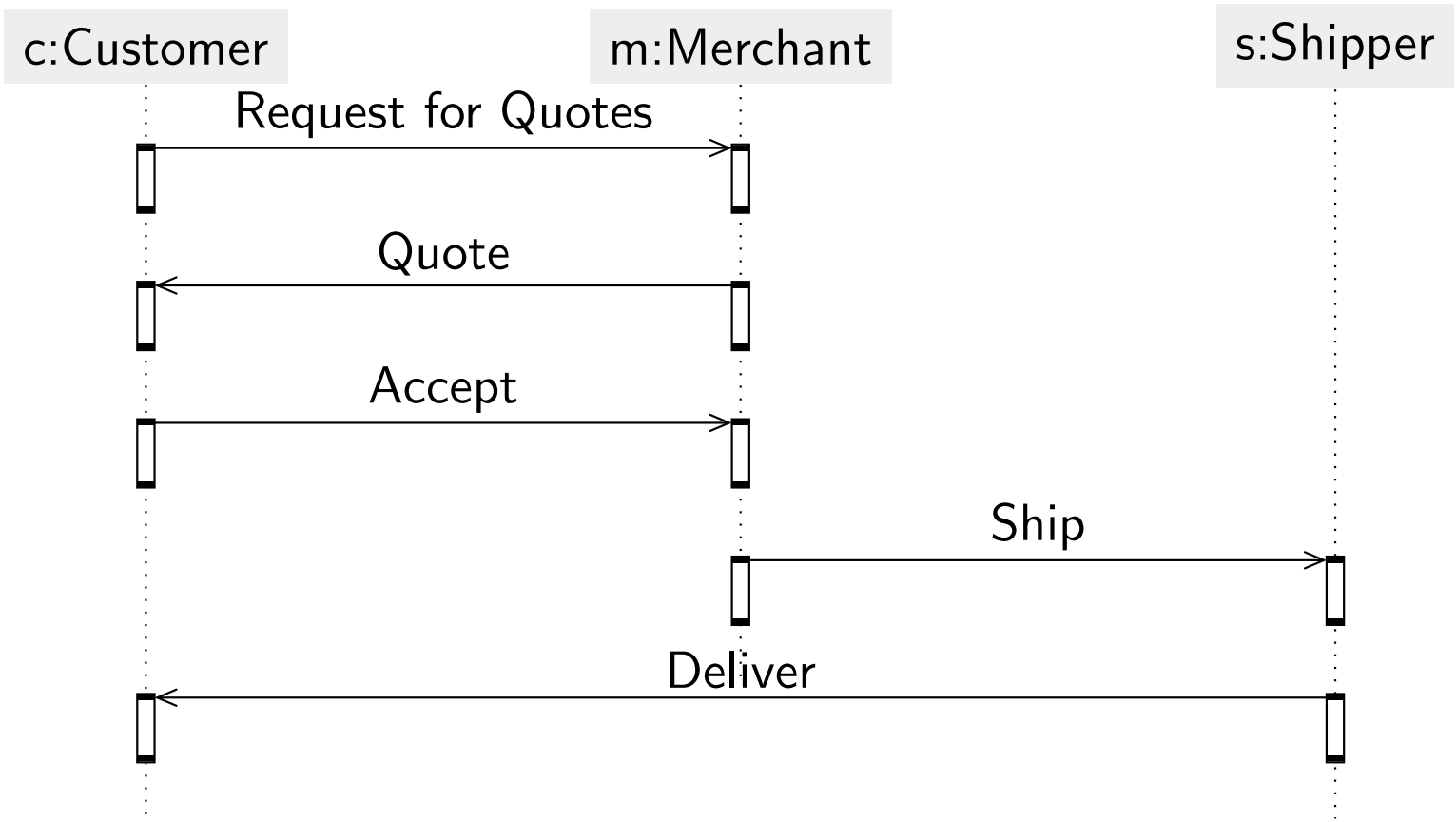
Business Protocols

Interactions among autonomous parties, understood at the business level

- *Conversation*: An instance of a protocol
- Operational representations: steps taken
  - Procedural
    - Sequence diagrams
    - State diagrams
    - Activity diagrams
    - Petri Nets
  - Declarative
    - Temporal logic
    - Dynamic logic
    - Information-based specifications
- Meaning-based representations: underlying business transaction
  - Declarative, if captured formally at all
    - Commitment machines
    - Constitutive specifications

Exercise: Identify the Public and Private Components

Process = Protocol + Policies



Exercise: How Might we Modularize Protocols?

Consider Purchase

Modular Business Protocols

- Identify small, well-defined interactions with clear business meanings
- Improve flexibility and concurrency
- Possibly lead to invalid executions
- How can we ensure good properties despite modularity?
  - Begin from a constraint language
  - Standardize modular fragments as patterns, e.g., RosettaNet

Sequence Diagrams for Business Modeling

No!

- No internal reasoning
  - No private predicates in guards
- No method calls
  - No self calls
- No synchronous messages
  - No business puts itself on indefinite hold waiting for its partner to proceed
- No causally invalid expectations
  - No *nonlocal* choice
    - No nonlocal choice that matters
  - No control of incoming message occurrence or ordering
  - No dependence on occurrence or ordering of remote message emission or reception
  - No reliance on ordering across channels
    - No reliance on ordering within a channel unless warranted