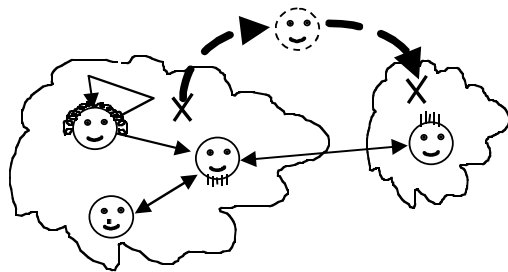
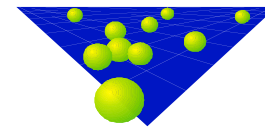


Representing Agent Interaction Protocols in UML



James J. Odell
H. Van Dyke Parunak
Bernhard Bauer

Agent UML A Formalism for Specifying Multiagent Software Systems



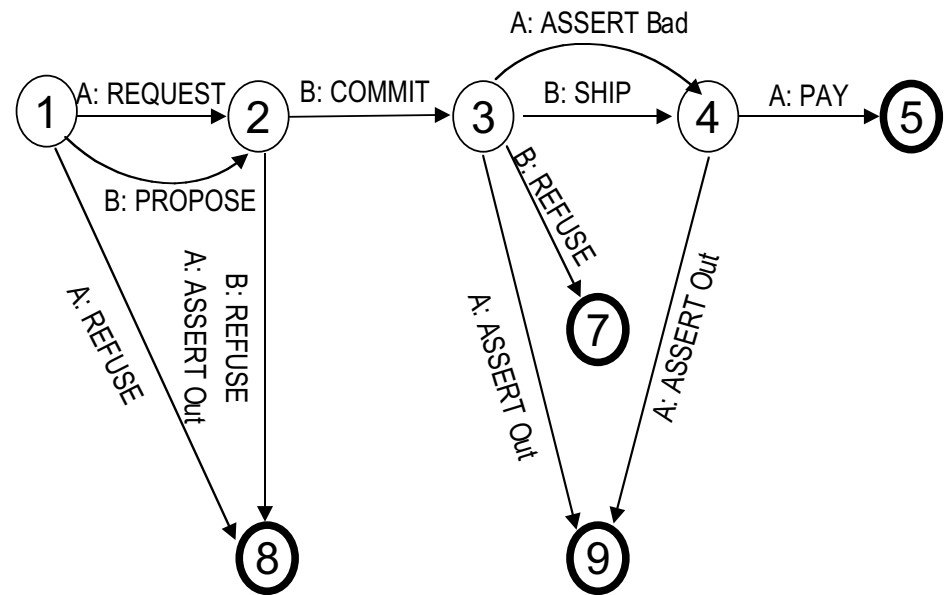
Bernhard Bauer
Jörg P. Müller
James Odell

Intelligent Autonomous Agents
© Siemens AG

AN AGENT CONVERSATION

Seq	Sndr	Rcvr	Utterance	Rspnds to	Replies to	Re-solves	Com-pletes
1.	A	B,C,D	REQUEST: Please send me 50 widgets at your catalog price by next Thursday.				
2.	B	C	QUESTION: Are you bidding on A's RFQ?	1			
3.	C	B	INFORM: Yes, I am.	2	2	2	
4.	B	A	REFUSE	3	1	1	
5.	C	A	PROPOSE (INFORM + REQUEST): How about 40 widgets at catalog price by next Friday?	1	1		
6.	A	C	REQUEST: Please send me 40 widgets at catalog price by next Friday.	5	5	5	
7.	C	A	COMMIT: I plan to send you 40 widgets at catalog price by next Friday.	6	6	6	
8.	D	A	COMMIT: I plan to send you 50 widgets at catalog price by next Thursday.	1	1	1	
9.	A	C	ASSERT: I've found a better supplier, and am not relying on your COMMIT.	7,8	7		
10.	C	A	REFUSE: I'm abandoning my COMMIT.	9	9		7
11.	D	A	SHIP: Here are your widgets. Please pay me.	1	1		8
12.	A	D	ASSERT + REQUEST: You're five short. Please send the difference.	11	11		
13.	D	A	SHIP: Here are five more widgets. Please pay me.	12	12	12	
14.	A	D	PAY	13	13	13	

WINOGRAD-FLORES VERSION OF AN AGENT INTERACTION PROTOCOL (AIP)



After Smith and Cohen 1995

STANDARDIZATION

Analysis and Design Task Force (ADTF) of Object Management Group (OMG)

Overall goal: vendor-neutral common semantics, meta-model, and abstract syntax for A&D methodologies

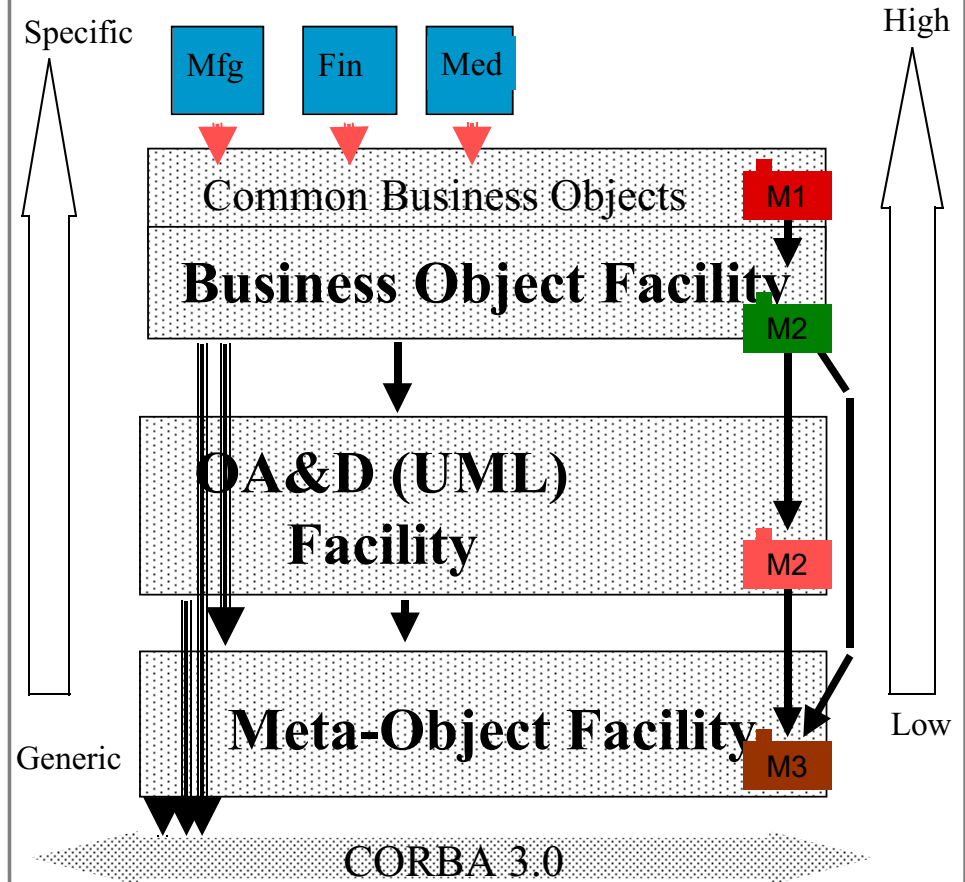
Mission

- To enable developers to better understand how to develop applications using OT—thereby growing the market.
- To recommend technology that interoperates across the lifecycle of A&D tools designs/work products.
- To recommend technology that enables reuse of designs and work products developed using A&D tools
- To recommend technology that has common semantics, meta-model, and abstract syntax for A&D methodologies.
- To leverage existing OMG specifications.

*OA&D TF RFP-1 - approved and released June 1996
Submissions due: 17 Jan 1997; Revisions due: 1 September 1997
Selection: 25 September 1997; Adoption: November 1997*

Object Management Group
www.omg.org
(508) 820-4300

MOF/OADF/BOF ARCHITECTURE



UML DIAGRAMS

- Static Diagrams
 - Class diagrams
 - Packages
 - Component diagrams
- Dynamic Diagrams
 - Statechart
 - Collaboration diagrams
 - Sequence diagrams
 - Activity diagrams
 - Deployment diagrams
 - Use Case diagrams

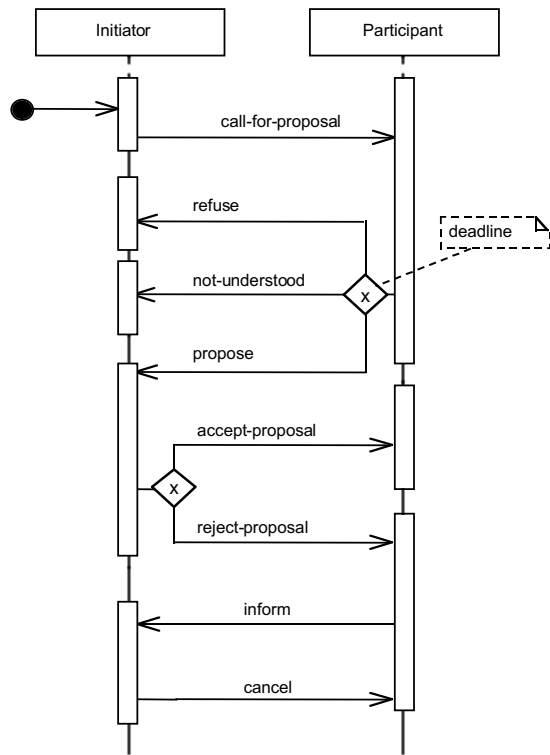
***So, which will be useful for representing
agent interaction protocols?***

AGENTS STANDARDIZATION AND AGENT UML (AUML)

- OMG Agents Working Group** recommends standards for agent technology where appropriate—particularly the OMG's Object Management Architecture (OMA). (www.omg.org)
- FIPA (Federated Intelligent Physical Agents)** has been working to develop and promote standardization in the area of agent interoperability since 1996. It has an on-going work program, meeting around the globe on a quarterly basis, with excess of 50 member organizations. (www.fipa.org)

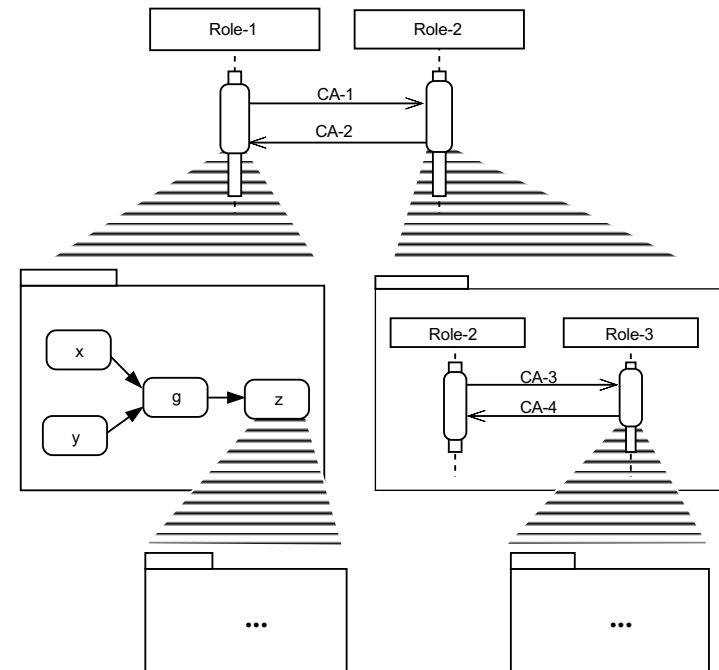
A COMMON AIP REPRESENTATION

UML Sequence Diagrams



FIPA Contract Net Protocol

INTERACTION PROTOCOLS CAN BE SPECIFIED IN MORE DETAIL



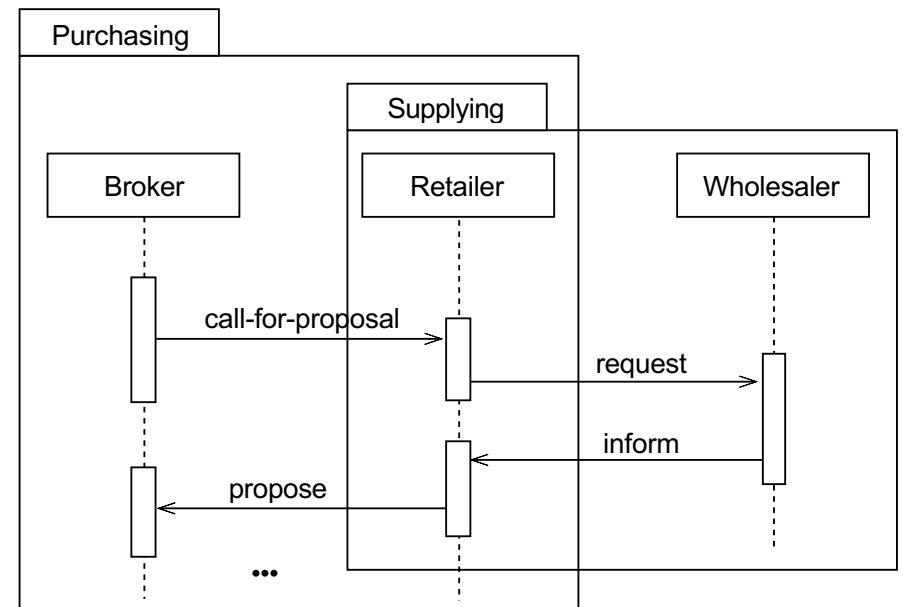
A LAYERED APPROACH TO AIPs

- ❑ Level 1: Representing the overall protocol

- ❑ Level 2: Representing interaction among agents

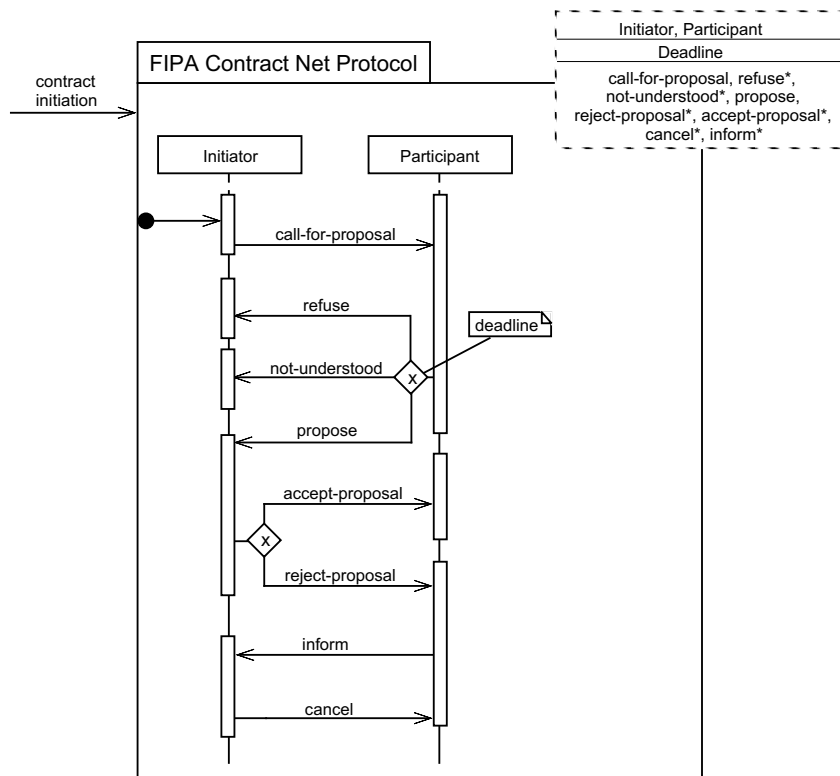
- ❑ Level 3: Representing internal agent processing

USING PACKAGES TO EXPRESS “NESTED” PROTOCOL

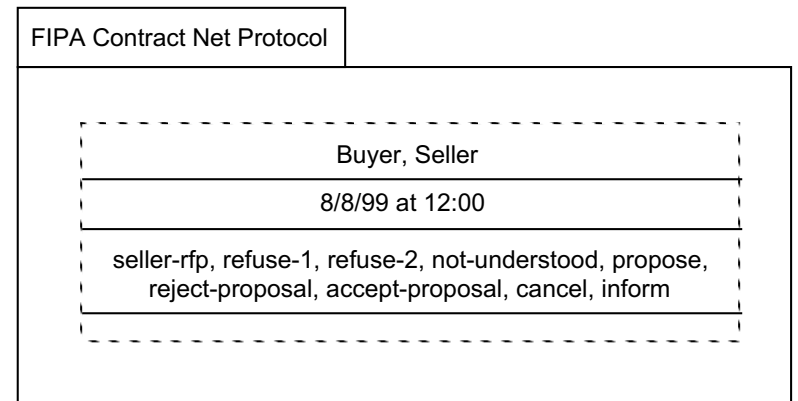


LEVEL 1

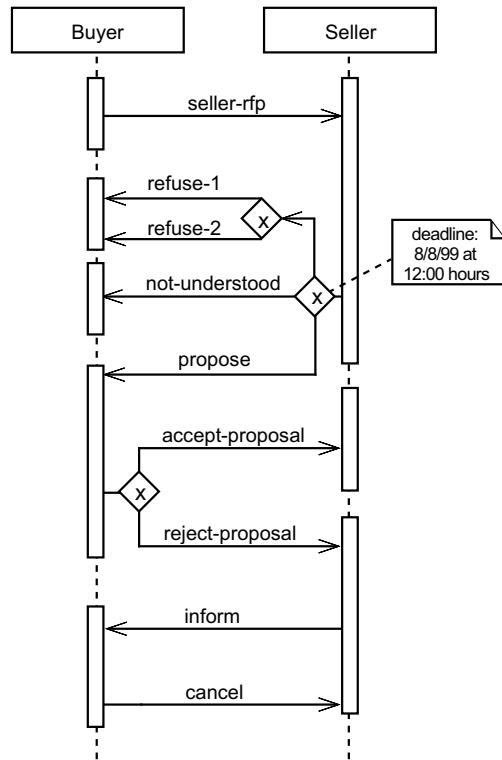
Generic AIP expressed as a template package



BINDING THE PARAMETERS OF THE FIPA CONTRACT NET PROTOCOL PACKAGE TEMPLATE

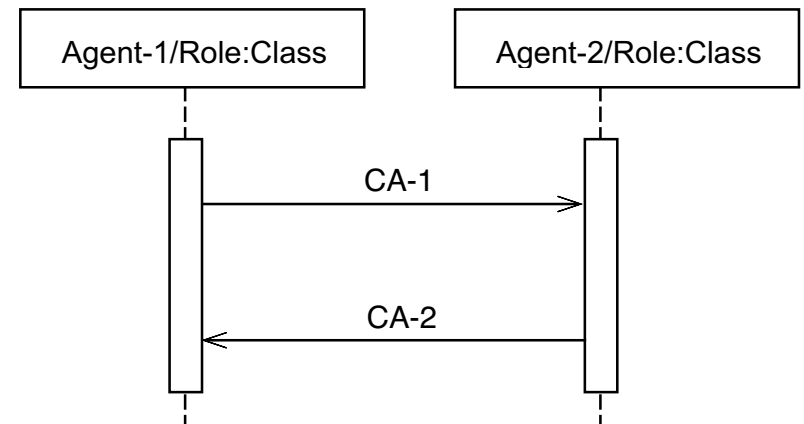


APPLYING A TEMPLATE TO A PARTICULAR SCENARIO

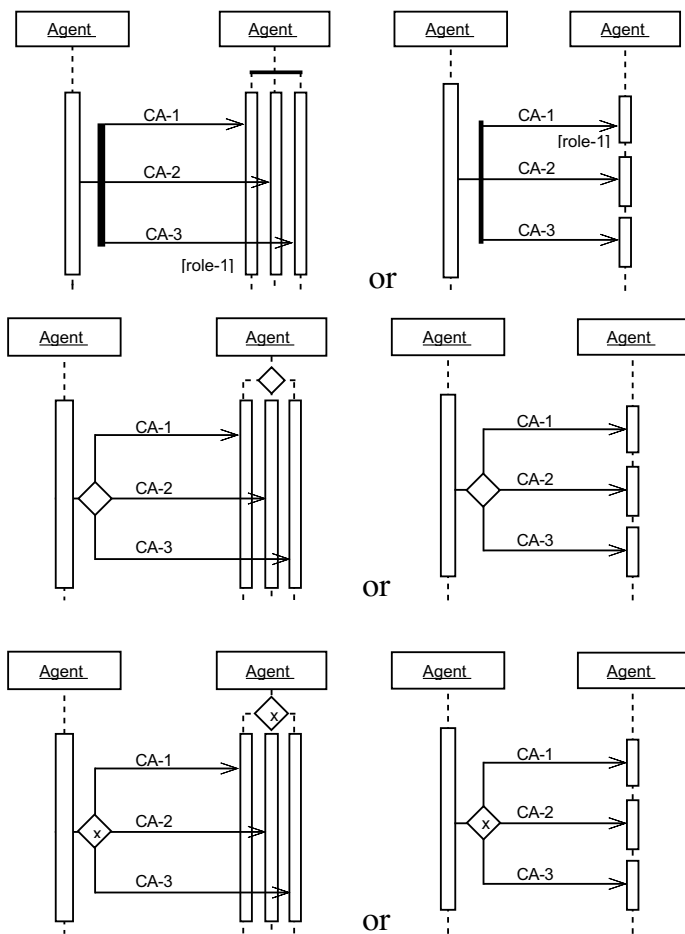


LEVEL 2:

Basic format of Sequence Diagrams for agent communication

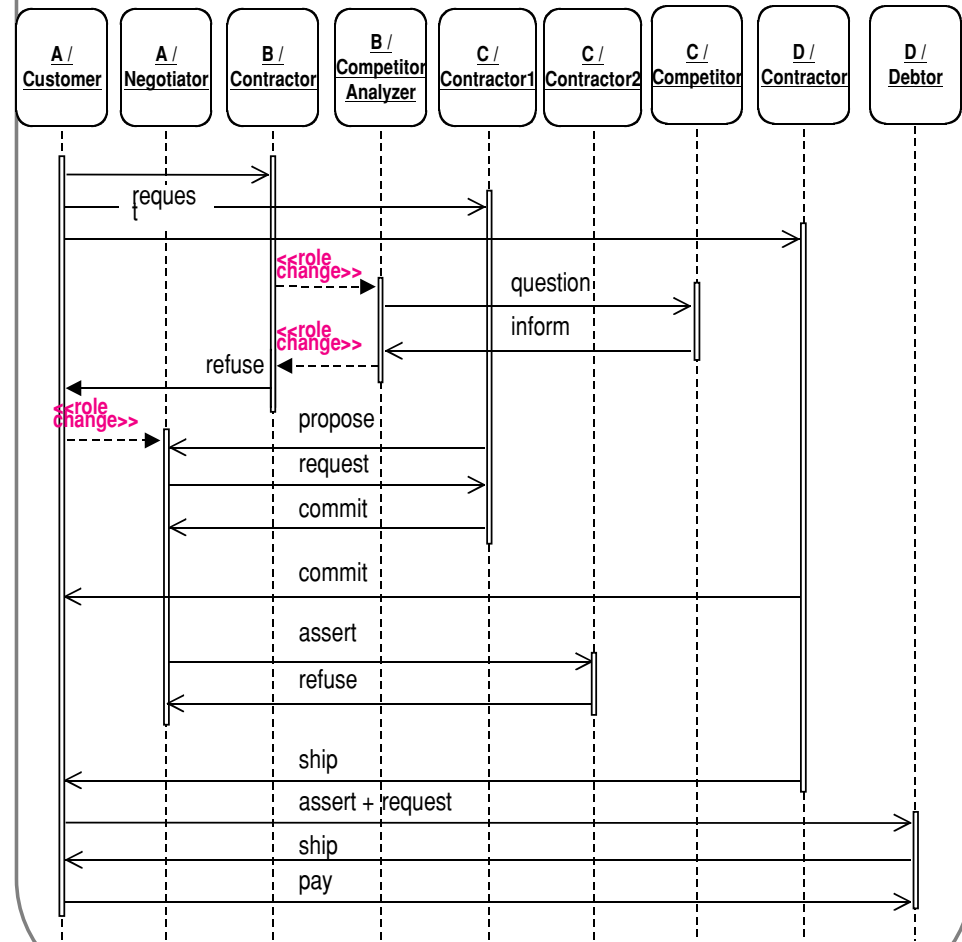


CONCURRENT COMMUNICATION WITH AN AGENT PLAYING DIFFERENT ROLES



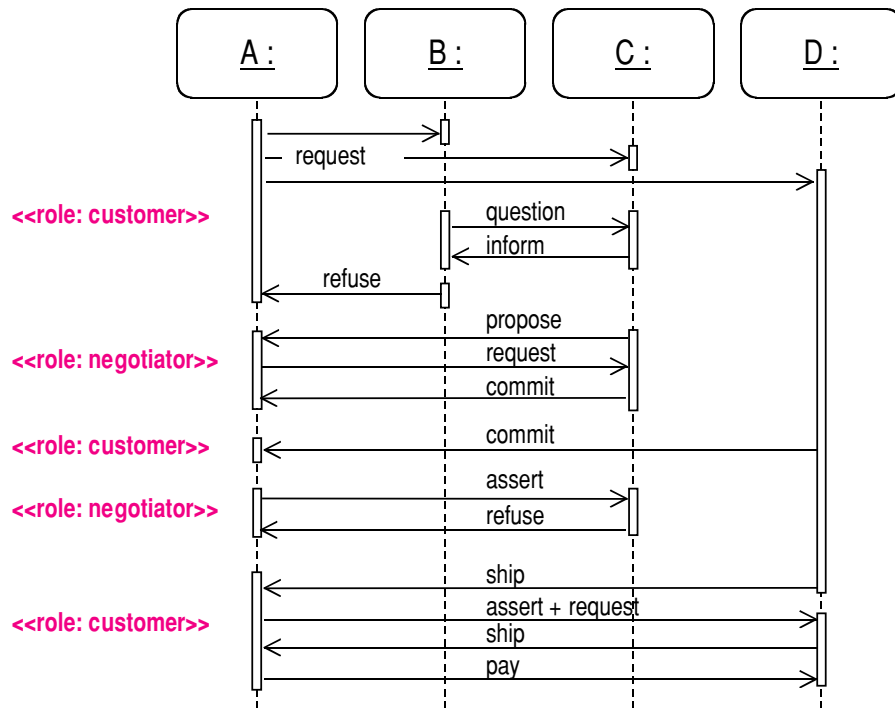
SEQUENCE DIAGRAM

Example

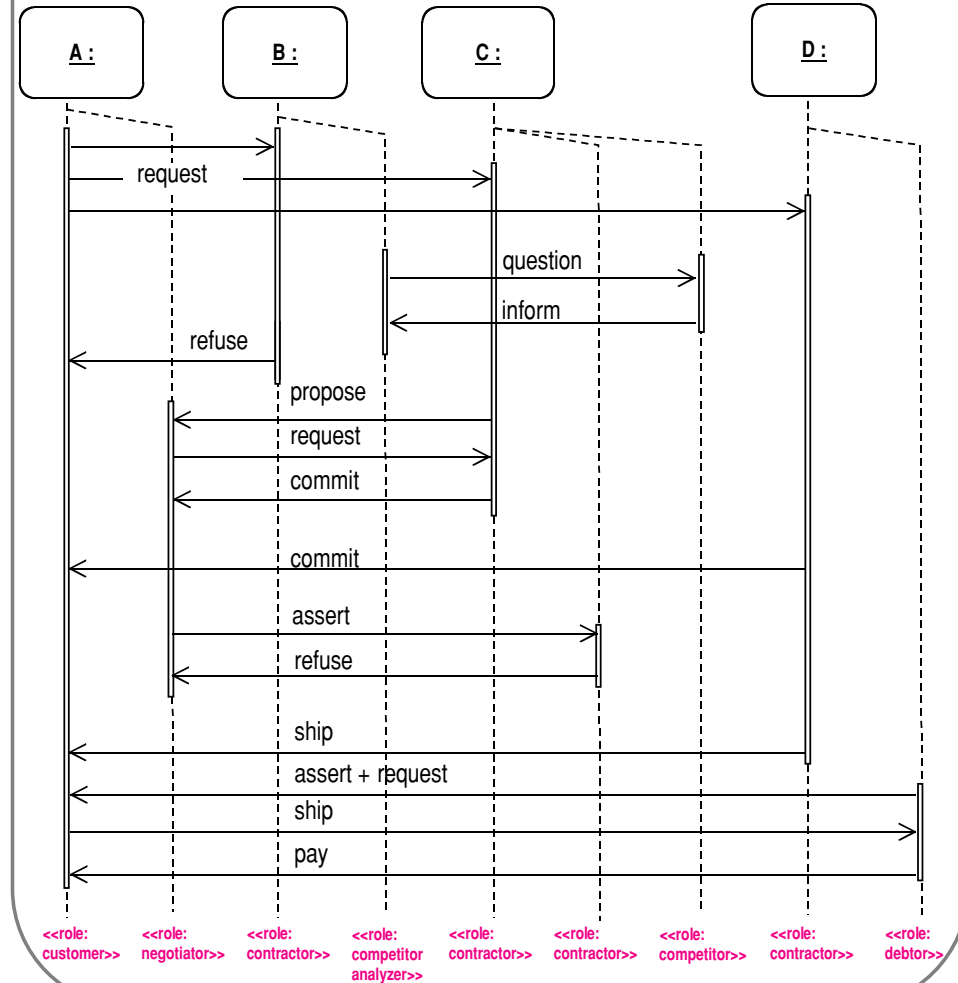


DETECTING ROLES AS TIME INTERVALS IN A SEQUENCE DIAGRAM

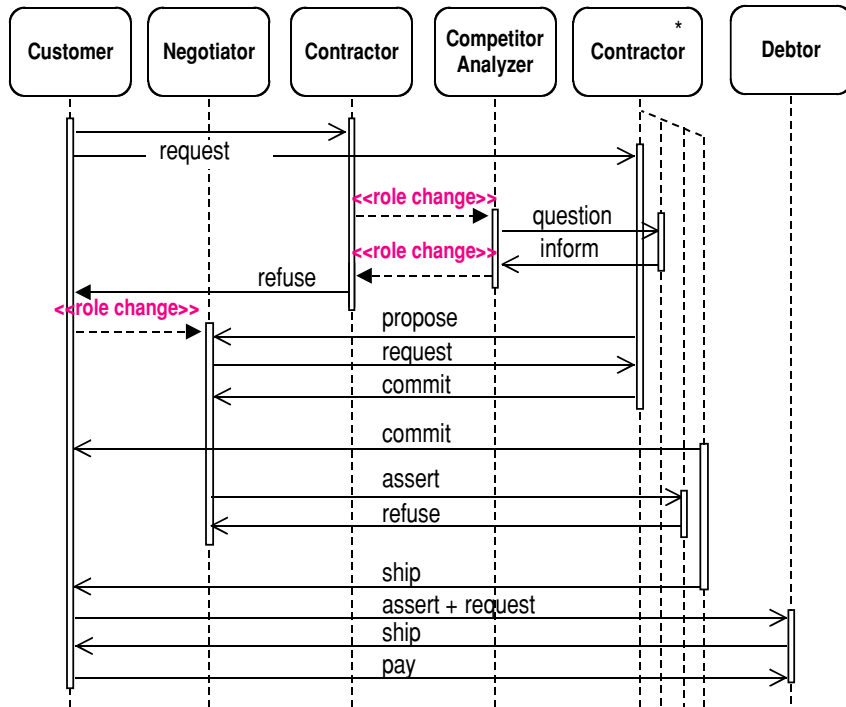
(only A's roles labeled)



ROLES AS PARALLEL BRANCHES IN A SEQUENCE DIAGRAM

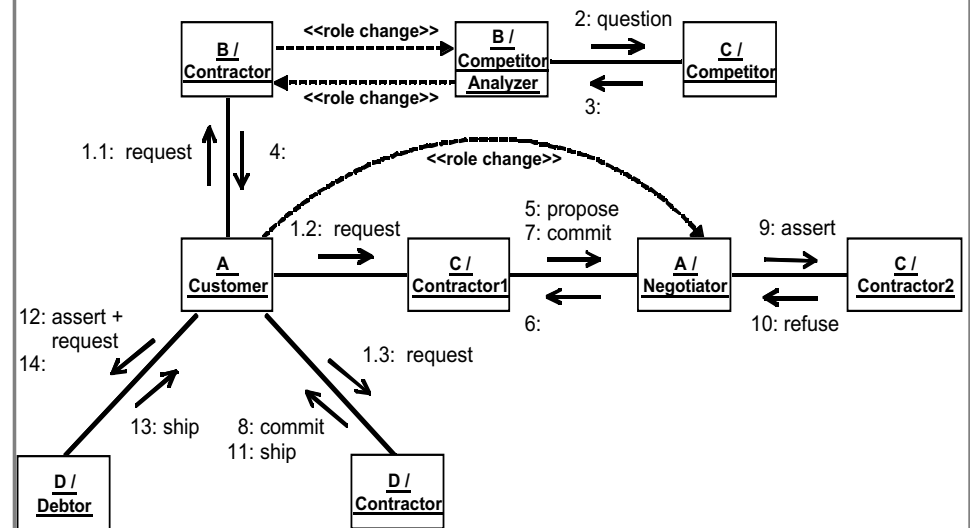


ROLES AS TYPES WITHOUT INDIVIDUAL AGENTS



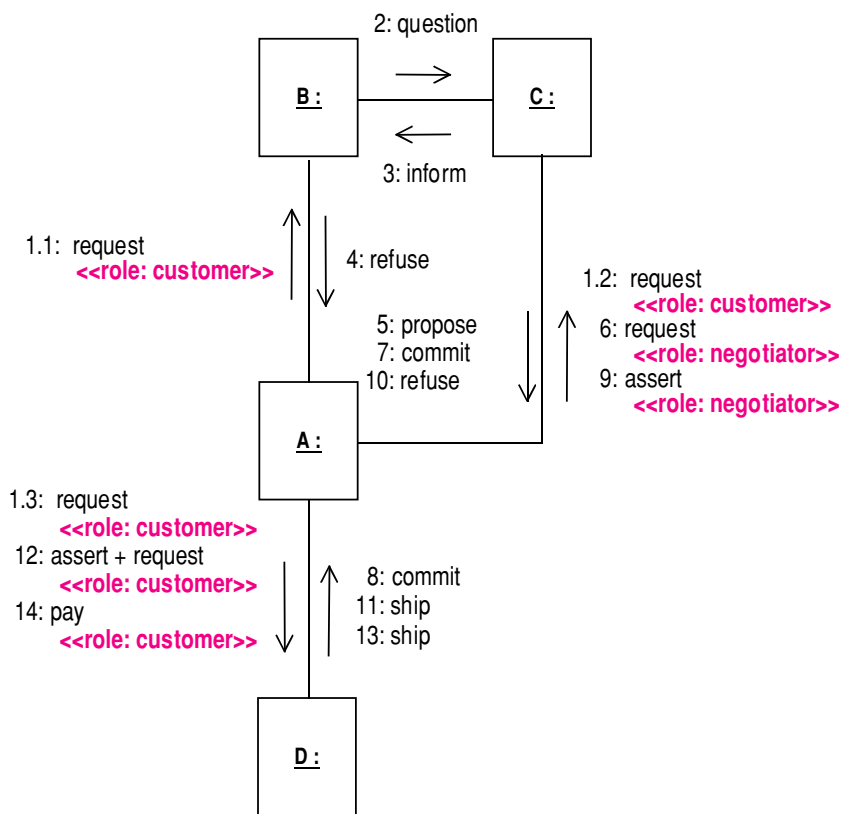
COLLABORATION DIAGRAM

An alternative representation



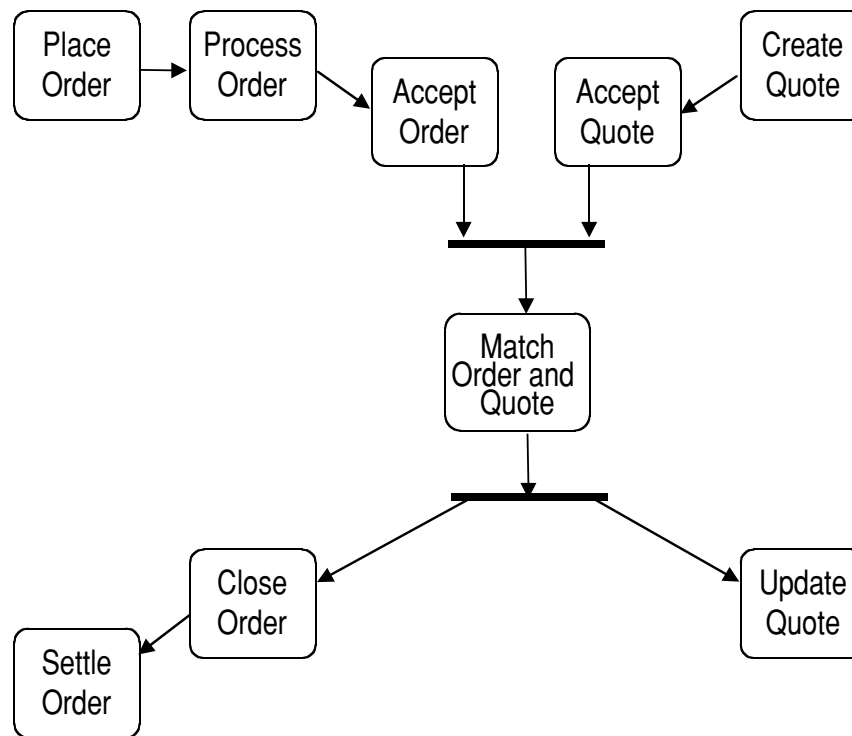
ROLES ON MESSAGES IN A COLLABORATION DIAGRAM

(only roles for A shown)

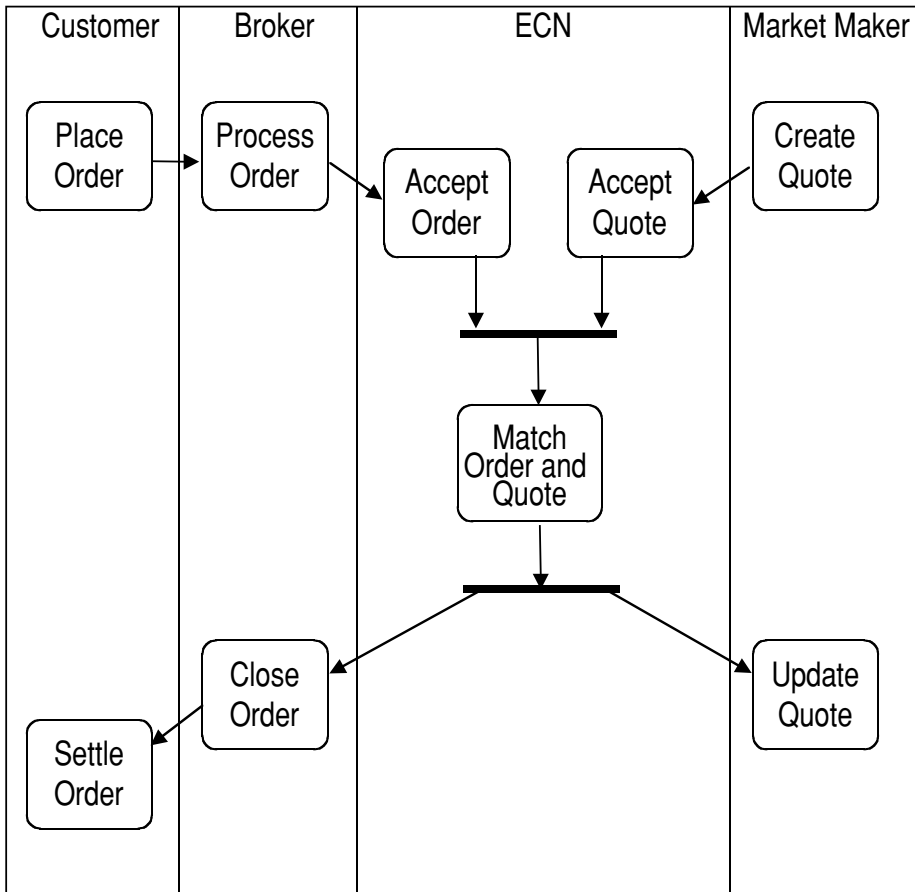


ACTIVITY DIAGRAMS

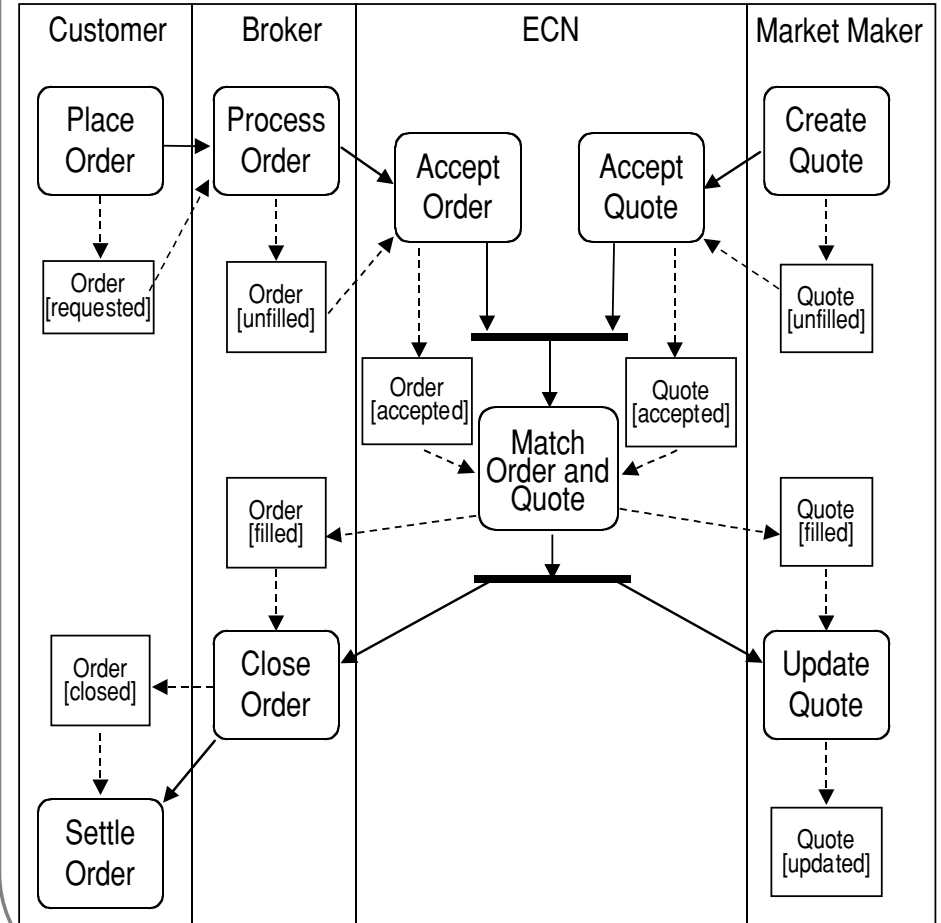
Another alternative representation



**ORDER PROCESSING:
ACTIVITY DIAGRAMS WITH SWIMLANES**

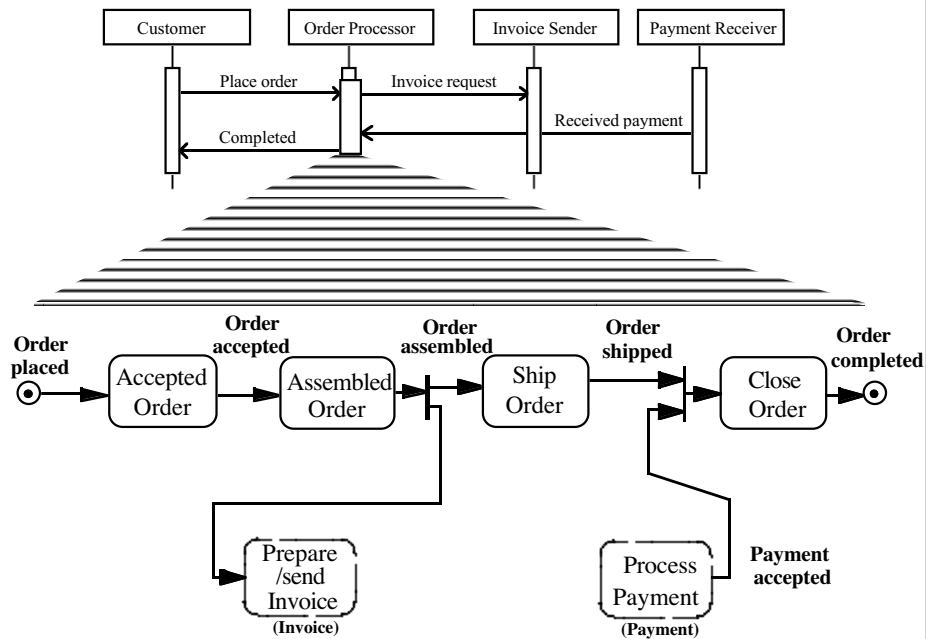


**ORDER PROCESSING:
ACTIVITY DIAGRAMS
WITH SWIMLANES AND OBJECT FLOW**



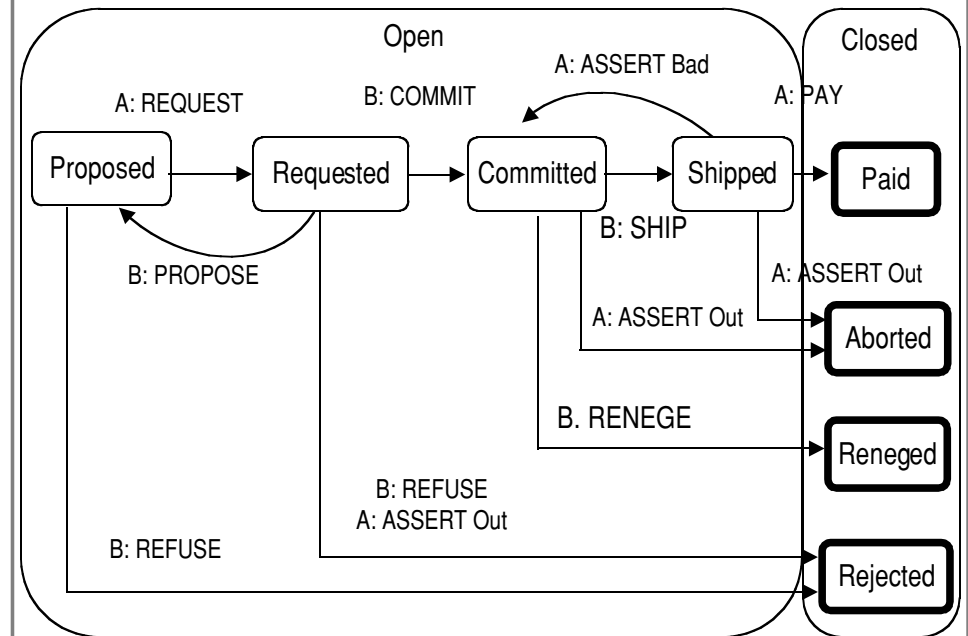
LEVEL 3

Generic AIP expressed
as a template package



STATECHART NOTATION

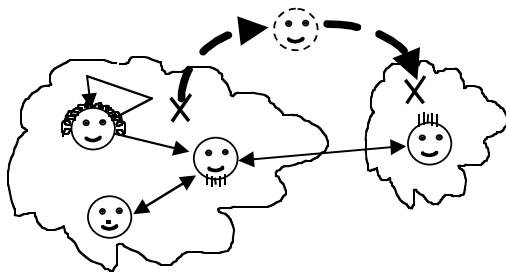
Even another alternative



*A state-based speech-act version
of the Winograd-Flores protocol
in UML statechart notation*

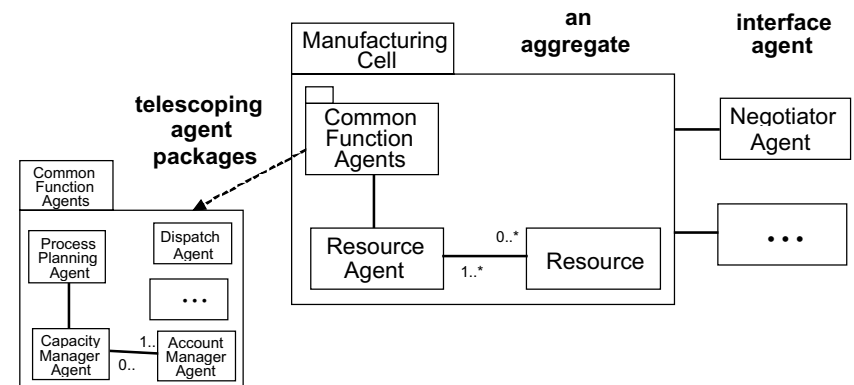
REPRESENTING AGENT INTERACTION PROTOCOLS IN UML

- ❑ Level 1: Representing the overall protocol
- ❑ Level 2: Representing interaction among agents
- ❑ Level 3: Representing internal agent processing



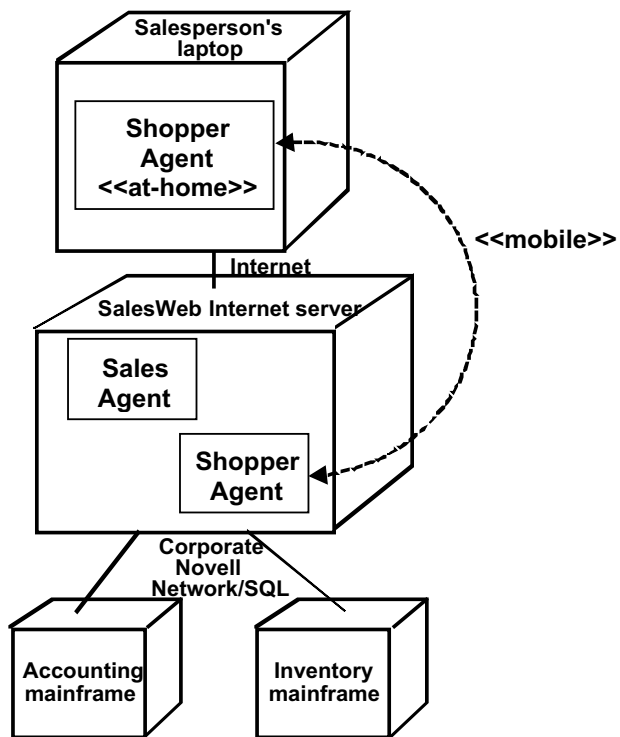
OTHER UML EXTENSION

Package specifying agents
instead of operations as interface points.



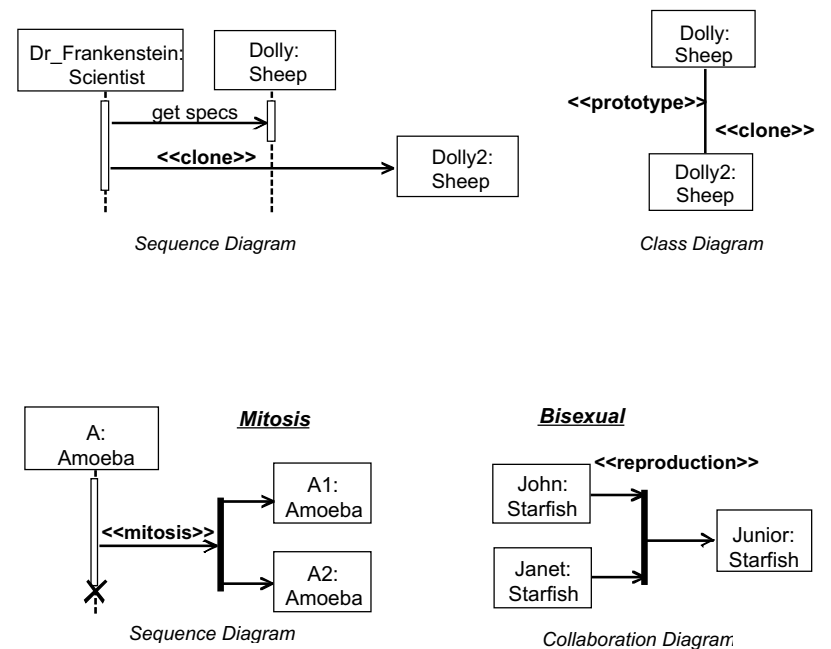
OTHER UML EXTENSION

Adding mobility to deployment diagrams.



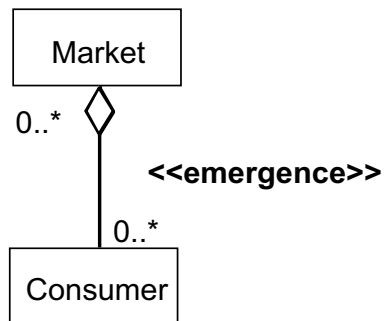
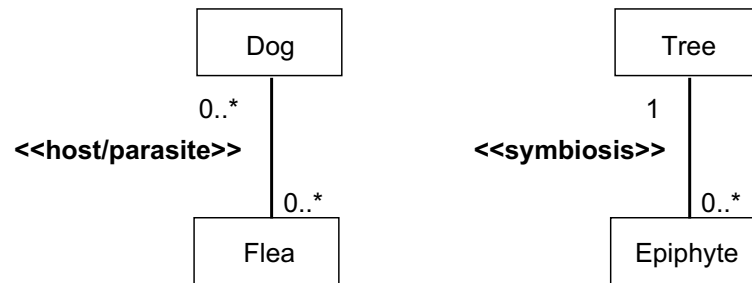
OTHER UML EXTENSION

Representing cloning, mitosis, and reproduction using sequence and activity diagrams



OTHER UML EXTENSION

Representing parasitic, symbiotic, and emergence relationship using class diagrams

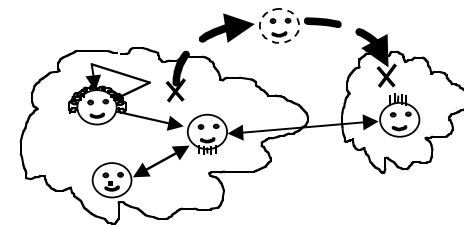


Representing Agent Interaction Protocols (and then some) in UML

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