TU WIEN

Specifying Requirements through Interaction Design

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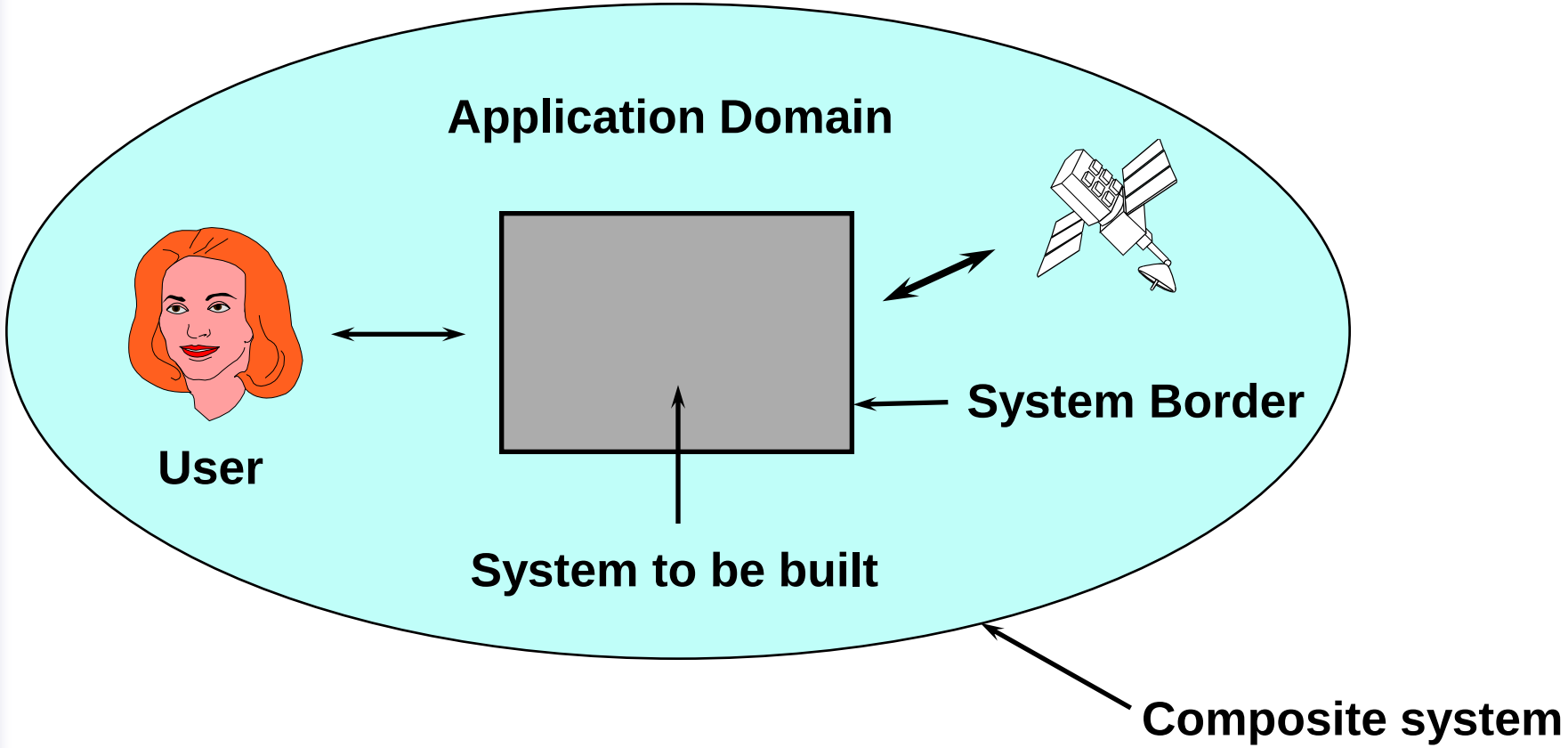
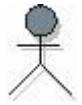
System overview



Outline

- Background
- Interaction design based on discourse modeling
- Use case specification
- Exercises
- Sketch of automated user-interface generation
- Summary and Conclusion

What are requirements?



- User wishes / needs
- *IEEE Standard:*
  "A condition or capacity needed by a user to solve a problem or achieve an objective."
- "The <*system*> shall be able to ..."
  - system to be built
  - composite system
- *Example:* "The ATM shall accept a cash card."
- Requirements modeling

Traditional UI development

- Based on toolkits employing widgets
- Widgets grouped according to their graphical appearance
- Highly-specialized designers and programmers needed
- Lots of UI code
- Error-prone, low maintainability
- Expensive

Interaction design

- Design of interactions between human and computer
- Relation to requirements engineering
- Relation to task analysis
- No commitment to specific user interface

Scenarios – Stories and narratives

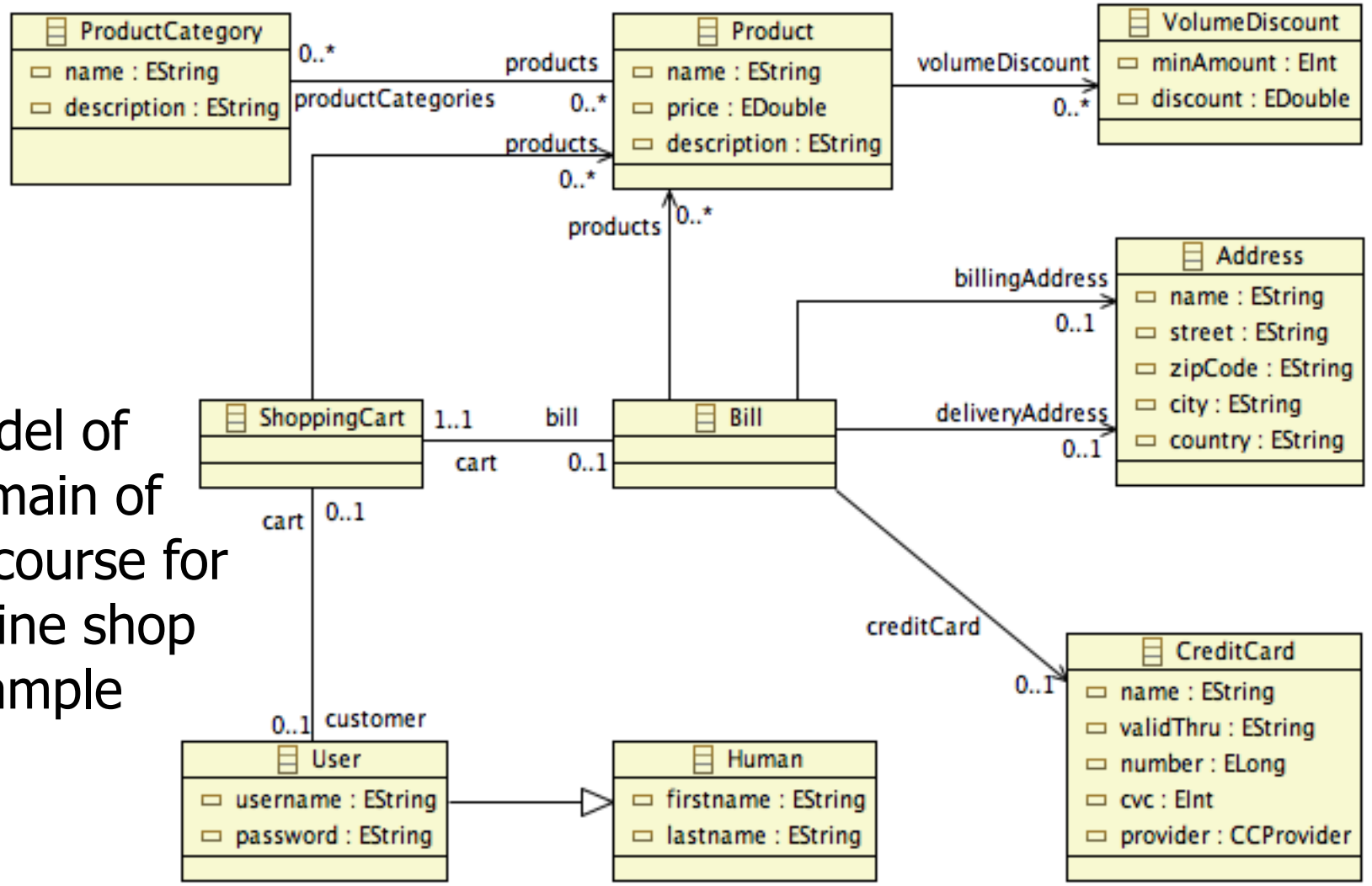
- For representation of
  - cultural heritage
  - explanations of events
  - everyday knowledge
- Human understanding in terms of specific situations
- Human verbal interactions by exchanging stories

Ontologies

- Tom Gruber
- Actually, the old Greeks
- Domain models
- Conceptualizations of a domain
- Often using taxonomies and object-based ideas
- Ontology languages based on knowledge-representation theories
- E.g., OWL based on description logic

Ontologies

Model of domain of discourse for online shop example



Speech acts

- John R. Searle
- Theory from philosophy of language
- Human speech also used to do something with intention — to act
- "Speaking a language is performing speech acts, act such as making statements, giving commands, asking questions and so on"
- Speech acts: basic units of language communication
- Communicative acts: abstraction from speech

Conversation Analysis

- Harvey Sacks; Luff, Gilbert and Frohlich
- Theory from sociology
- Focus on sequences of naturally-occurring talk "turns"
- To detect patterns that are specific to human oral communication
- Adjacency pair: e.g., a question should have a related answer
- Inserted sequence: subordinate interactions

Rhetorical Structure Theory (RST)

- Mann and Thompson
- Linguistic theory
- Internal relationships among text portions and associated constraints and effects
- Relationships in a text are organized in a tree structure
- Rhetorical relations associated with non-leaf nodes, and text portions with leaf nodes

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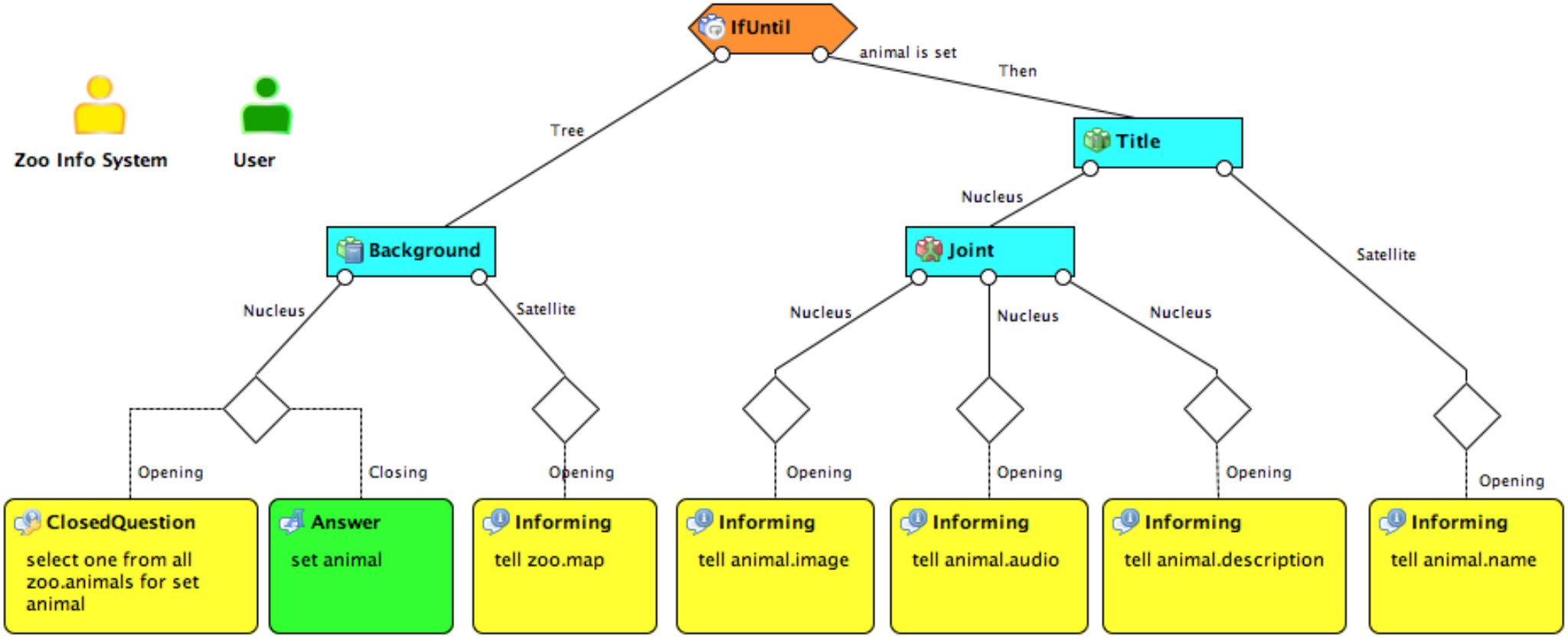
Discourse Example



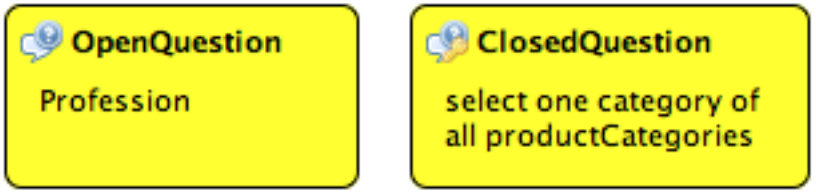
Discourse Model

Discourse “atoms” and “molecules”

- Metaphorical view
  - Communicative acts as atoms
  - Adjacency pairs as molecules
- Communicative acts instead of RST text portions
  - Interaction instead of text
- Two dimensions
  - Tree with discourse relations (monologue)
  - Adjacency pair (dialogue)
- Integration of RST and procedural constructs with Conversation Analysis

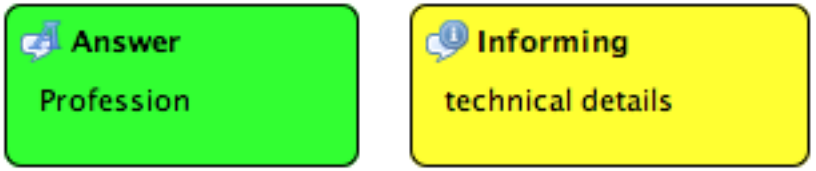
Communicative Acts – Open & Closed Question

- Open Questions enable asking for a particular type of information, respectively, an instance of a domain class.
- Closed Questions restrict the possible answer to a list of provided domain instances to choose from.



Communicative Acts – Informing & Answer

- Both are used to convey information.
- Answer communicative acts are always directly related to questions, whereas Informing is uttered standalone or together with acknowledgment.



Communicative Acts – Request

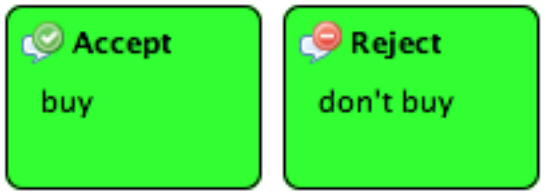
Used to request the communication partner to act. Thus, the propositional content of a request is always an action that has to be carried out. The action can be defined either for the given application, or it can be the request to utter a particular communicative act.

Communicative Acts – Offer

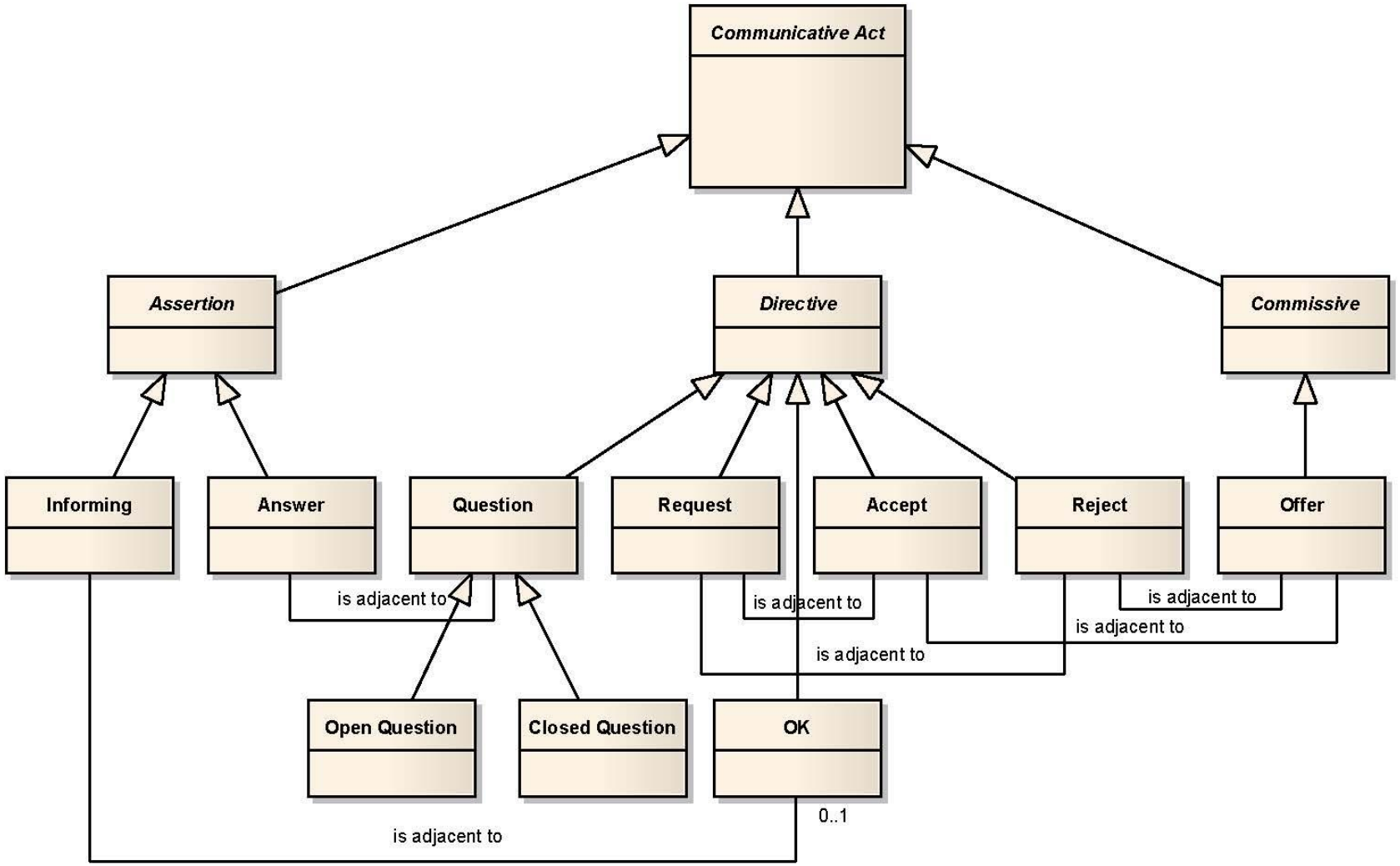
Offers to carry out an action or to add information to the shared knowledge.

Communicative Acts – Accept & Reject

Accept and Reject provide for accepting or rejecting a particular request or offer.

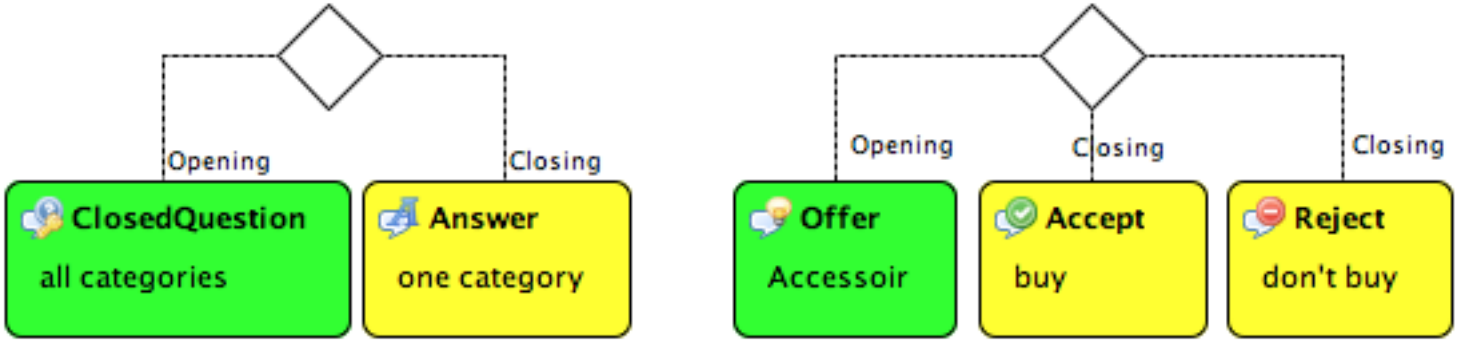


Communicative Acts Taxonomy



Adjacency Pair

- Relates an initial communicative act with one subsequent communicative act or two alternative subsequent communicative acts.
- Typical adjacency pairs of communicative acts are:
  - ClosedQuestion–Answer, OpenQuestion–Answer
  - Offer–Accept, Offer–Reject
  - Request–Informing, Request–Accept, Request–Reject

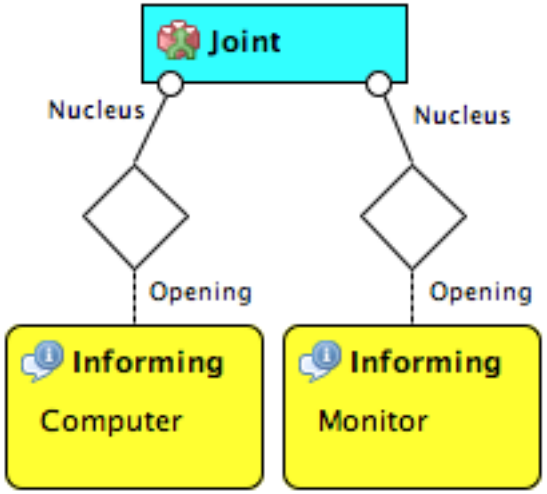


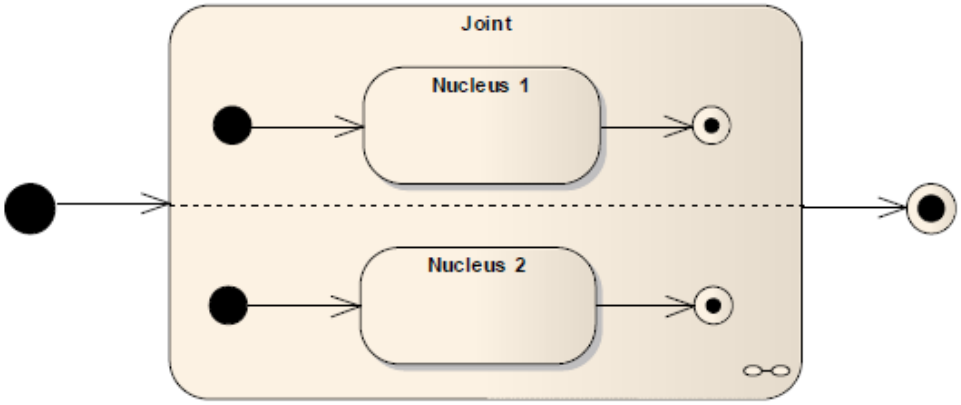
RST relations (in our approach)

- Nucleus: the main part of the communication
- Satellite: the helper part
- Communicative acts instead of text portions

RST relation – Joint

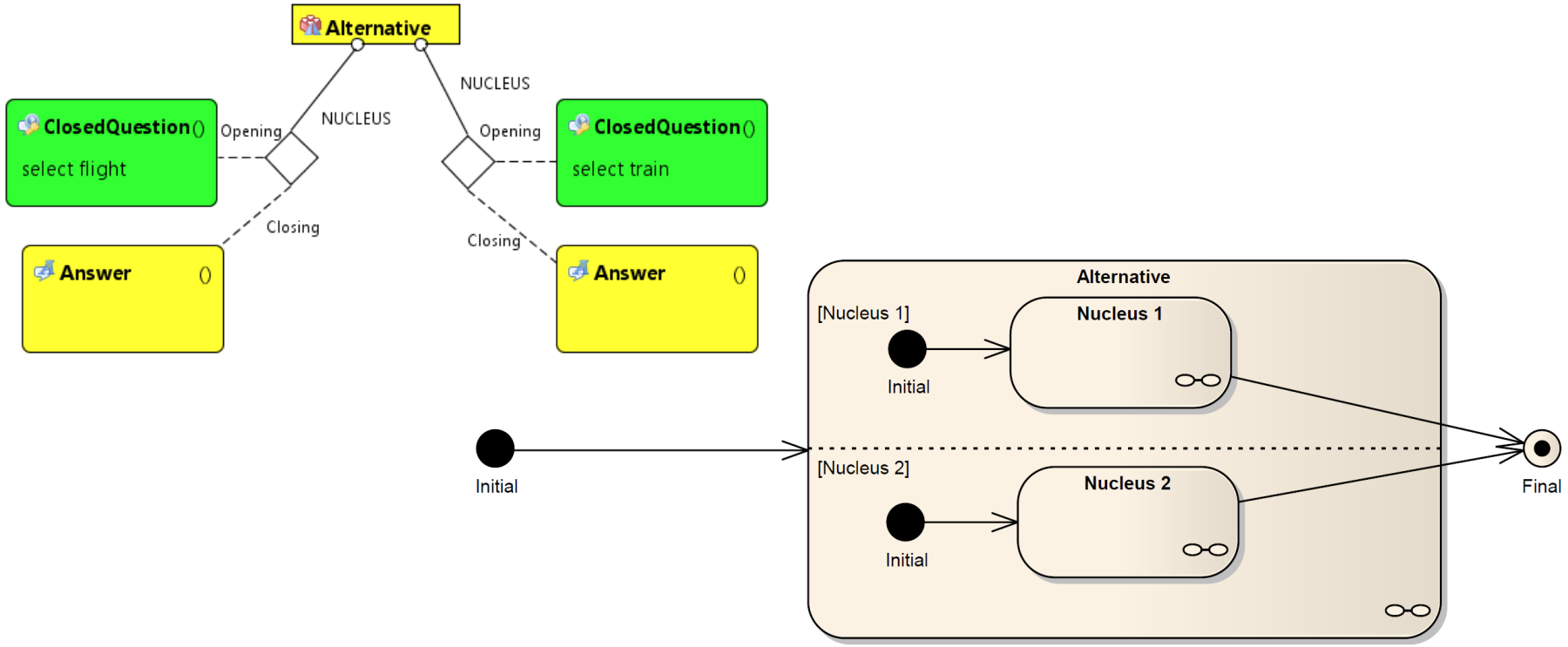
Relates independent subtrees with communicative acts of the same kind. It does not imply any order. So, it is also possible to issue both nuclei concurrently (e.g., on a GUI).





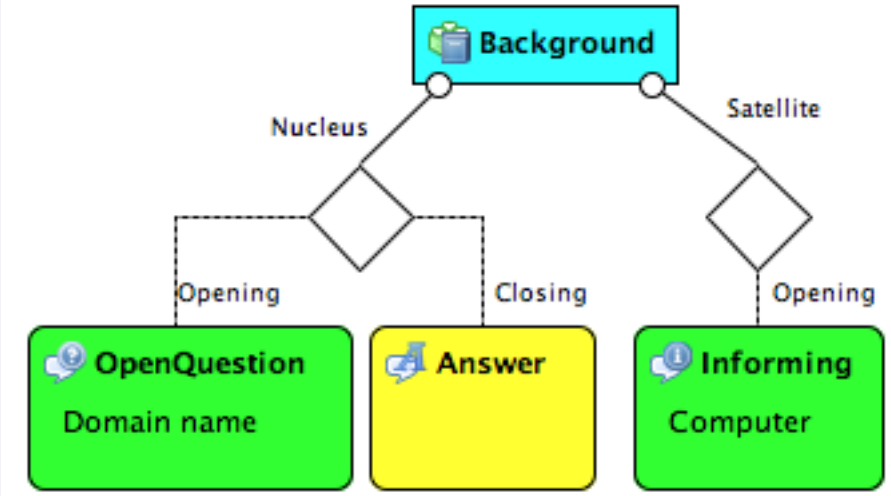
RST relation – Alternative

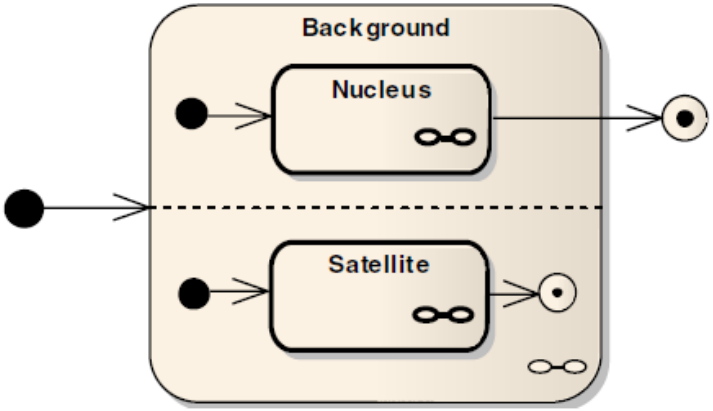
Relates alternative subtrees with communicative acts. Only one subtree can be finished.



RST relation – Background

- General information of any sort that is likely to help understand the nucleus.
- Thus, satellite of the background relation shall only contain Informing communicative acts.

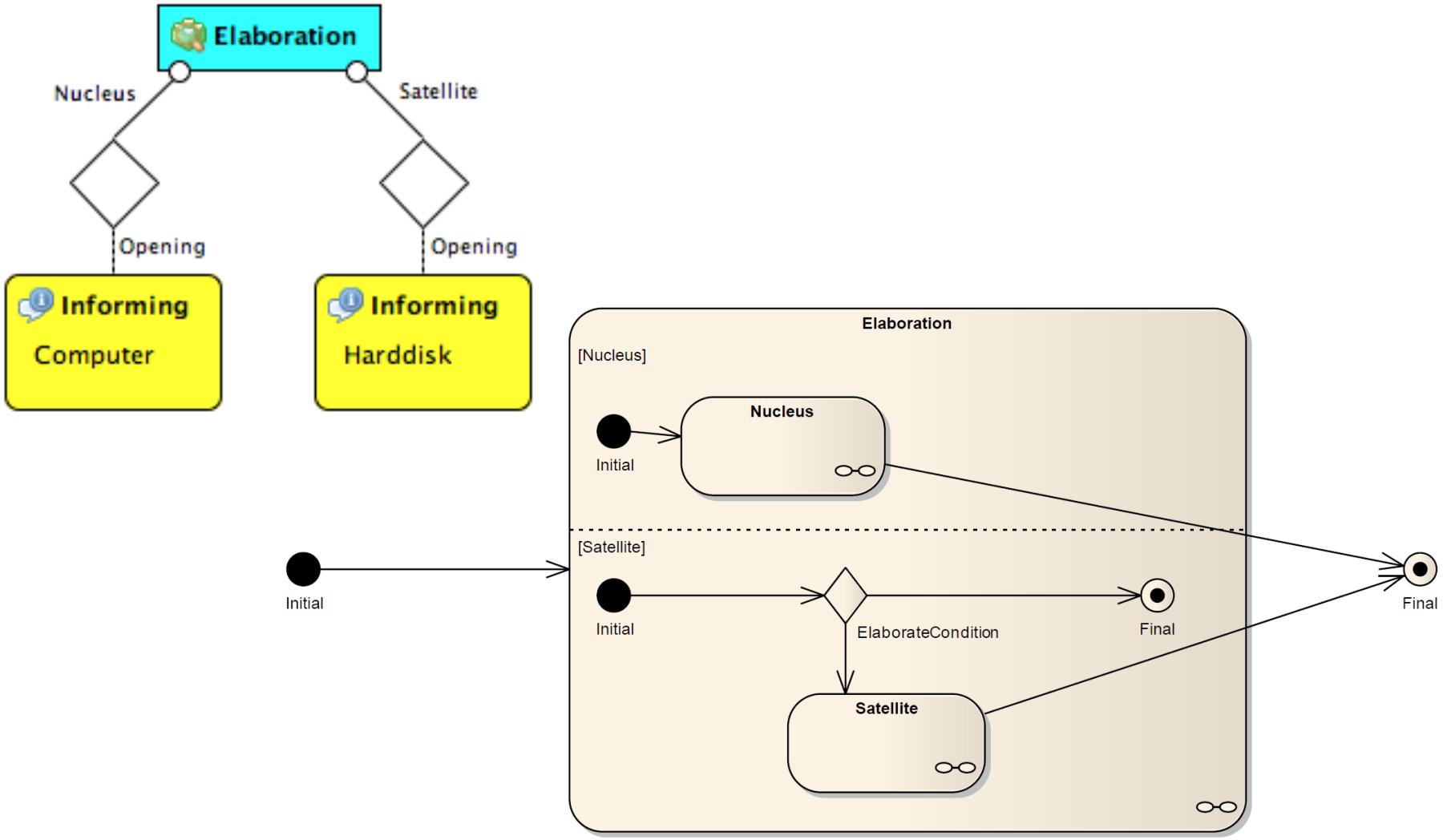




RST relation – Elaboration

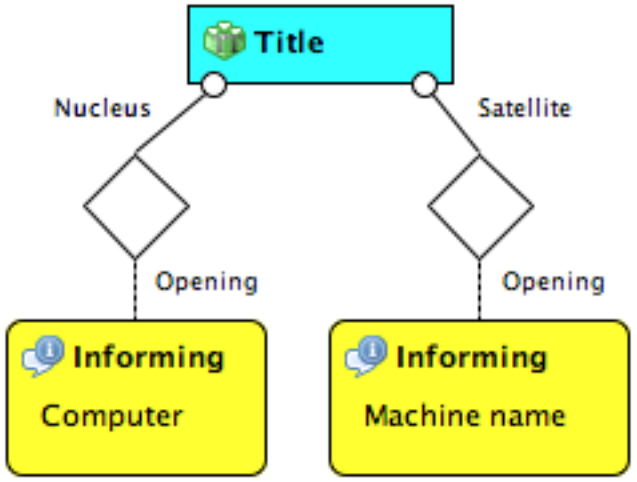
- Satellite contains additional detail about some element of subject matter which is presented in the nucleus, in one or more of the ways listed below (nucleus :: satellite):
  - set :: member
  - abstraction :: instance
  - whole :: part
  - process :: step
  - object :: attribute
  - generalization :: specific
- The communicative acts can also be questions, for example, if one communicative partner wants to figure out additional details about the subject matter.

RST relation – Elaboration (cont.)

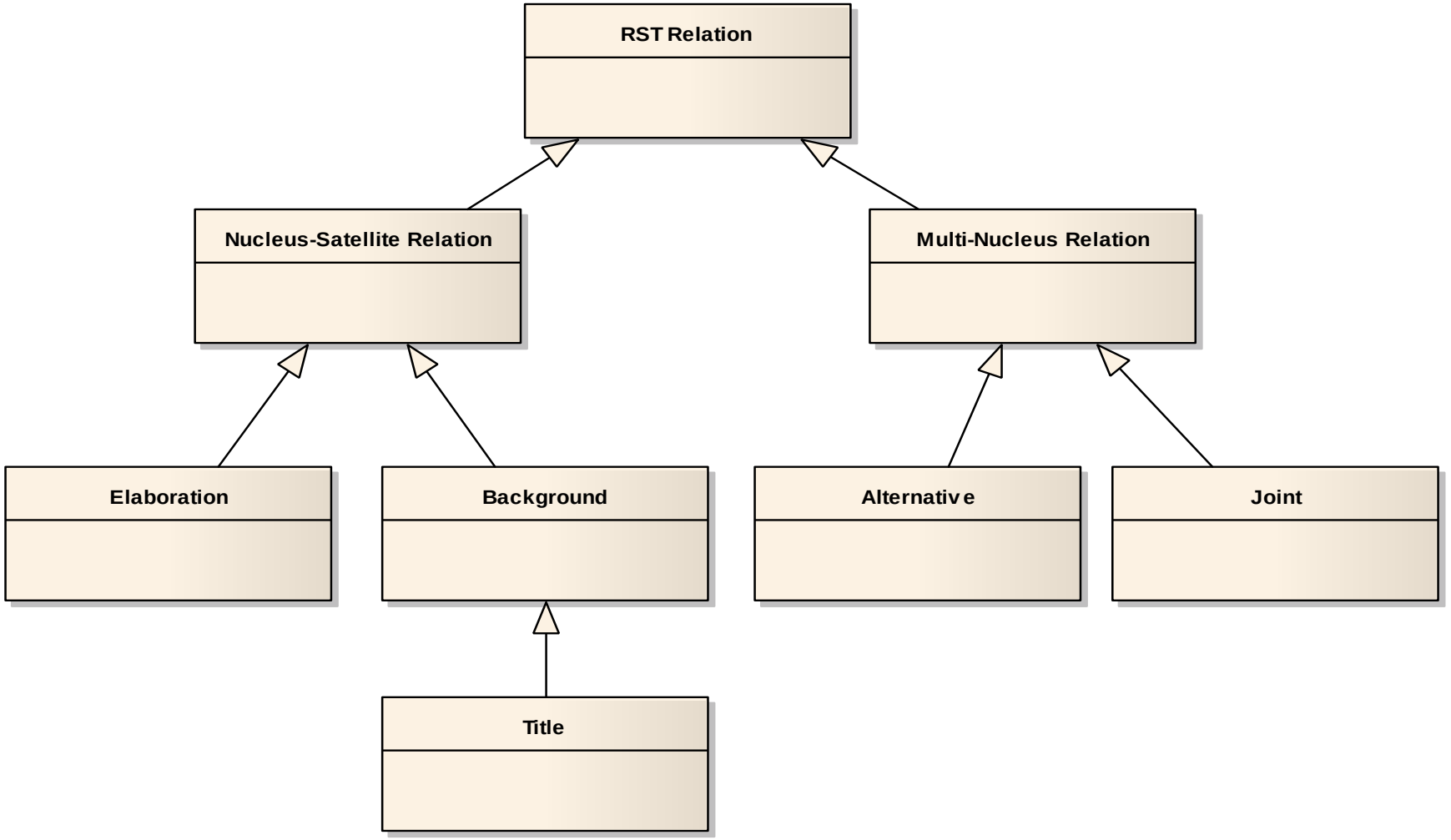


RST relation – Title

Specialization of Elaboration, restricting the additional detail of some element of subject matter to a short description, either title or caption.

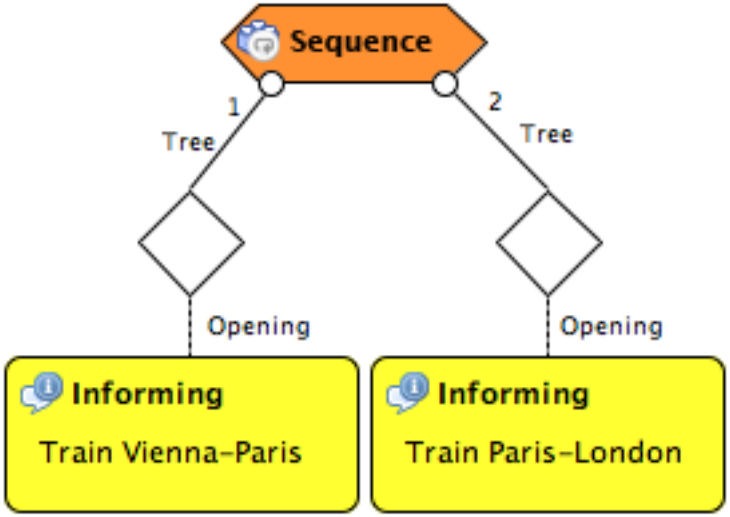


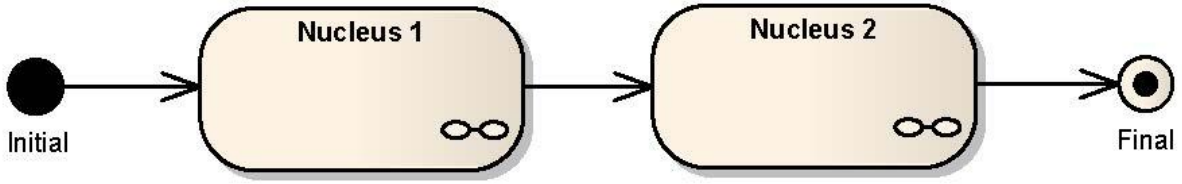
Taxonomy of RST relations



Procedural construct – Sequence

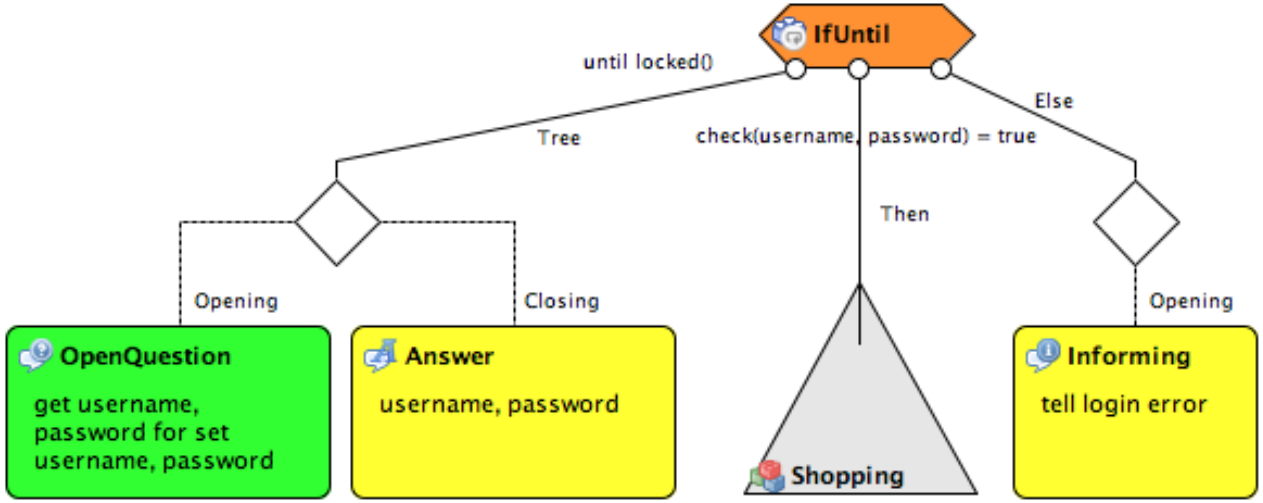
Defined order of uttering the communicative acts or subtrees.



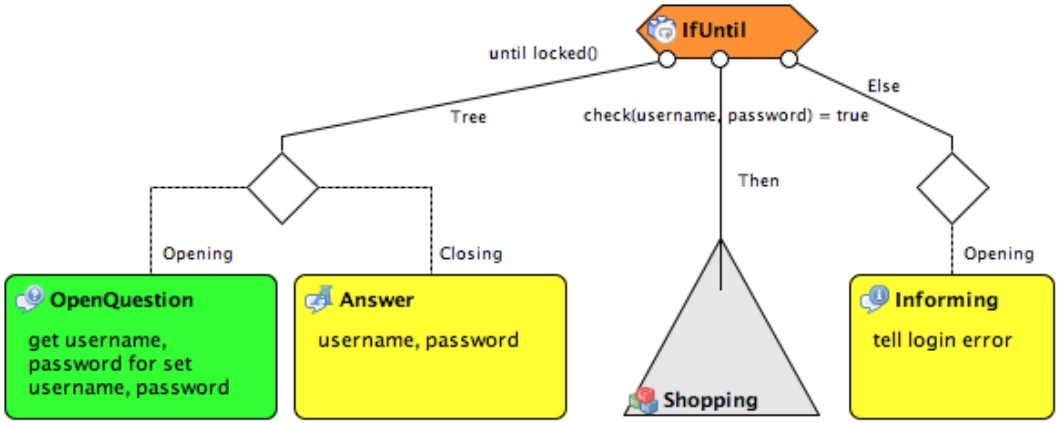


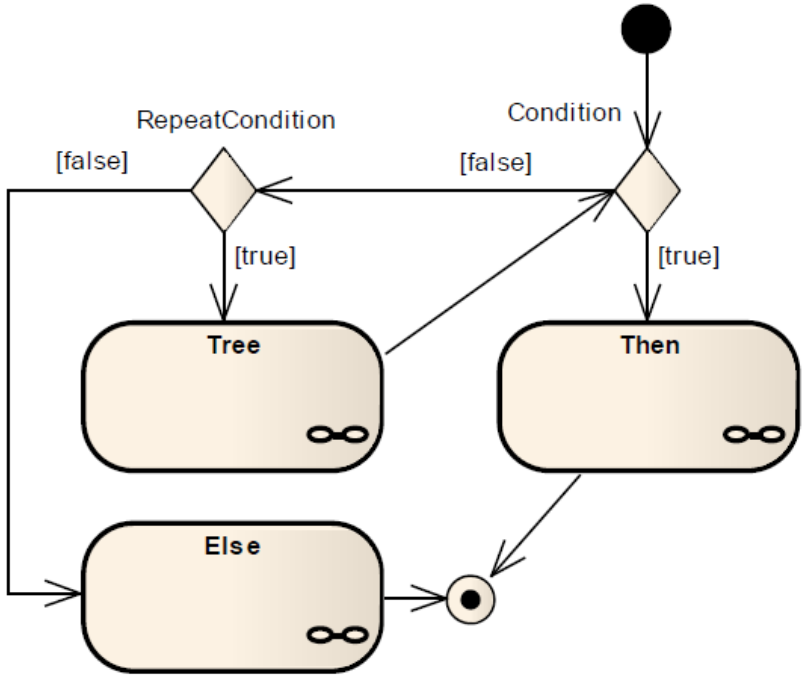
Procedural construct – IfUntil

- If-statement combined with a conditional loop
- Utterance of the <Then> subtree depends on successful execution of the related Condition.
- Repetition of the <Tree> branch until Condition becomes fulfilled, while RepeatCondition is fulfilled

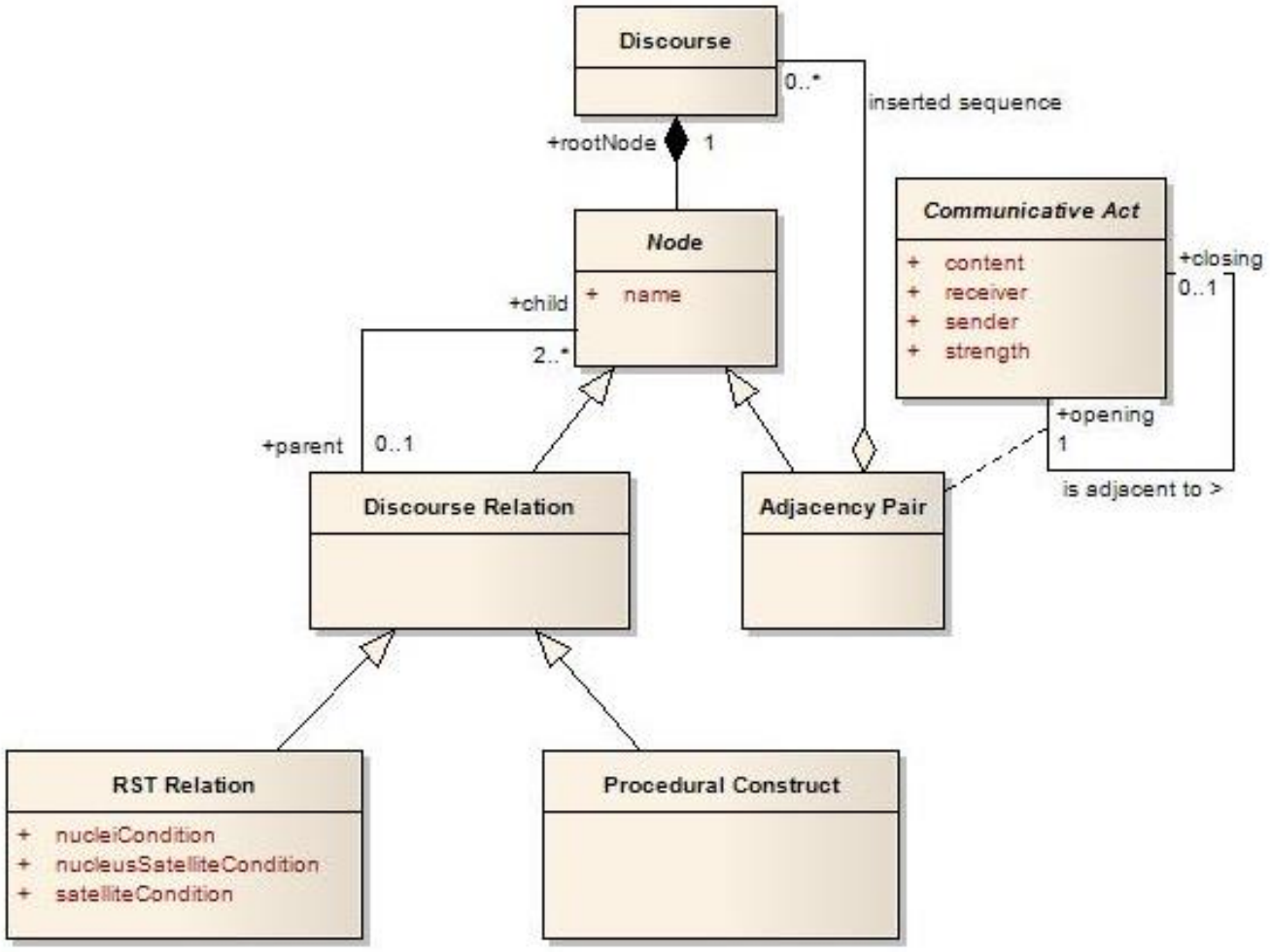


Procedural construct – IfUntil (cont.)

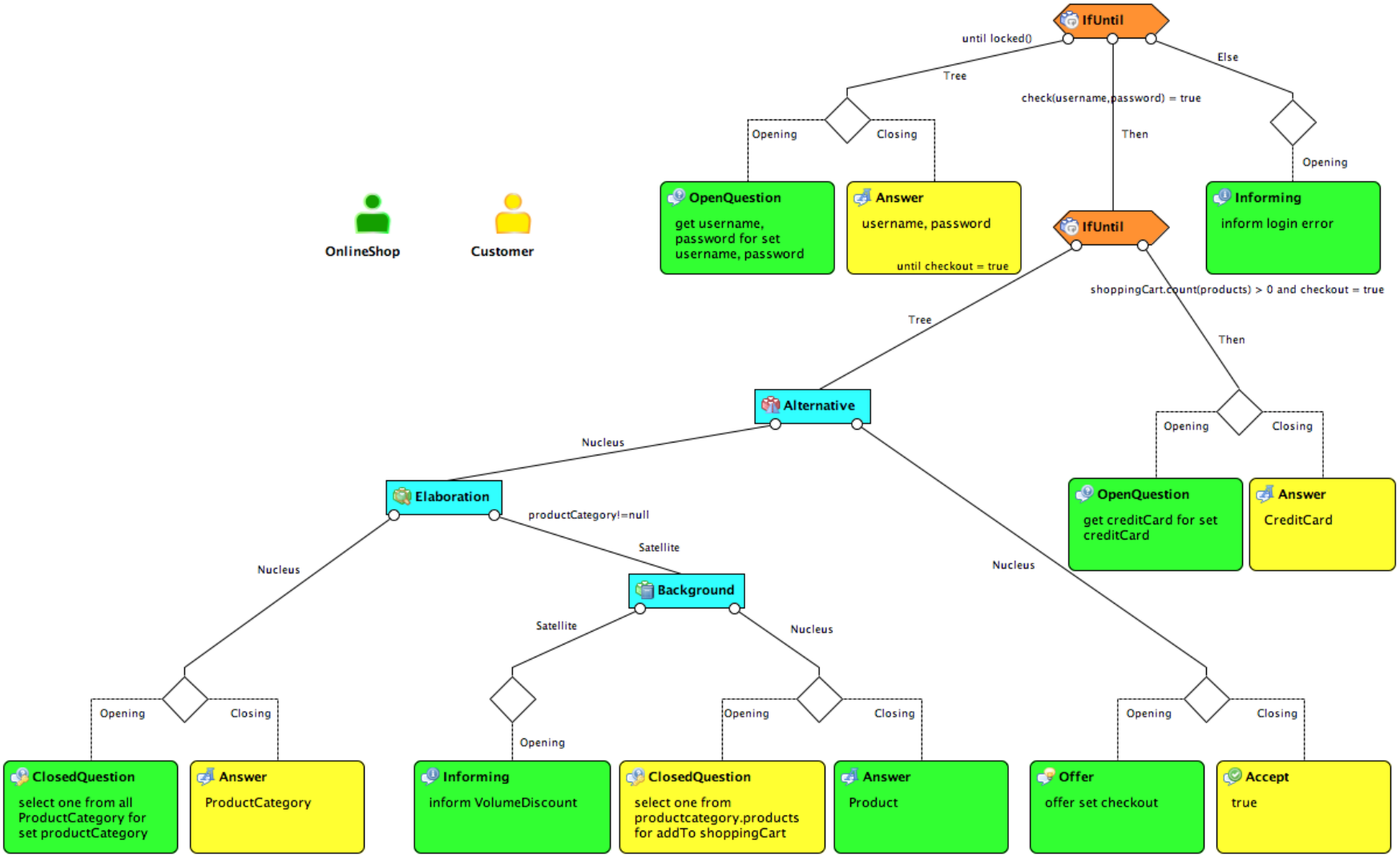




Conceptual Discourse Metamodel



Example model



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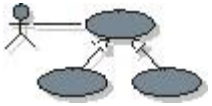
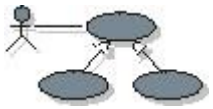
Use cases

- "particular cases of how the system is to be used"
- Use-Case Report (according to Unified Process):
  1. Brief Description
  2. Flow of Events
  3. Special Requirements
  4. Pre-conditions
  5. Post-conditions
  6. Extension Points
  7. Relationships
  8. Use-Case Diagrams
  9. Other Diagrams

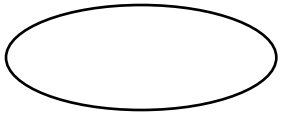


Use-case diagram

- UML graphical notation

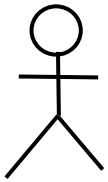


- Ellipse: use case



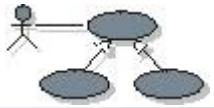
Name of use case

- Stick man: actor

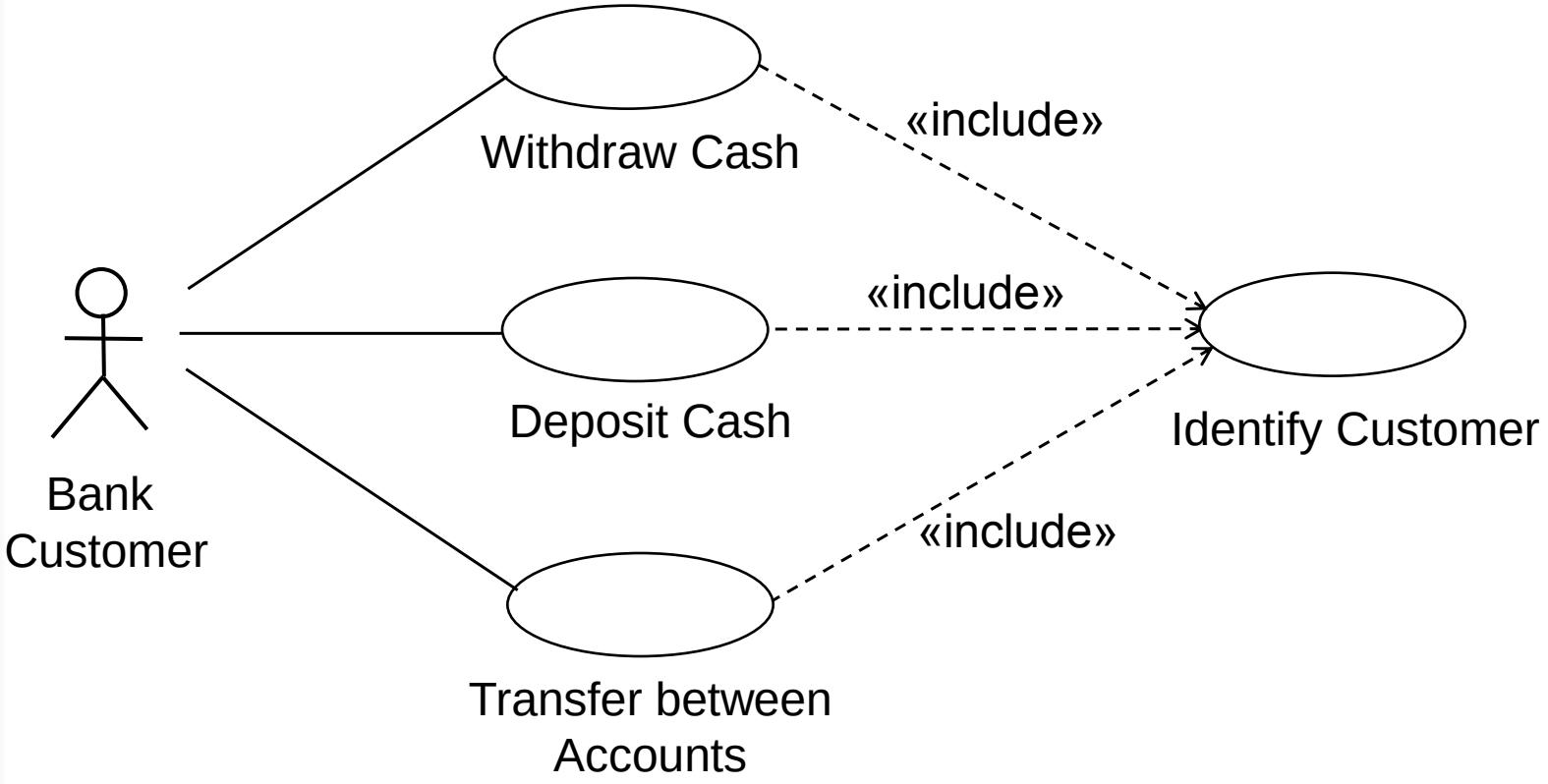


Name of actor

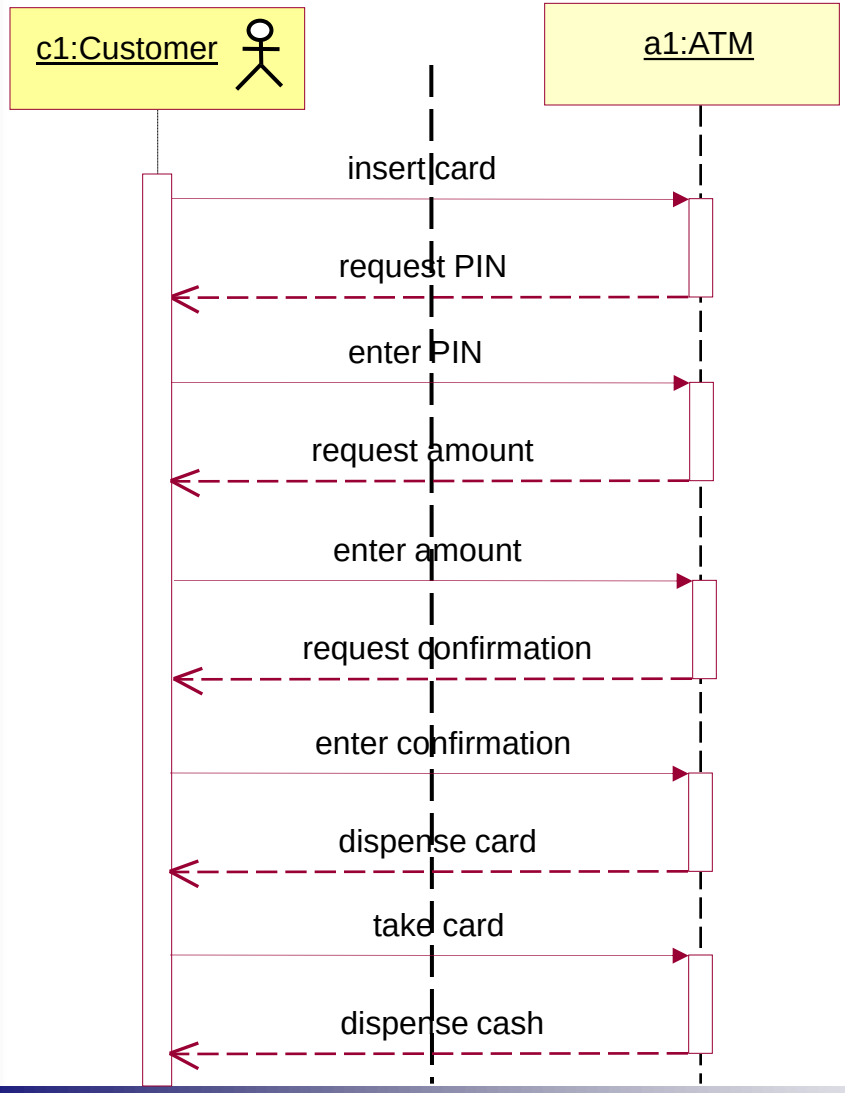
- Connecting line: association



Use-case diagram

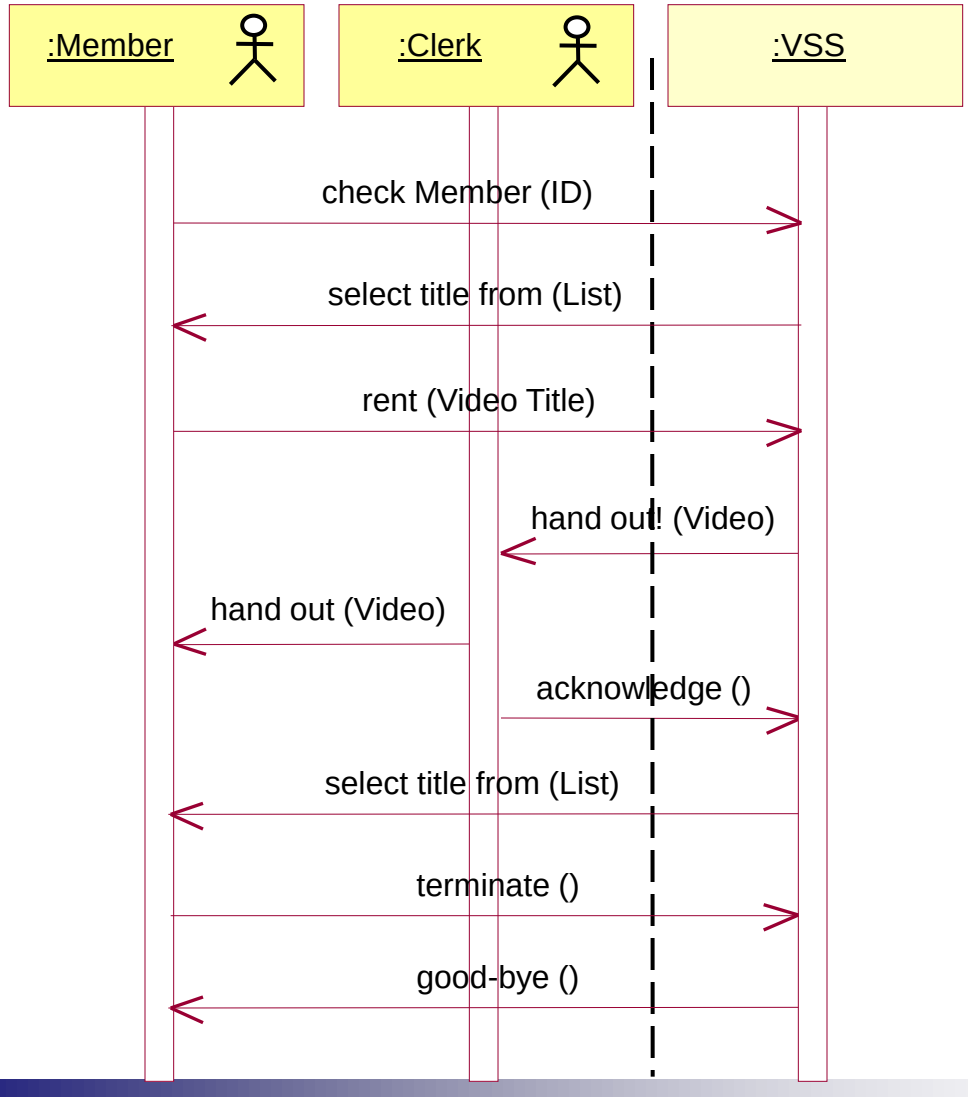


OOA model – UML sequence diagram



- Represents a scenario
- Interaction of instances
- Activation
- System border

OOA model – UML sequence diagram

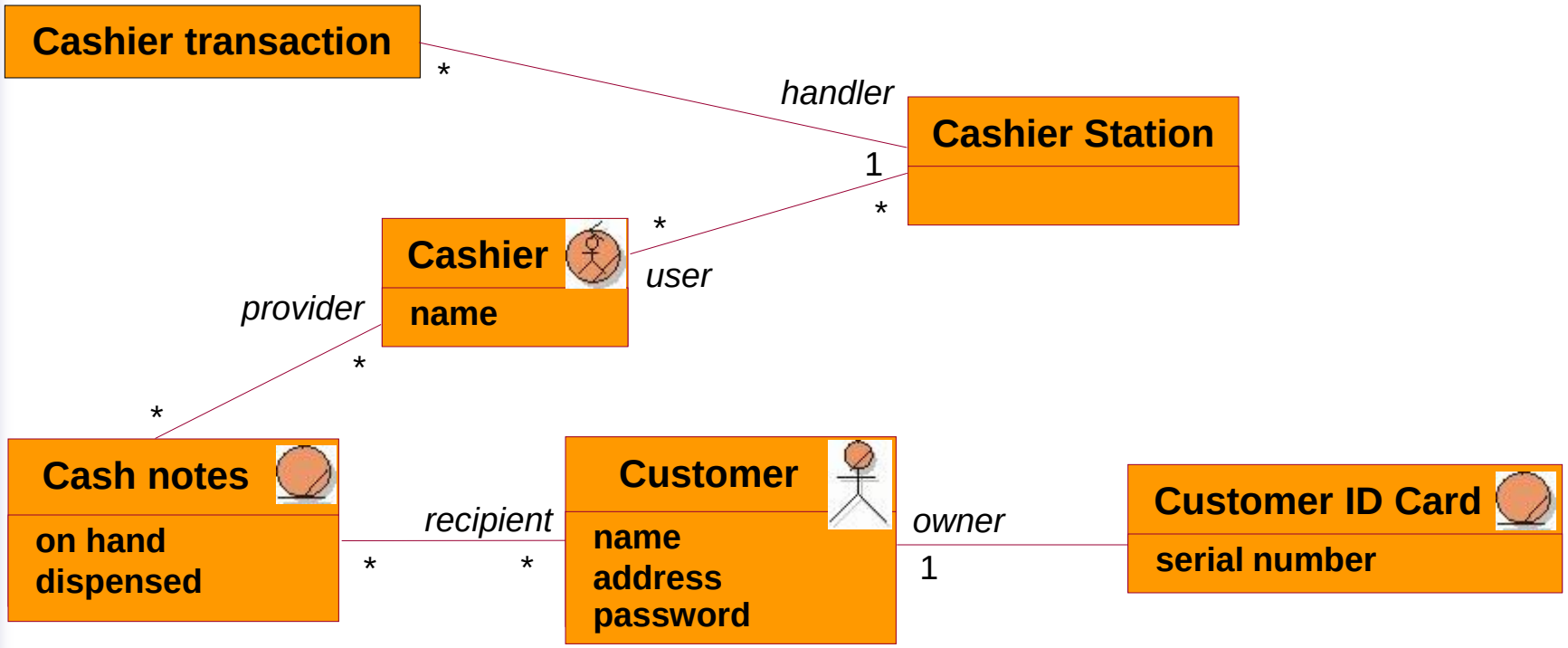


Unnamed instances

Concurrent objects

Domain model – ATM example

- UML class diagram (RUP "business object model")
- Associations with names of assoc. ends (roles)



Specification based on discourse model

- Scenario: focus on thread of events or actions
- Difficult to specify variations in Use-Case Report
- Discourse model: specification of class of dialogues
- Possible flows well defined and understandable
- Additional information in RST relations

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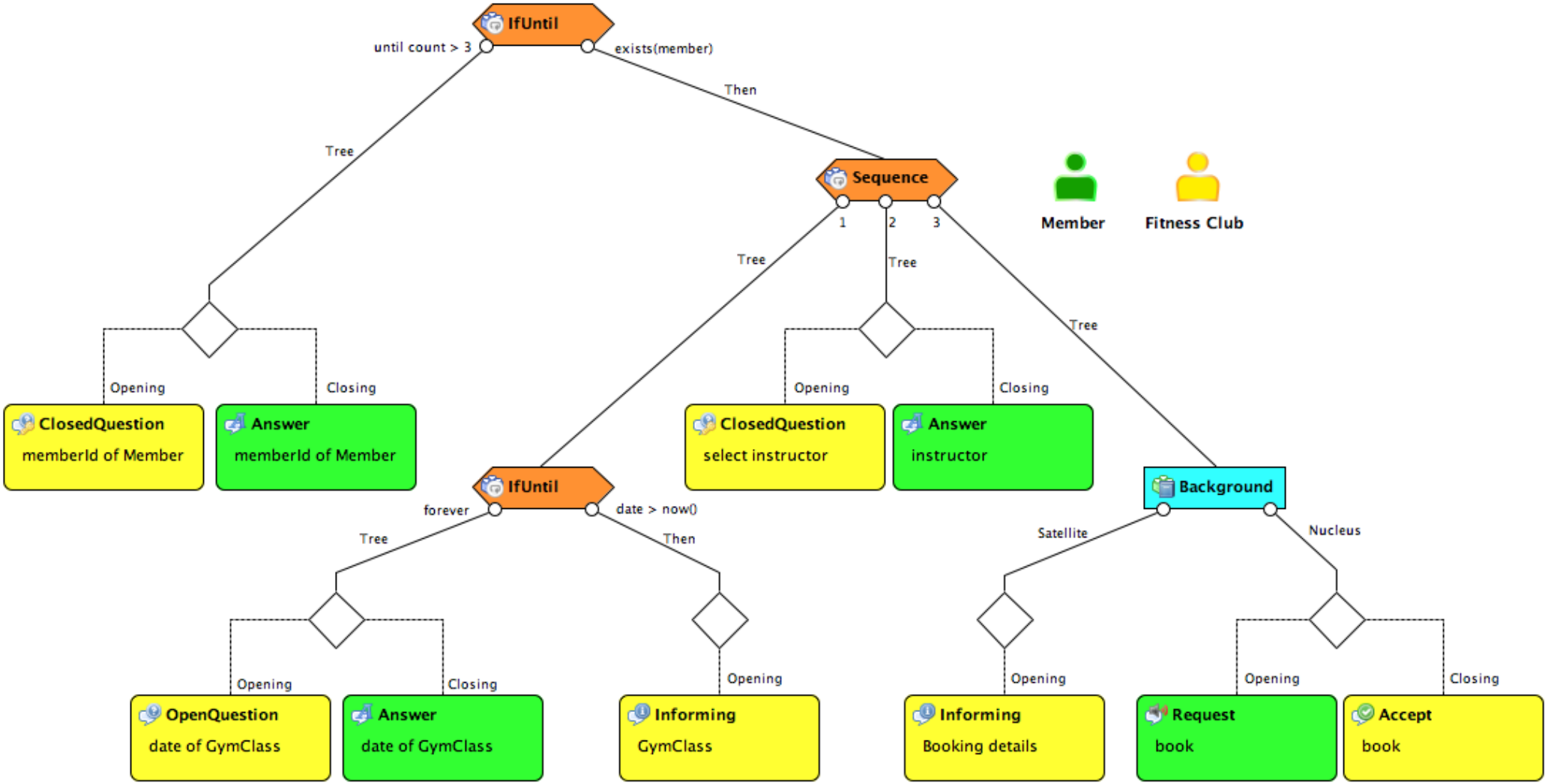
Exercise – Fitness Studio

- Interaction design model according to our approach, for the website of a fitness club which should allow registered users to book the various courses that the club offers
- Try to understand the model sketch of a discourse for this application!

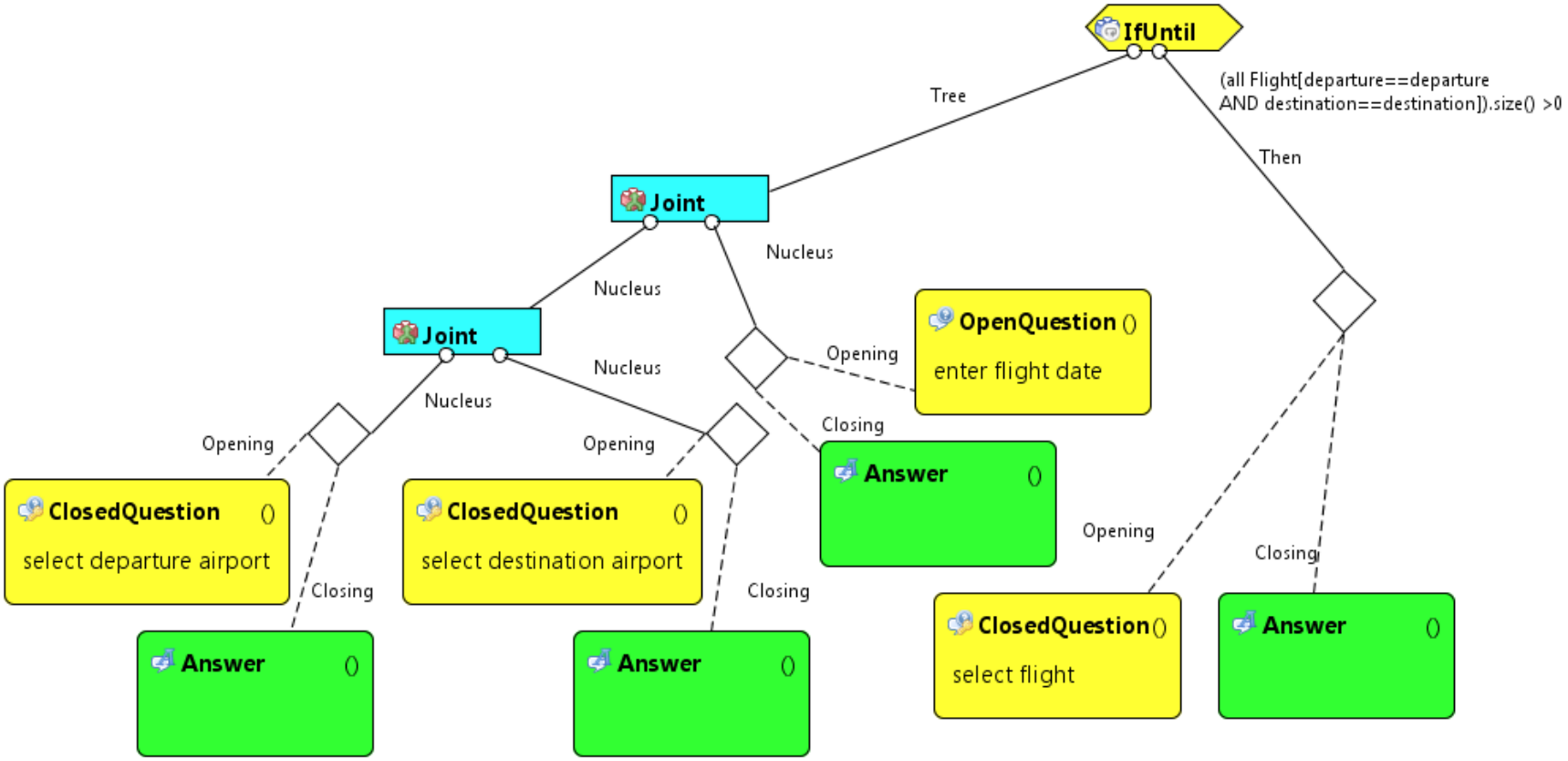
Fitness Studio Discourse Model



Exercise – Flight Selection

- Interaction design model according to our approach, for the website of an airline which should allow users to select flights
- Try to model a discourse for this application!

Flight Selection Discourse Model



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Integration and Use of Ontologies

- Speech act usually talks about something in the domain of discourse.
- Selection from ontology in Domain-of-Discourse Model
- References from Discourse Model to Domain-of-Discourse Model

Interface to Application Logic

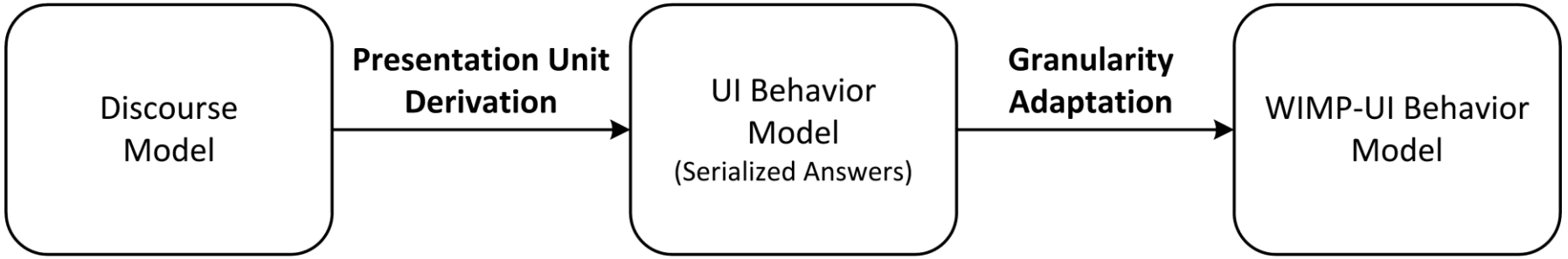
- Specification of (interfaces of) methods of the application logic
- Action-Notification Model
  - Access or change of data (Domain-of-Discourse Model), and
  - Application-specific actions
    - Actions of software, or
    - Physical actions (e.g., of a robot)
- References from Discourse Model to Action-Notification Model

Rendering of Final User Interfaces

- Automated generation of final (multimodal) UIs
- Generation of GUIs (WIMP UIs)
  - Generation of Behavioral UI Model
  - Generation of Structural UI Model
  - Optimization (e.g., tailoring for smartphones)
  - Weaving of Structural and Behavioral Models
- Even for multiple platforms

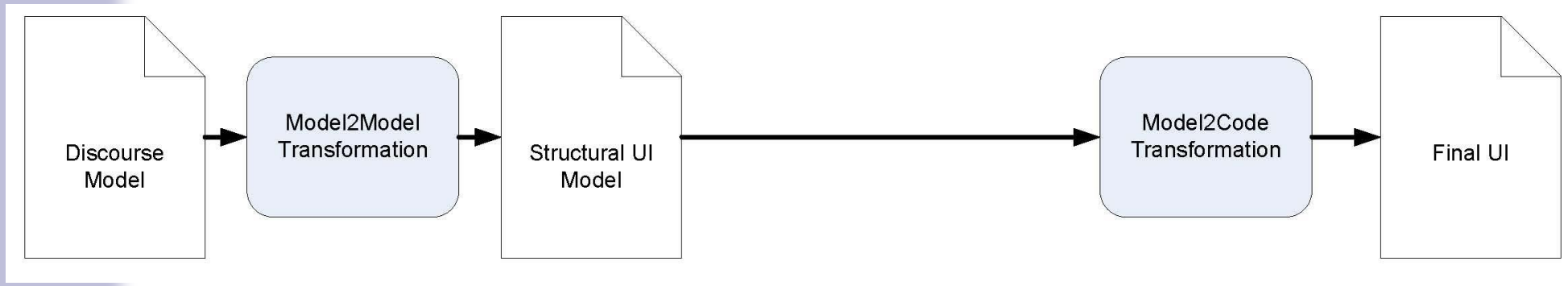
Generation of Behavioral UI Model

- UML state machines for each part defined
- Composition of state machines according to structure of Discourse Model
- Determination of Presentation Units (for GUI)
- Parallelism and Granularity of Communication Units



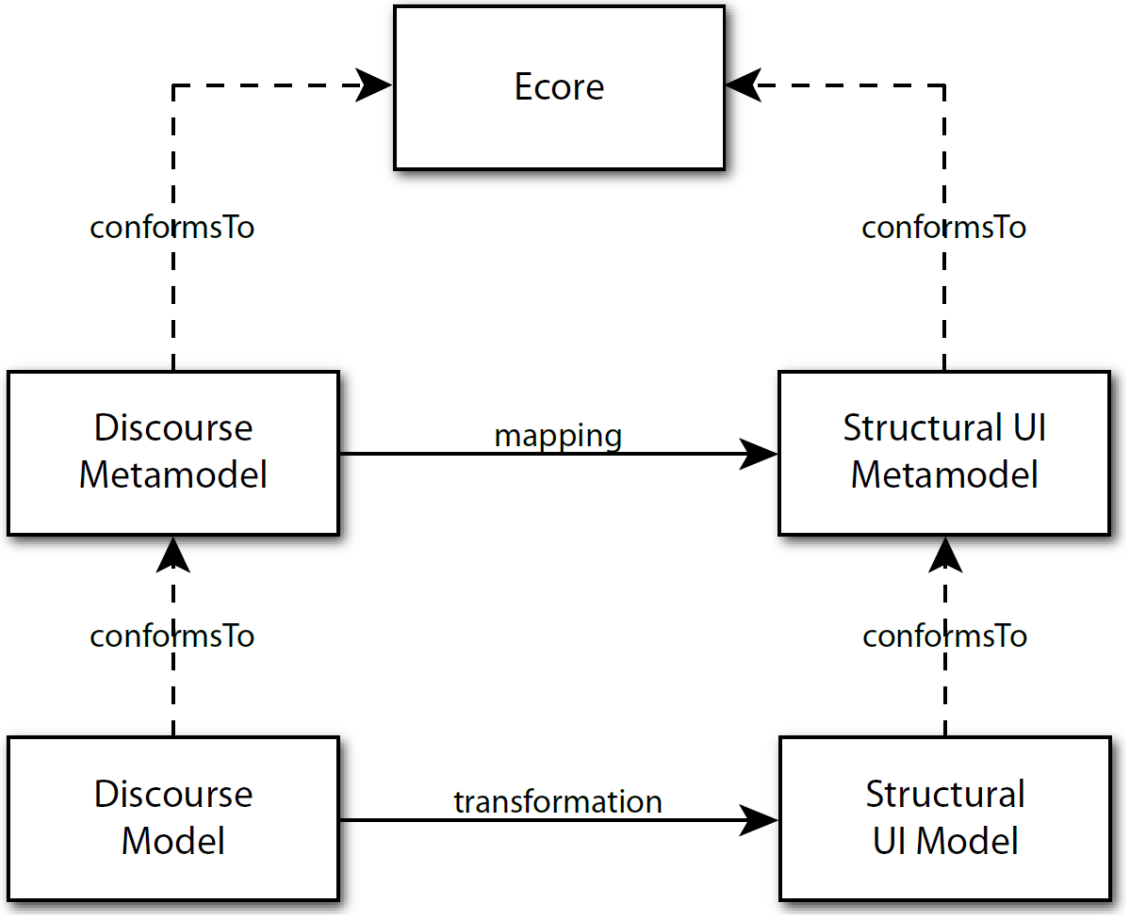
Generation of Structural UI Model

- Model-driven transformations
- Two major steps to structure of Final GUI



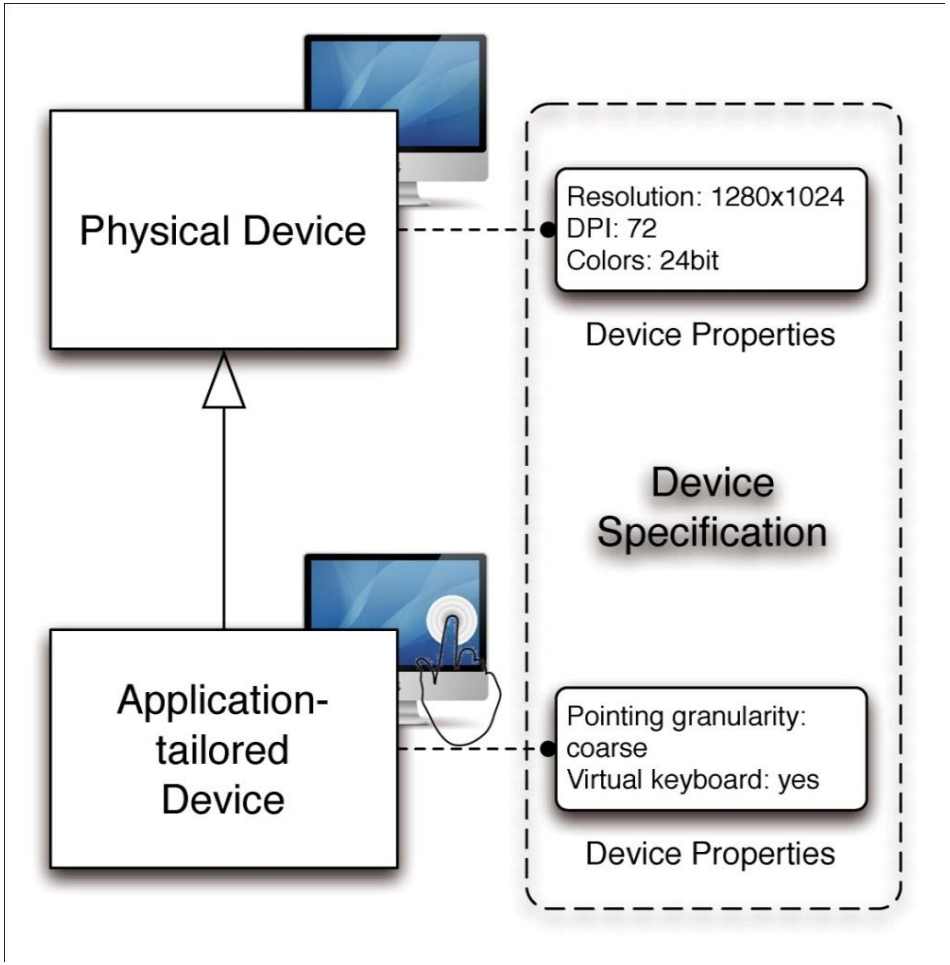
Generation of Structural UI Model – MDA

- Model Driven Architecture
- Metamodels
- Transformation Rules
- Model transformation by rule application



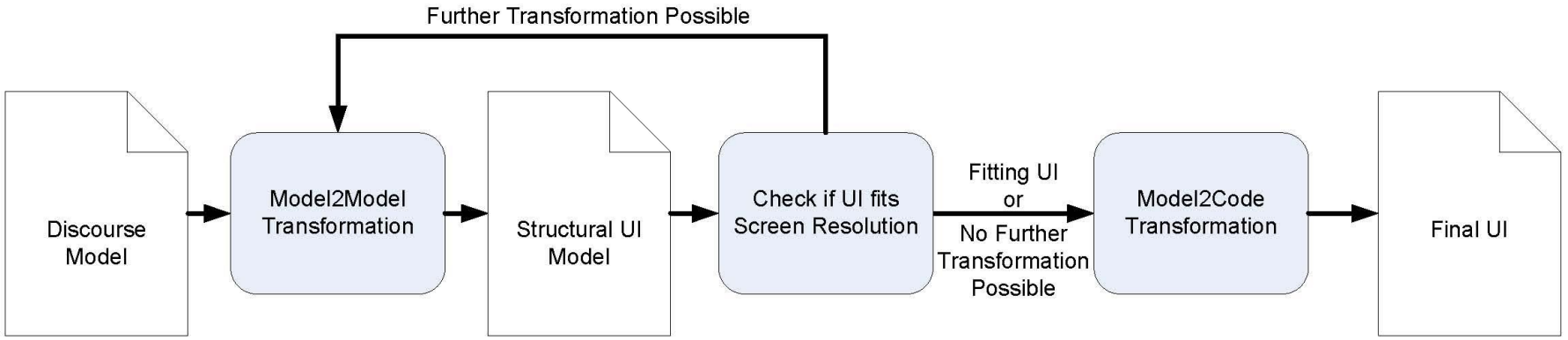
Generation of Structural UI Model – Devices

- Generation according to device specifications
- Application-tailored device specifications in addition to physical ones



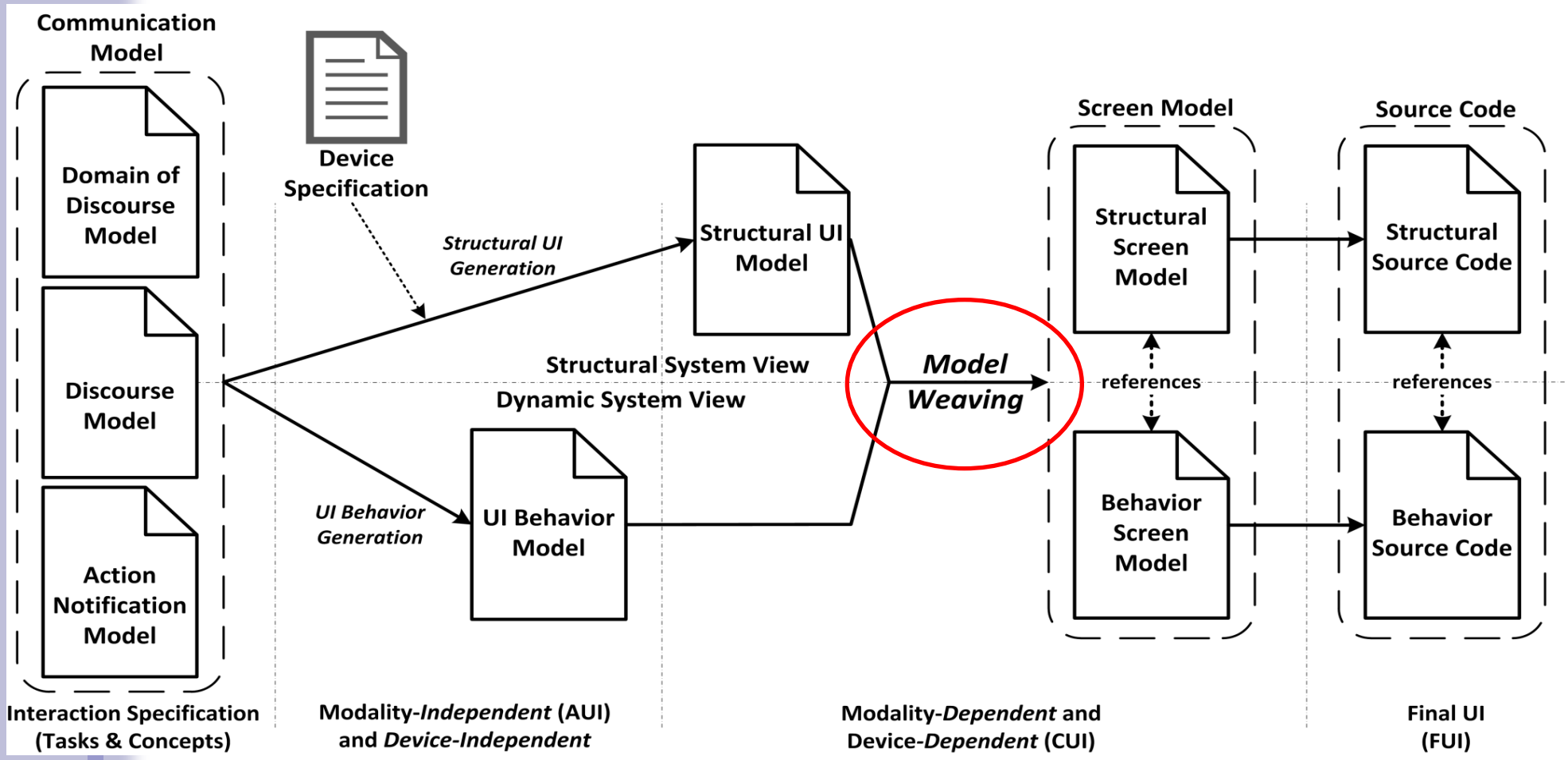
Tailoring for Specific Device (e.g., Smartphone)

- Objectives:
  - Maximum use of the available space
  - Minimum amount of navigation clicks, and
  - Minimum scrolling (except list widgets)
- Heuristic search for optimization (Branch & Bound)

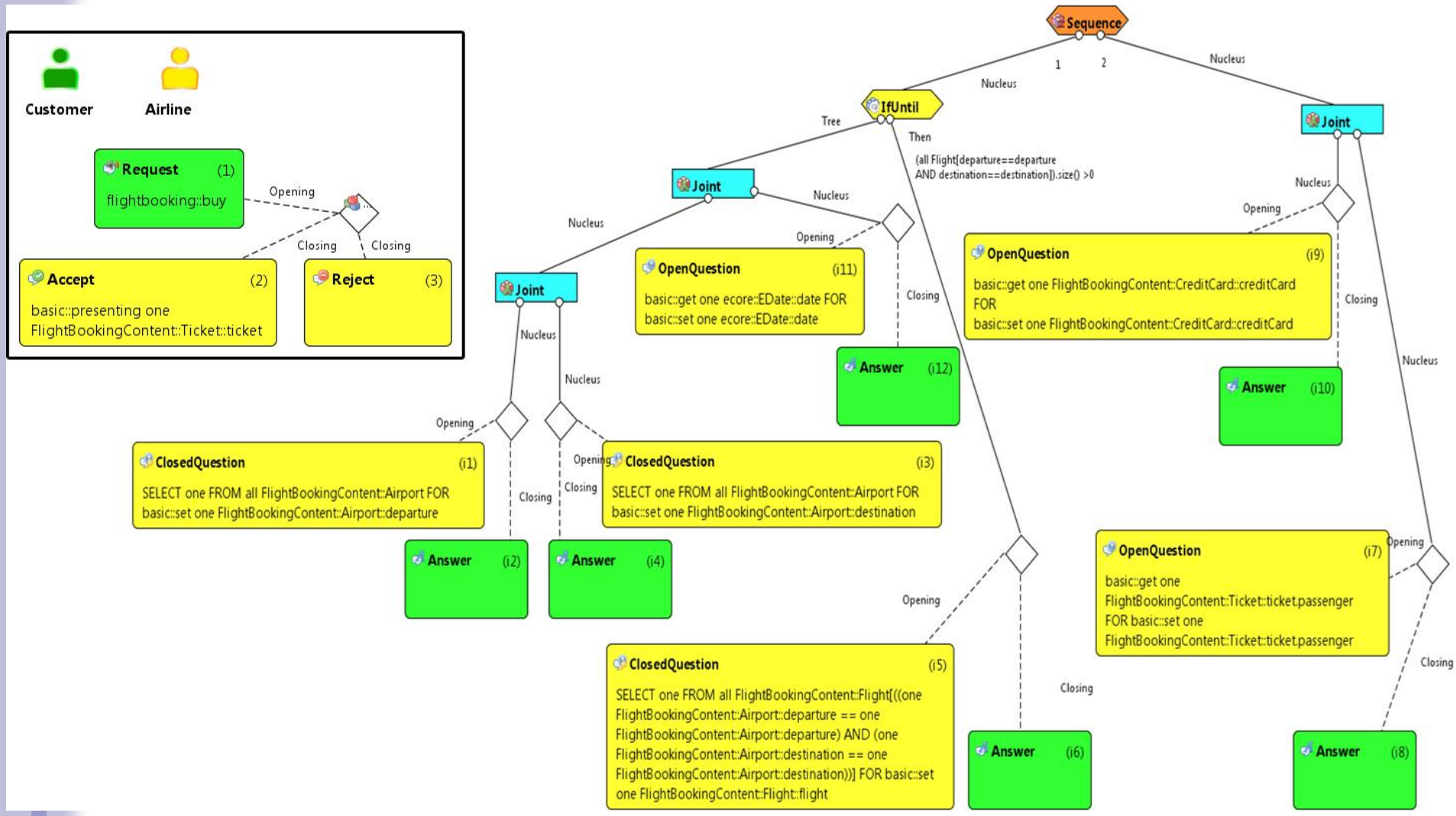


Weaving of Structural and Behavioral Models

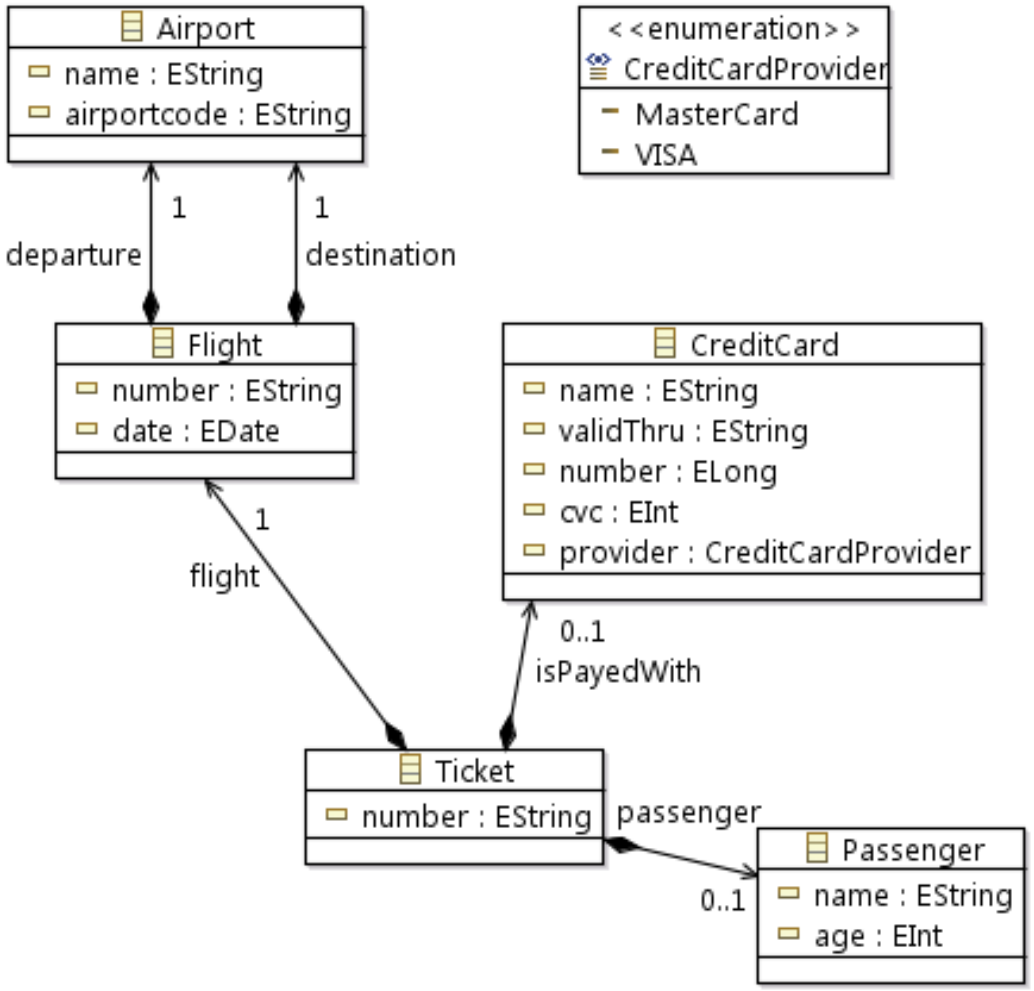
- Different levels of abstraction



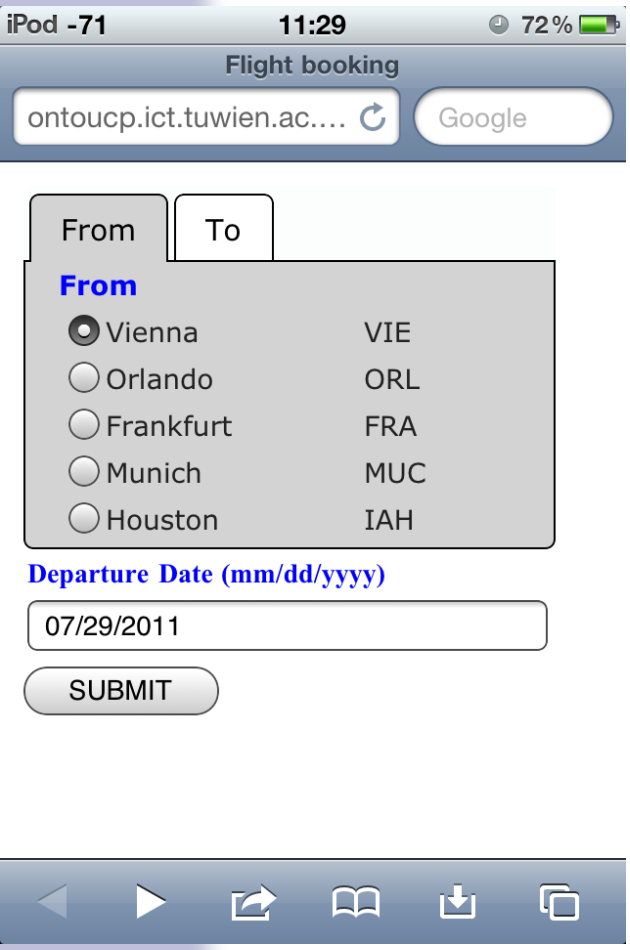
Flight Booking Discourse Model

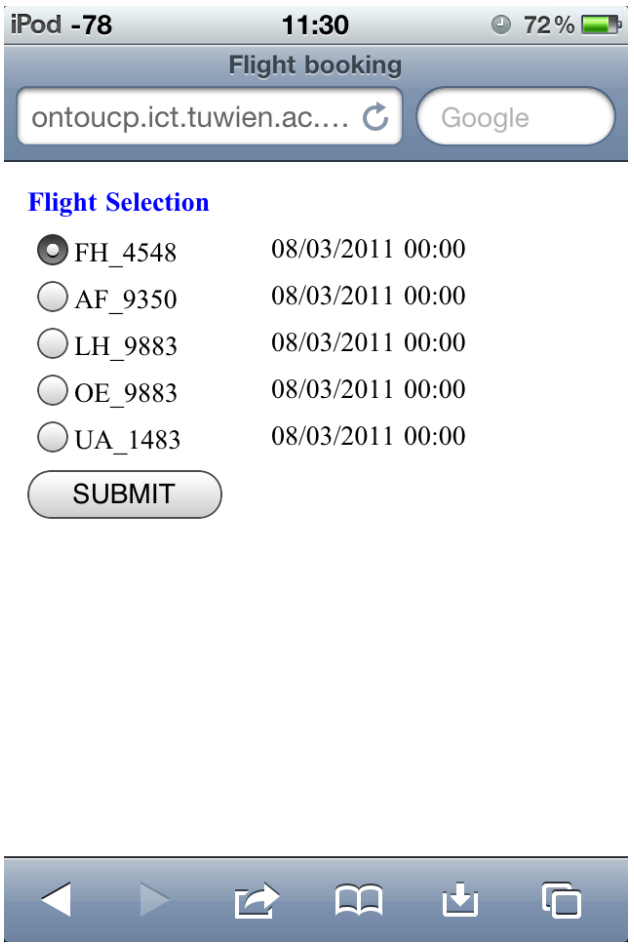


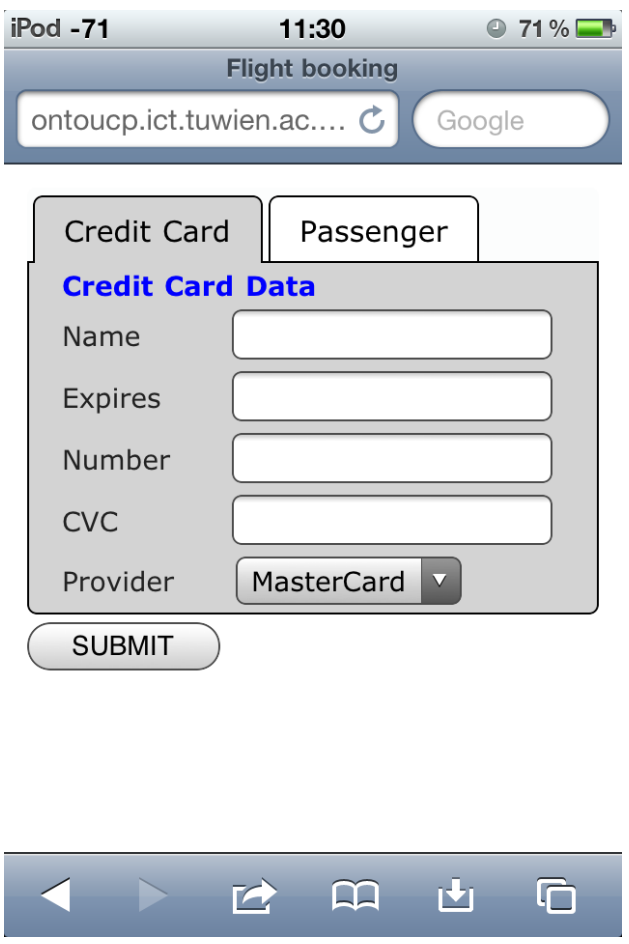
Flight Booking Domain-of-Discourse Model



Flight Booking Rendered for iPod Touch





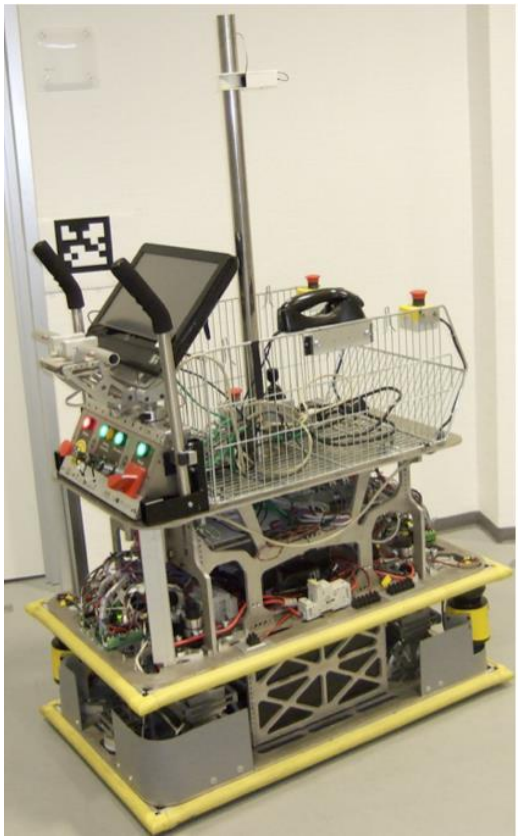


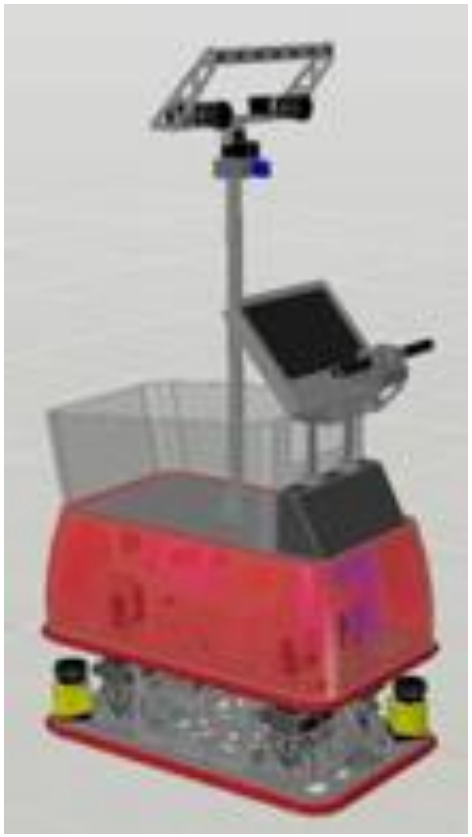
Examples of Final User Interfaces – Desktop and Smartphones

- Simple flight-booking GUIs tailored with different strategies:
  http://ontoucp.ict.tuwien.ac.at/UI/FlightBooking
  http://ucp.ict.tuwien.ac.at/UI/FlightBookingScrolling
- Vacation planning:
  http://ucp.ict.tuwien.ac.at/UI/accomodationBooking
- Potentially different GUIs tailored through optimization for different smartphones (screens)

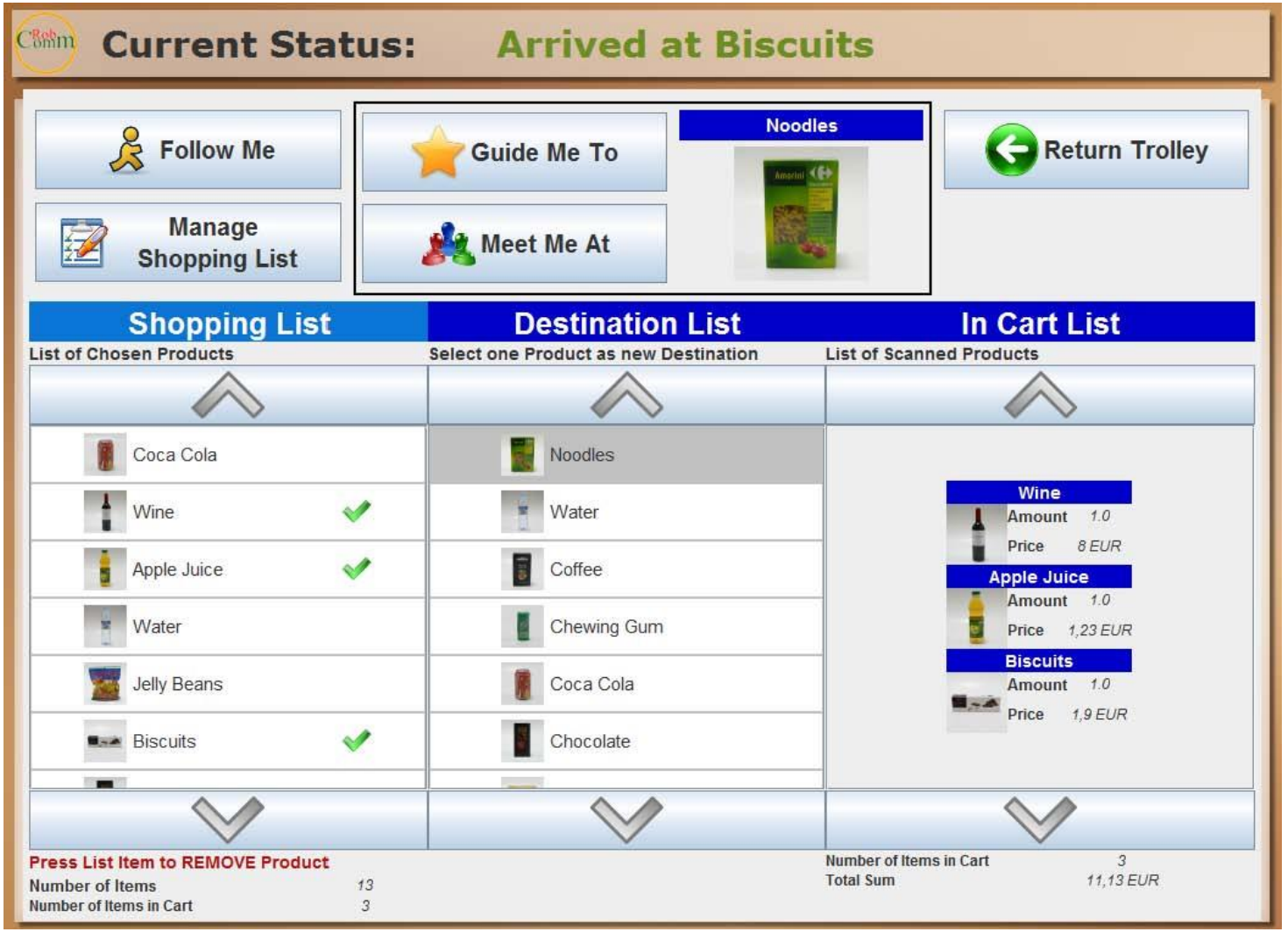
Examples of Final User Interfaces – Robots

- EU-funded research project CommRob: http://www.commrob.eu
- Semi-autonomous Robot Carts
- Specific transformation rules for a given GUI design
- Touchscreen

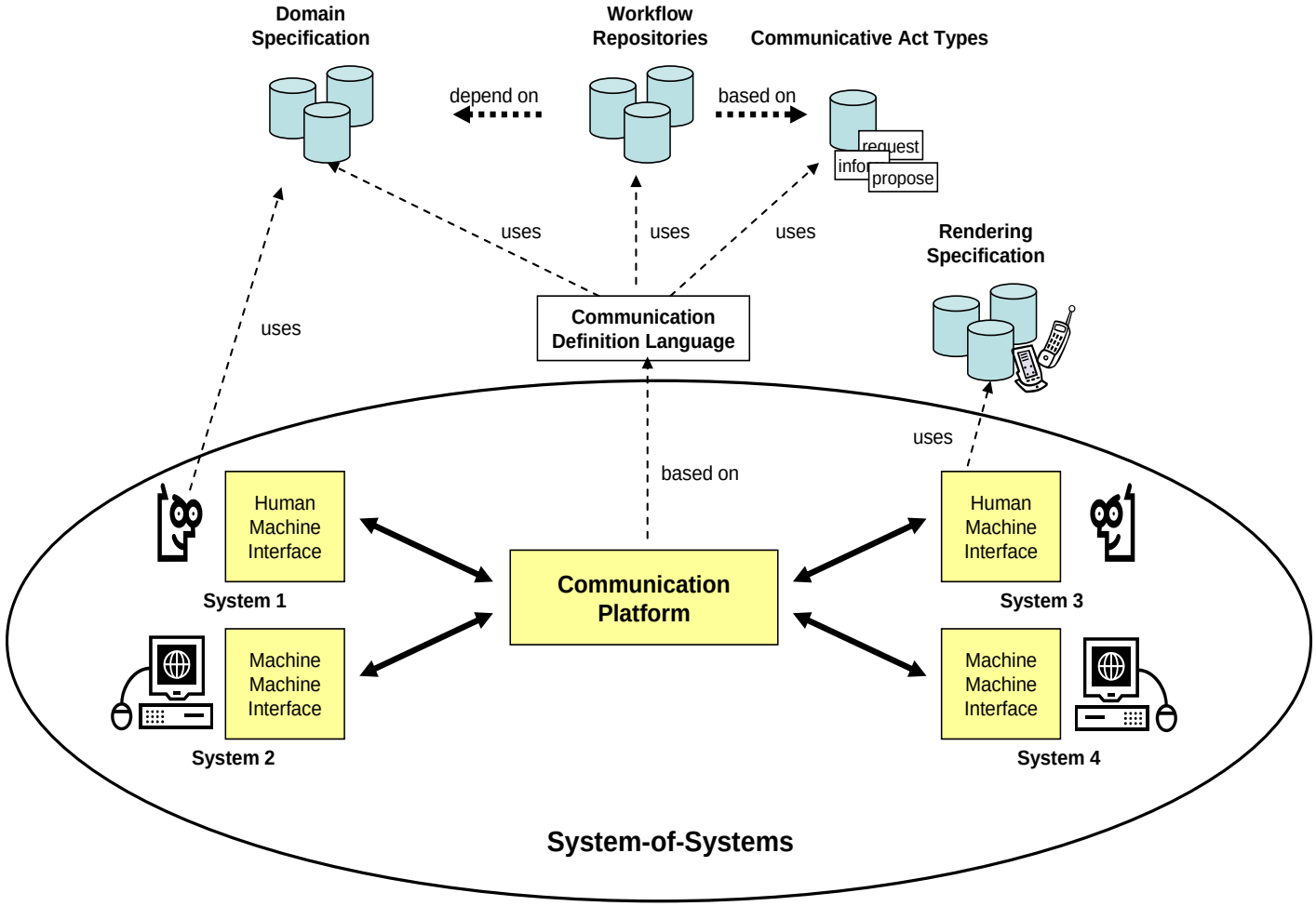




Final UI for Finger-based Touchscreen



Unified Communication Platform



Outline

- Background
- Interaction design based on discourse modeling
- Use case specification
- Exercises
- Sketch of automated user-interface generation
- Summary and Conclusion

Summary and Conclusion

- Interaction design can be based on discourse modeling.
- These models can be used for generating user interfaces.
- These models can be also viewed as specifying classes of scenarios, i.e., use cases.
- Requirements meet interaction design to make applications both more useful and usable.

Thank you for your attention!

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