

Distributed Artificial Intelligence and Intelligent Agents (ID2209): Project assignment

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I. INTRODUCTION

The requirements statement is essentially just a set of articulated requirements for the system/organization to be designed, for structural reasons the requirements are divided into various related models that use different levels of detail. The system in this context is a SmartMuseum Agent Framework, as of following the GAIA methodology [1] I will from here on frequently use the *organization* metaphor when referring to the system.

II. TASK 1 - MODELING WITH GAIA METHDOLOGY

I. Analysis

I.1 Requirements Statement

I.1.1 Mission Statement

The SmartMuseum organization has the purpose of connecting different people and entities that are in some sense involved in consuming or providing services related to art. The goal of the organization is to improve the overall experience for everyone involved. The organization should make it easier for consumers to view and find interesting art, for art-curators to provide art and reach out to consumers, for tourguides to find interested consumers as well as building relevant tours and finally for artists to sell their work.

I.1.2 Organization Description

The activity of a consumer viewing an art-artifact involves atleast three, sometimes four, or five main divisions: *tour-guide division*, *art-curator division*, *artist-management division*, *user-service division* and *artist-division*. The activity is initiated by the consumer who contacts the user-service division and selects some type of art-service, the user-service division support the consumer in requesting/retrieving the service from either the art-curator division or tour-guide-division. In parellel to managing consumer requests the tour-guide division browses art-artifacts that is curated by the art-curator division. Further more, the art-curator division participates in auctions for obtaining art-artifacts from the artist-management division, in parallel to managing requests from consumers and tourguides. Finally, the artist-management division initiates auctions for art-artifacts on request from artists.

The activities described above can the be modelled as an organization in the following way. The organization consists of 7 roles. The ARTCONSUMER (AC) who consumes arts in different forms. The USERHANDLER (UH) which the consumer uses to purchase and browse services related

to art. The TOURGUIDE (TA) which builds and offers virtual tours. The ARTBUYER (AB) who buys art to include in its gallery/museum, the ARTQUOTER (AQ) who quotes the price for arts and sells it to consumers. The ARTSELLER (AS) who is hired by artists to sell their work to art buyers. And finally the ARTIST (A) who produces art.

I.2 Roles Model

The following assumption is necessary to avoid making decisions about implementation details when doing the analysis/design.

Assumption 1-A. Roles can find each other in some way in order to communicate

Role Schema: ARTCONSUMER (AC)	
Description: Initiates activity of consuming art, either buying artifact or downloading a virtual tour	
Protocols and activities: DownloadVirtualTour, BuyArt, <u>ConsumeService</u>	
Permissions:	
reads	<i>supplied availableServices</i> // <i>list of services</i> <i>money</i> // <i>money of the consumer</i> <i>userProfile</i> // <i>profile of the consumer</i> <i>visitedArtifacts</i> // <i>list of visited artifacts</i>
generates	<i>valuation</i> // <i>valuation of selected artifact</i> <i>artifactTitle</i> // <i>title of selected artifact</i> <i>virtualTourTitle</i> // <i>title of selected virtual-tour</i> <i>moneyForArtifact</i> // <i>money for selected artifact</i> <i>supplied virtualTour</i> // <i>downloaded virtual-tour</i> <i>supplied auctionResult</i> // <i>bought artifact or nil</i>
Responsibilities	
Liveness:	
$\text{ARTCONSUMER} = (\text{GetService. } \underline{\text{ConsumeService}})^{\omega}$ $\text{GETSERVICE} = (\text{DownloadVirtualTour} \mid \text{BuyArt})$	
Safety:	
<ul style="list-style-type: none"> • $\text{moneyForArtifact} \leq \text{money}$ • $\text{artifactTitle} \in \text{availableServices.artifacts}$ • $\text{virtualTourTitle} \in \text{availableServices.artifacts}$ 	

Figure 1: Schema for role ARTCONSUMER

Role Schema: USERHANDLER (UH)	
Description: Receives request to buy art-services from consumers and manages the process of the consumer purchasing and obtaining the service.	
Protocols and activities: GetArtifact, GetVirtualTour, GetArtifactsList, GetVirtualTourList, <u>GenerateListOfArtServices</u>	
Permissions:	
generates	<i>availableServices</i> // <i>list of services</i> <i>strategy</i> // <i>strategy for dutch auction</i>
reads	supplied <i>virtualTours</i> // <i>list of virtual tours</i> supplied <i>artifacts</i> // <i>list of art-artifacts</i> supplied <i>moneyForArtifact</i> // <i>consumer money to purchase artifact</i> supplied <i>valuation</i> // <i>consumer valuation of artifact</i> supplied <i>artifactTitle</i> // <i>title of artifact-purchase</i> supplied <i>virtualTourTitle</i> // <i>title of virtual-tour selection</i> supplied <i>virtualTour</i> // <i>virtual-tour downloaded by consumer</i> supplied <i>auctionResult</i> // <i>artifact bought by consumer or nil</i>
Responsibilities	
Liveness:	
USERHANDLER = (All) ^ω ALL = (PresentServices HandleConsumerRequest) ^ω PRESENTSERVICES = GetServices. <u>GenerateListOfArtServices</u> GETSERVICES = GetArtifactsList. <u>GetVirtualToursList</u> HANDLECONSUMERREQUEST = GetArtifact GetVirtualTour	
Safety:	
<ul style="list-style-type: none">• <i>availableServices</i> = <i>artifacts</i> ∪ <i>virtualTours</i>• <i>auctionResult</i> ≠ nil ⇒ <i>auctionResult</i> ∈ <i>artifacts</i>• <i>virtualTour</i> ∈ <i>virtualTours</i>	

Figure 2: Schema for role USERHANDLER

Role Schema: TOURGUIDE (TG)			
Description:			
Responsible for constructing virtual tours of art-artifacts. Looks up available artifacts at curators and then builds different types of tours.			
Sends tours to user-handlers.			
Protocols and activities:			
SendVirtualTours, SendVirtualTour, GetArtifactList, <u>BuildVirtualTour</u>			
Permissions:			
	generates	<i>virtualTour</i>	// <i>virtual tour of art-artifacts</i>
		<i>virtualTours</i>	// <i>list of virtual-tours</i>
	reads	<i>supplied artifacts</i>	// <i>list of artifacts</i>
		<i>supplied virtualTourTitle</i>	// <i>specific virtual-tour title</i>
Responsibilities			
Liveness:			
TOURGUIDEBUILDER = (ConstructTour [Send]) ^ω			
CONSTRUCTTOUR = (GetArtifactList. <u>BuildVirtualTour</u>) ^ω			
SEND = SendVirtualTours SendVirtualTour			
Safety:			
● $\forall virtualTour.artifact \quad virtualTour.artifact \in artifacts$			

Figure 3: Schema for role TOURGUIDE

Role Schema: ARTBUYER (AB)			
Description: Buys art-artifacts from art-sellers.			
Protocols and activities: BuyArt, SendArtifacts			
Permissions:			
	generates	<i>artifacts</i>	// <i>list of purchased artifacts</i>
		<i>strategy</i>	// <i>strategy for dutch auction</i>
		<i>valuation</i>	// <i>valuation for artifact</i>
		<i>moneyForArtifact</i>	// <i>money for artifact</i>
	reads	<i>money</i>	// <i>the buyer's money</i>
		<i>artifactTitle</i>	// <i>title for a specific artifact</i>
		<i>supplied artifactResult</i>	// <i>bought artifact or nil</i>
Responsibilities			
Liveness:			
	$\text{ARTBUYER} = ([\text{BuyArt}] \parallel [\text{SendArtifacts}])^\omega$		
Safety:			
	<ul style="list-style-type: none">• $\text{moneyForArtifact} \leq \text{money}$• $\text{artifactTitle} \in \text{artifacts}$		

Figure 4: Schema for role ARTBUYER

Role Schema: ARTQUOTER (AQ)			
Description: Quotes art and resells it to consumers			
Protocols and activities: <u>QuoteArt</u> , SellArt, GetArtifacts, SendArtifacts			
Permissions:			
	reads	supplied <i>artifacts</i>	// list of artifacts
		supplied <i>artifact</i>	// artifact for auction
	generates	<i>quote</i>	// quote of artifact
		<i>rateOfReduction</i>	// rate of reduction for dutch auction
		<i>initialPrice</i>	// initial price for auction
		<i>reservePrice</i>	// reserved price for auction
		<i>price</i>	// price auction ended at
		<i>winner</i>	// winner of auction or nil
		<i>artifactResult</i>	// result of auction
		<i>bidders</i>	// bidders of auction
Responsibilities			
Liveness:			
	ARTQUOTER = ((GetArtifacts. <u>QuoteArt</u> . SellArt) SendArtifacts) ^ω		
Safety:			
	<ul style="list-style-type: none">• <i>winner</i> ∈ <i>bidders</i>• <i>reservePrice</i> ≤ <i>price</i> ≤ <i>initialPrice</i>		

Figure 5: Schema for role ARTQUOTER

Role Schema: ARTSELLER (AS)			
Description: Sells art to art-traders/curators.			
Protocols and activities: SellArt, GetArtifact			
Permissions:			
	reads	<i>supplied artifact</i>	// <i>artifact to be sold</i>
	generates	<i>rateOfReduction</i>	// <i>rate of reduction for dutch auction</i>
		<i>initialPrice</i>	// <i>initial price for auction</i>
		<i>reservePrice</i>	// <i>reserved price for auction</i>
		<i>price</i>	// <i>price auction ended at</i>
		<i>winner</i>	// <i>winner of auction or nil</i>
		<i>artifactResult</i>	// <i>result of auction</i>
		<i>bidders</i>	// <i>bidders of auction</i>
Responsibilities			
Liveness:			
	ARTSELLER = (GetArtifact. SellArt) ^ω		
Safety:			
	<ul style="list-style-type: none">• <i>winner</i> ∈ <i>bidders</i>• <i>reservePrice</i> ≤ <i>price</i> ≤ <i>initialPrice</i>		

Figure 6: Schema for role ARTSELLER

Role Schema: ARTIST (A)
Description: Sells art to art-traders/curators.
Protocols and activities: <u>ProduceArt</u> , SendArtifact
Permissions: <div style="text-align: right;">generates <i>artifact</i> // <i>produced artifact</i></div>
Responsibilities
Liveness: <div style="text-align: right;">ARTIST = (<u>ProduceArt</u>. SendArtifact)^ω</div>
Safety: <div style="text-align: right;">• true</div>

Figure 7: Schema for role ARTIST

I.3 Interaction Model

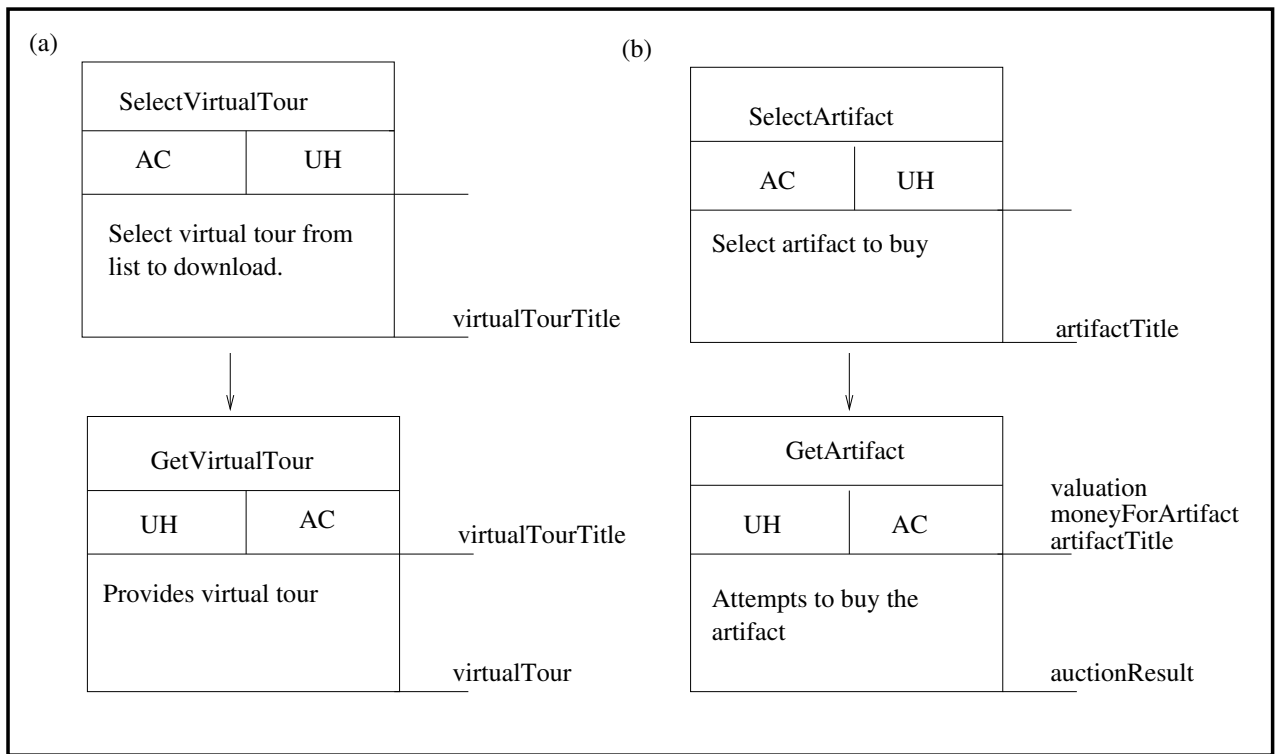


Figure 8: Definition of protocols associated with the ARTCONSUMER role: (a) DownloadVirtualTour, (b) BuyArt

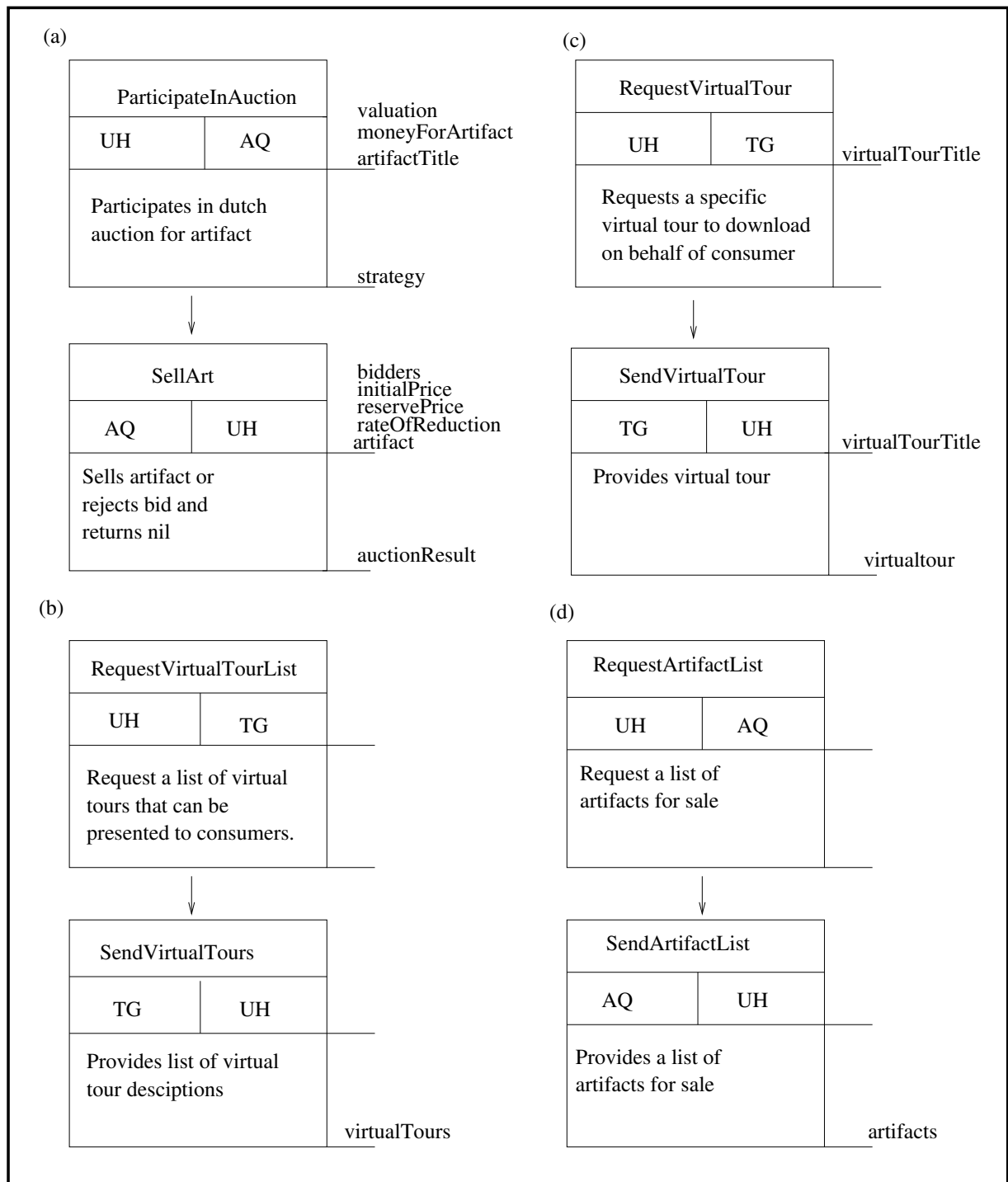


Figure 9: Definition of protocols associated with the USERHANDLER role: (a) GetArtifact, (b) GetVirtualTourList, (c) GetVirtualTour, (d) GetArtifactsList

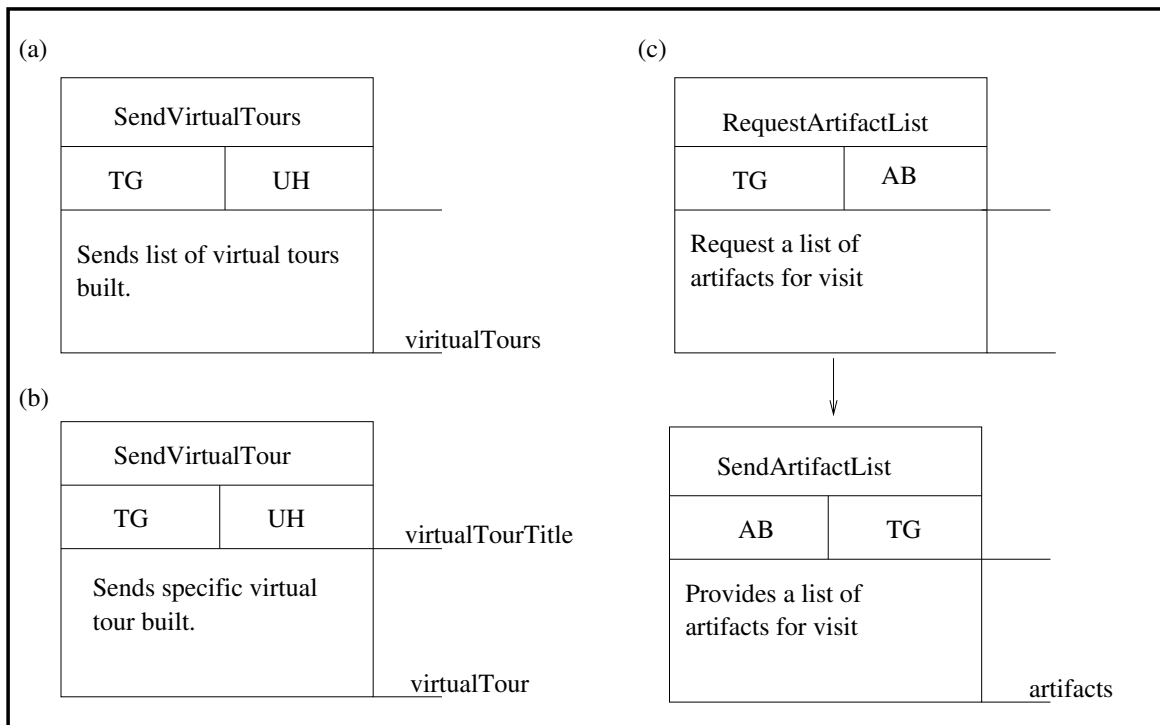


Figure 10: Definition of protocols associated with the TOURGUIDE role: (a) SendVirtualTours, (b) SendVirtualTour, (c) GetArtifactList

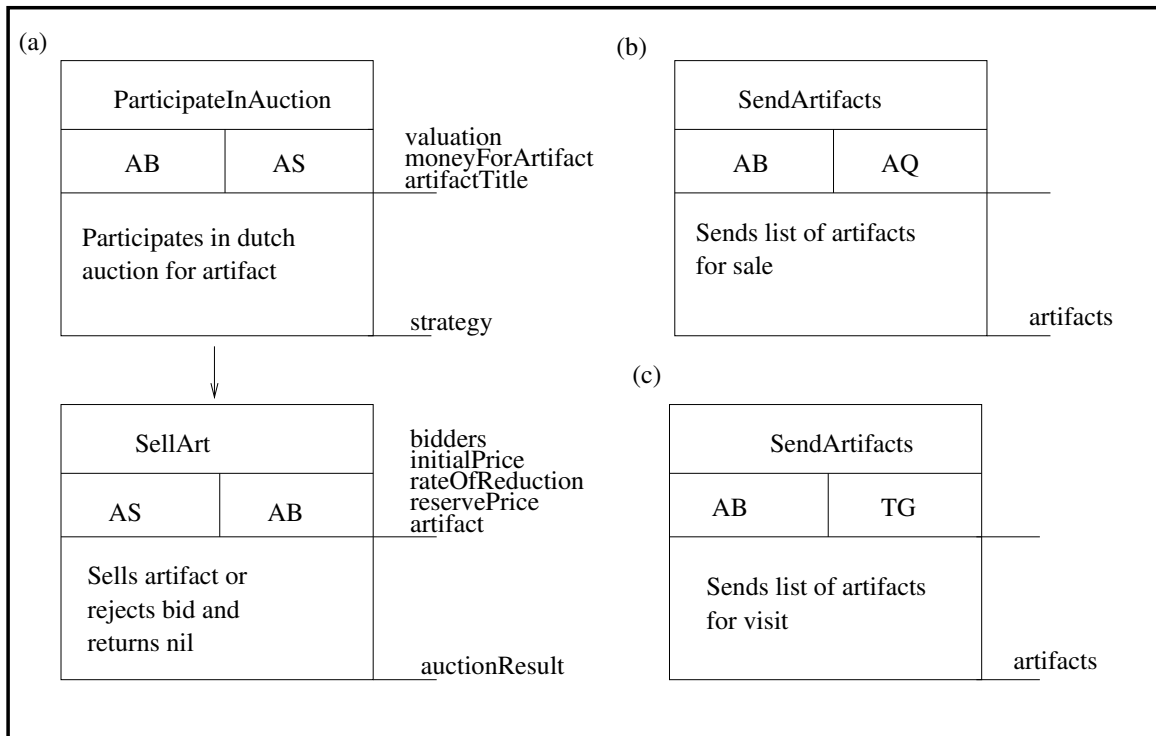


Figure 11: Definition of protocols associated with the ARTBUYER role: (a) BuyArt, (b) SendArtifacts (1), (c) SendArtifacts (2)

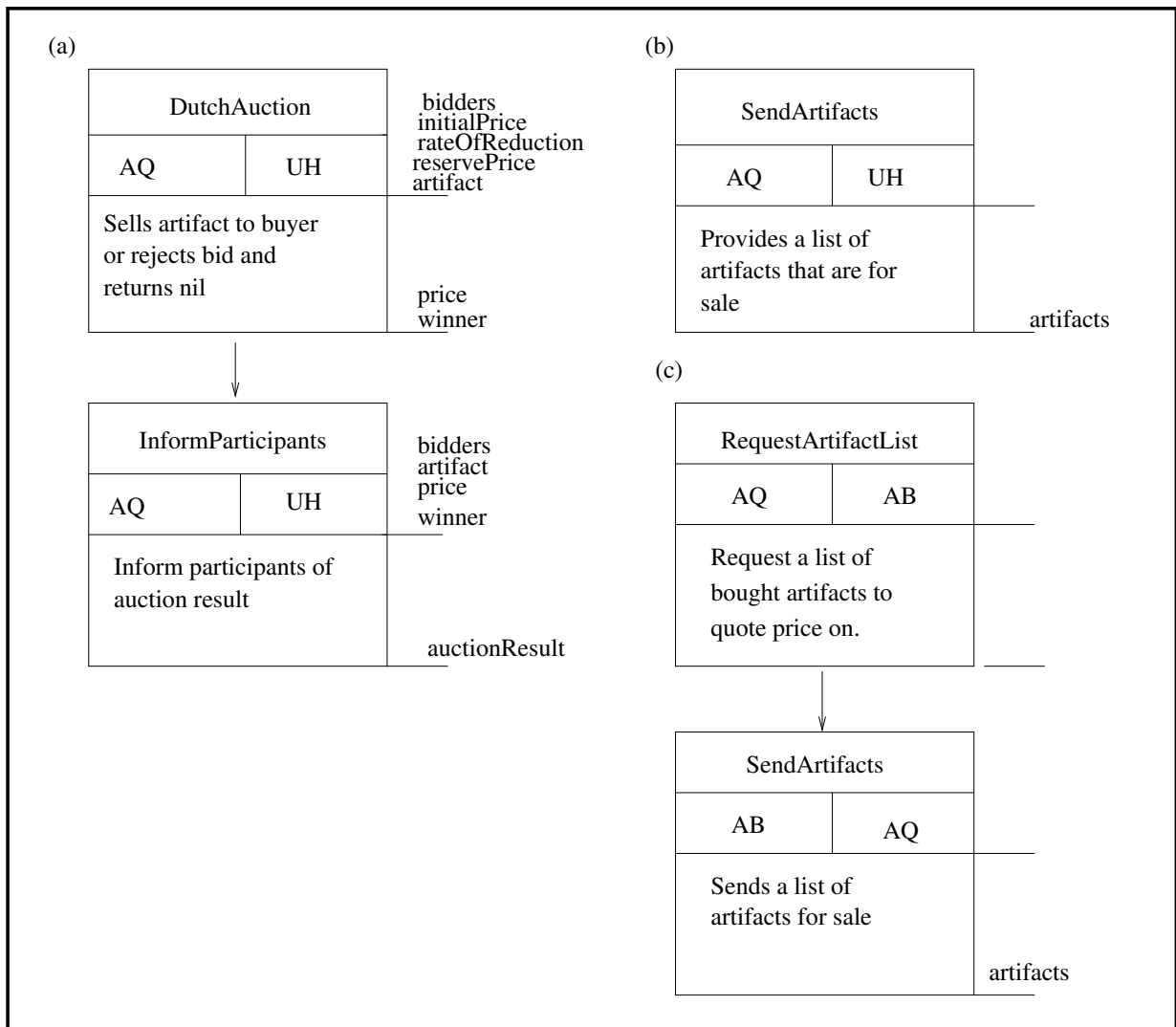


Figure 12: Definition of protocols associated with the ARTQUOTER role: (a) SellArt, (b) SendArtifacts, (c) GetArtifacts

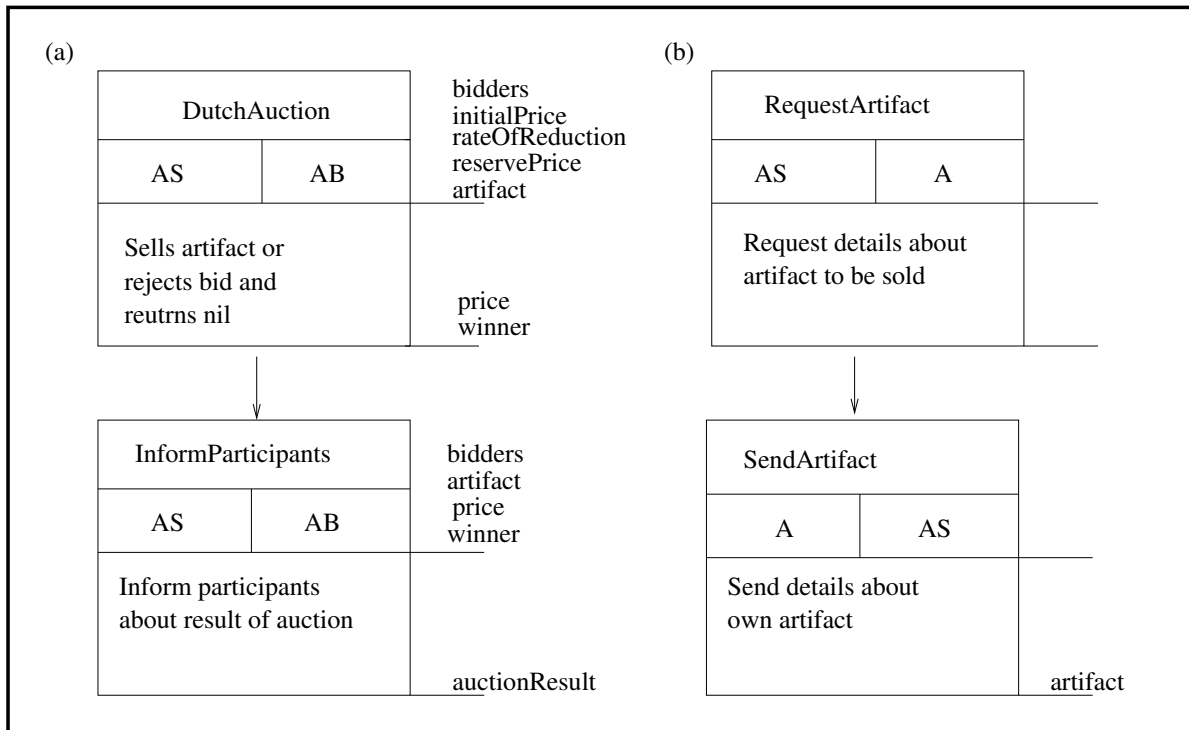


Figure 13: Definition of protocols associated with the ARTSELLER role: (a) SellArt, (b) GetArtifact

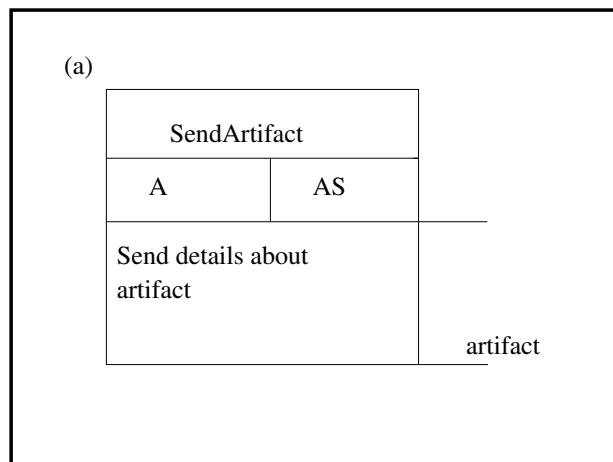


Figure 14: Definition of protocols associated with the ARTIST role: (a) SendArtifact

II. Design

II.1 Agent Model

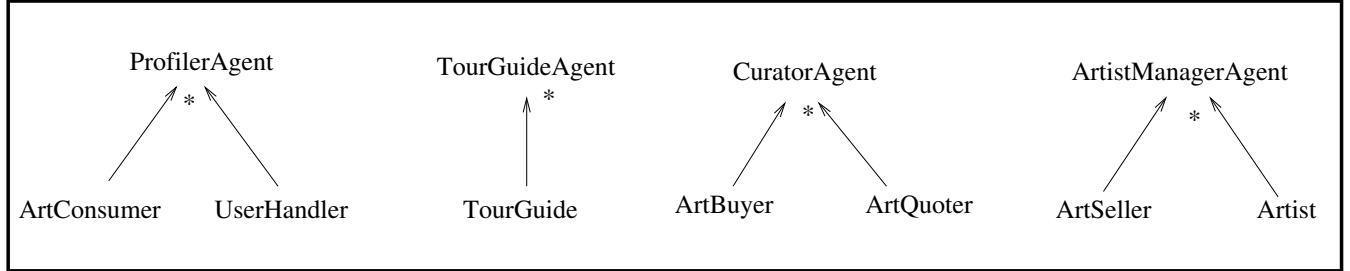


Figure 15: The agent model

II.2 Services Model

Table 1: Services model for agent PROFILERAGENT

Service	Inputs	Outputs	Pre-condition	Post-condition
obtain virtual-tour list		<i>virtualTours</i>	true	<i>virtualTours</i> \neq nil
obtain artifact list		<i>artifacts</i>	true	<i>artifacts</i> \neq nil
generate list of services	<i>virtualTours</i> , <i>artifacts</i>	<i>availableServices</i>	\exists <i>virtualTours</i> , <i>artifacts</i>	created list of available services
register as bidder for auction	<i>auctioneer</i> , <i>artifact</i>		auction exists	<i>self</i> \in <i>auctioneer.bidders</i> \wedge <i>strategy</i> \neq nil
receive CFP	<i>currentPrice</i>		is participating in the auction	true
place bid	<i>currentPrice</i>		<i>currentPrice</i> \leq <i>moneyForArtifact</i>	bid sent to auctioneer
receive bid result	<i>accept</i> \vee <i>reject</i>		have bidden	bid accepted or rejected
informed auction ended	<i>artifact</i> \vee nil		participated in auction	informed auction ended and received result
download virtual tour	<i>tourguide</i> , <i>virtualtour</i>		\exists <i>tourguide</i> , <i>virtualtour</i>	downloaded virtual tour
visitArtifact	<i>curator</i> , <i>artifactTitle</i>		<i>artifactTitle</i> \in <i>curator.gallery.titles</i>	<i>artifactTitle</i> \in <i>visitedArtifacts</i>

Table 2: Services model for agent TOURGUIDEAGENT

Service	Inputs	Outputs	Pre-condition	Post-condition
obtain artifact list		<i>artifacts</i>	true	<i>artifacts</i> \neq <i>nil</i>
manage virtual-tour request	<i>virtualTourTitle</i>	<i>virtualTour</i> \vee <i>nil</i>	true	true
manage list of virtual-tours-request		<i>virtualTours</i>	true	true
build virtual tour	<i>artifacts</i>	<i>virtualTour</i>	<i>artifacts.size</i> $>$ 0	<i>virtualTour</i> \neq <i>nil</i>

Table 3: Services model for agent ARTISTMANAGERAGENT

Service	Inputs	Outputs	Pre-condition	Post-condition
get registered bidders		<i>bidders</i>	true	true
send inform-start-of-auction	<i>bidders</i>	<i>informMessage</i>	bidders are registered	bidders informed about start of auction
send CFP	<i>bidders</i>	<i>CFP</i>	bidders are registered and auction ongoing	bidders informed about current price and encouraged to bid
receive bid	<i>bid</i>	<i>bids</i>	bidder registered	<i>bid</i> \in <i>bids</i>
manage bids	<i>bids</i>	<i>bidResponses</i>	<i>bids</i> $>$ 0	one bid was accepted and the bidder received the good, the rest was rejected and the bidders were informed
modify price	<i>reservePrice</i> , <i>rateOfReduction</i> , <i>currentPrice</i>	<i>newPrice</i>	no bids was received	<i>reservePrice</i> \leq <i>newPrice</i> \leq <i>currentPrice</i>
send inform-auction-closed	<i>bidders</i> , <i>auctionResult</i>	<i>informMessage</i>	bidders are registered	bidders informed about close of auction

Table 4: Services model for agent CURATORAGENT

Service	Inputs	Outputs	Pre-condition	Post-condition
get registered bidders		<i>bidders</i>	true	true
register as bidder for auction	<i>auctioneer, artifact</i>		auction exists is participating in the auction	$self \in auctioneer.bidders$ $strategy \neq nil$ true
receive CFP	<i>currentPrice</i>			
place bid	<i>currentPrice</i>		$currentPrice \leq moneyForArtifact$ have bidden participated in auction	bid sent to auctioneer
receive bid result informed auction ended	<i>accept \vee reject artifact \vee nil</i>			bid accepted or rejected curator were informed auction ended and received result
manage artifact-list request		<i>artifacts</i>	true	true
manage visit-artifact request	<i>artifactTitle</i>	<i>artifact</i>	true	provided artifact for visit only
quote art	<i>artifact</i>	<i>quote</i>	true	true
send inform-start-of-auction	<i>bidders</i>	<i>informMessage</i>	bidders are registered	bidders informed about start of auction
send CFP	<i>bidders</i>	<i>CFP</i>	bidders are registered and auction ongoing	bidders informed about current price and encouraged to bid
receive bid	<i>bid</i>	<i>bids</i>	bidder registered	$bid \in bids$
manage bids	<i>bids</i>	<i>bidResponses</i>	$bids > 0$	one bid was accepted and the bidder received the good, the rest was rejected and the bidders were informed
modify price	<i>reservePrice, rateOfReduction, currentPrice</i>	<i>newPrice</i>	no bids was received	$reservePrice \leq newPrice$ $newPrice \leq currentPrice$
send inform-auction-closed	<i>bidders, auctionResult</i>	<i>informMessage</i>	bidders are registered	bidders informed about close of auction

II.3 Acquaintance Model

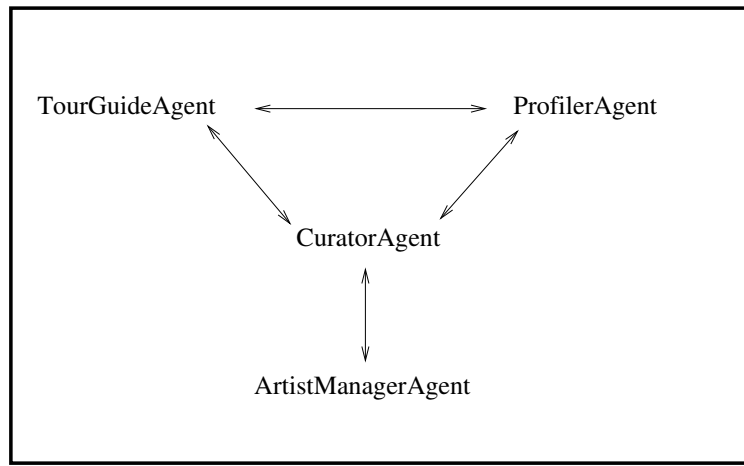


Figure 16: Acquaintance model

II.4 Mobility Model

Assumption 2-A. *I've assumed the mobile architecture that I used for homework 3, i.e that only artistmanager agents and curator agents are mobile and can clone themselves. Further more the cardinality of agents and places also follow from this assumption.*

Table 5: Place Types

Place Types	Description	Instances
Heritage Malta Container	Container where art-curators can reside and perform their services and where artistmanager agents can reside temporarily to perform auctions	1
Museo Galileo Container	Container where art-curators can reside and perform their services and where artistmanager agents can reside temporarily to perform auctions	1
ArtistManager Container	Container where artistmanager agents reside and where they come back to after performing auctions	*
ProfilerAgent Container	Container where profiler agents reside	*
TourGuideAgent Container	Container where tourguide agents reside	*

Table 6: Agents and Places Specification

Agent Type	Mobile	Place Type	Constraints
ProfilerAgent	No	ProfilerAgent Container	
TourGuideAgent	No	TourGuideAgent Container	
CuratorAgent	Yes	Museo Galileo Container, Heritage Malta Container	
ArtistManagerAgent	Yes	ArtistManagerAgentContainer, Museo Galileo Container, Heritage Malta Container	

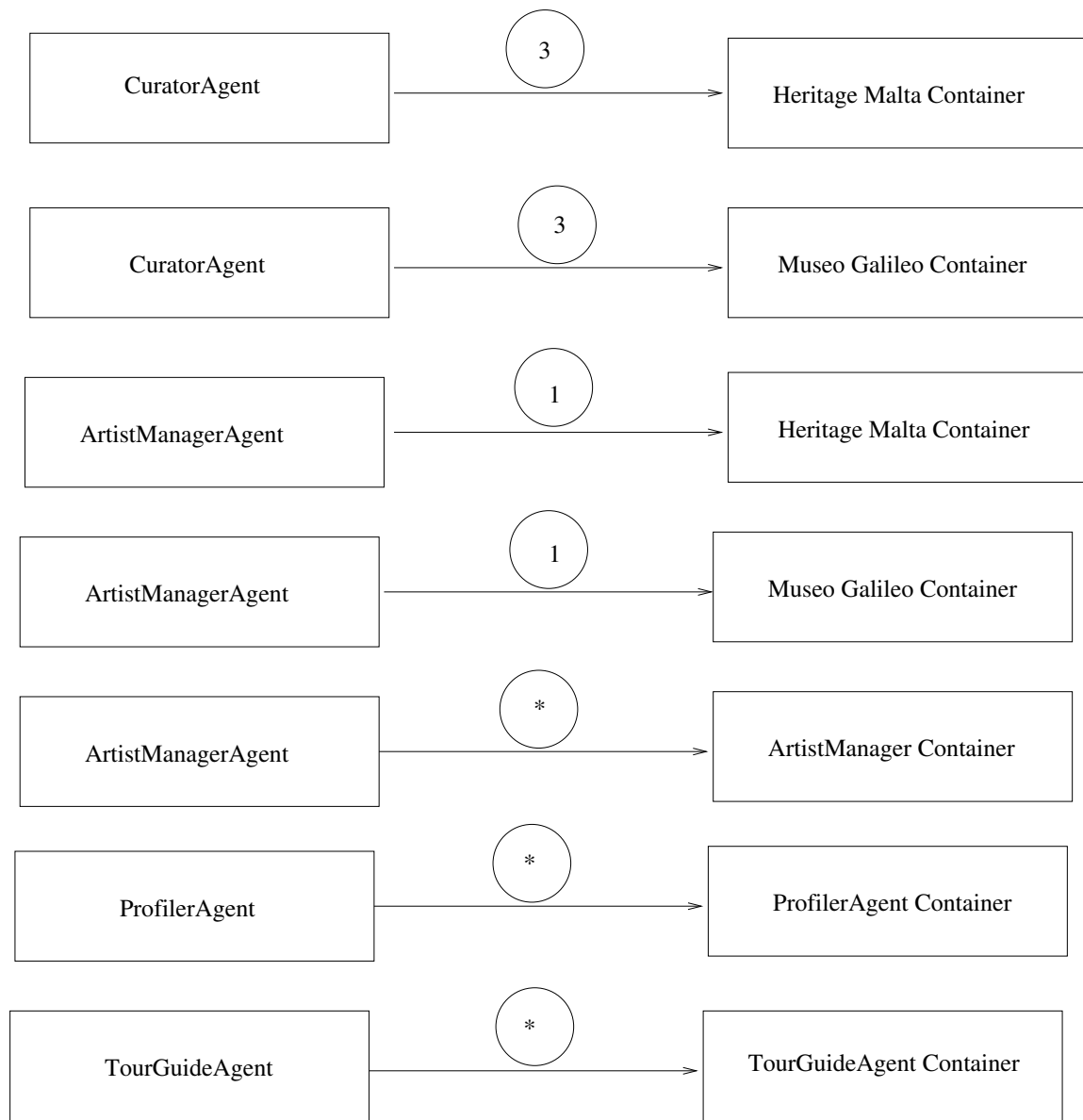


Figure 17: Cardinality of Agents and Places

Agent Type:	CURATORAGENT
Description:	Can be cloned in current container to participate in auctions.
Origin:	Heritage Malta Container or Museo Galileo Container.
Final Destination:	Same as its origin container.
List of atomic movements:	
1	Cloned in Heritage Malta Container
2	Cloned in Museo Galileo Container
Paths:	Cloned in the same container, no paths.

Figure 18: Travel schema for agentCURATORAGENT

Agent Type:	ARTISTMANAGERAGENT
Description:	Can move between Museo Galileo Container, Heritage Malta Container and ArtistManager Container.
Origin:	ArtistManager Container
Final Destination:	ArtistManager Container
List of atomic movements:	
1	Move from ArtistManager to Heritage Malta Container.
2	Move from Heritage Malta to ArtistManager Container.
3	Move from ArtistManager to Museo Galileo Container.
4	Move from Museo Galileo to ArtistManager Container.
5	Move from Museo Galileo to Heritage Malta Container.
6	Move from Heritage Malta to Museo Galileo Container.
Paths:	
1	1.2
1	3.4
1	1.6
1	3.5
1	3.5.2
1	1.6.4

Figure 19: Travel schema for agentARTISTMANAGERAGENT

Agent Type:	PROFILERAGENT
Description:	Static agent, not mobile.
Origin:	ProfilerAgentContainer
Final Destination:	ProfilerAgentContainer
List of atomic movements:	The agent is static and don't have any atomic movements.
Paths:	No paths

Figure 20: Travel schema for agentPROFILERAGENT

Agent Type:	TOURGUIDEAGENT
Description:	Static agent, not mobile.
Origin:	TourGuideAgentContainer
Final Destination:	TourGuideAgentContainer
List of atomic movements:	The agent is static and don't have any atomic movements.
Paths:	No paths

Figure 21: Travel schema for agentTOURGUIDEAGENT

III. TASK 2 - MODELING WITH AGENTUML

I. The Overall Protocol

I.1 ArtistManager Auction package

High-level overview of the protocol where ArtistManagerAgents auctions art-artifacts to Curator-Agents using dutch auctions.

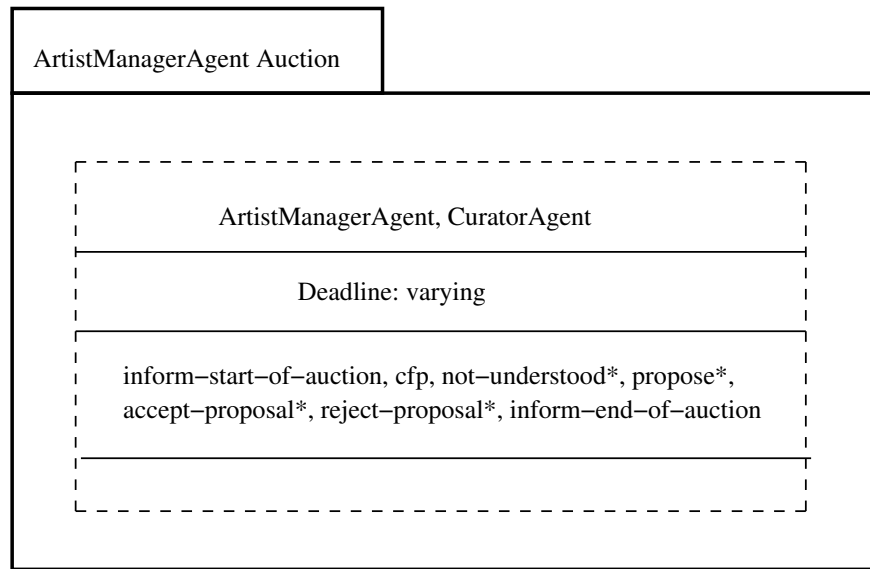


Figure 22: ArtistManager Auction package

I.2 Curator Auction package

High-level overview of the protocol where CuratorAgents auctions art-artifacts to ProfilerAgents using dutch auctions.

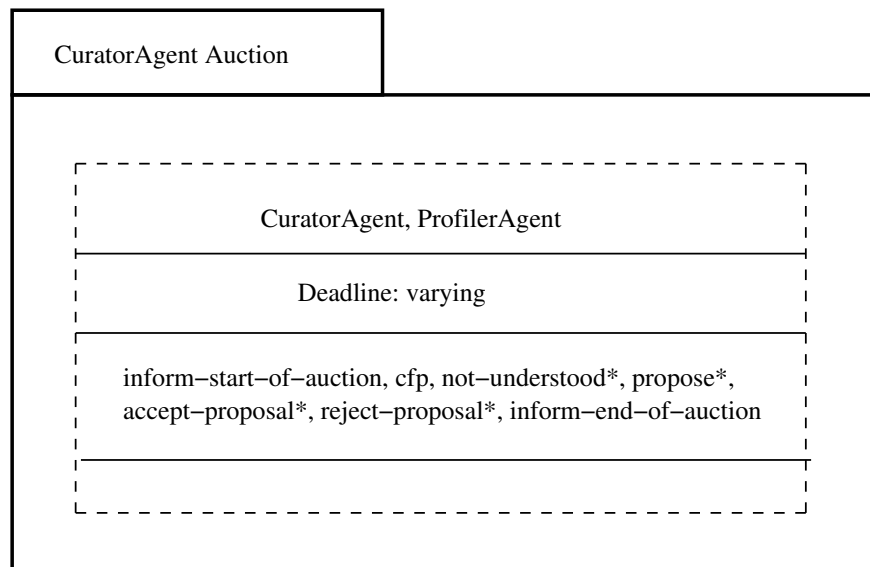


Figure 23: Curator Auction package

I.3 BuildVirtualTour package

High-level overview of the protocol where TourGuideAgents sends the terrain of artifacts at different curators and then build virtual tours of different type.

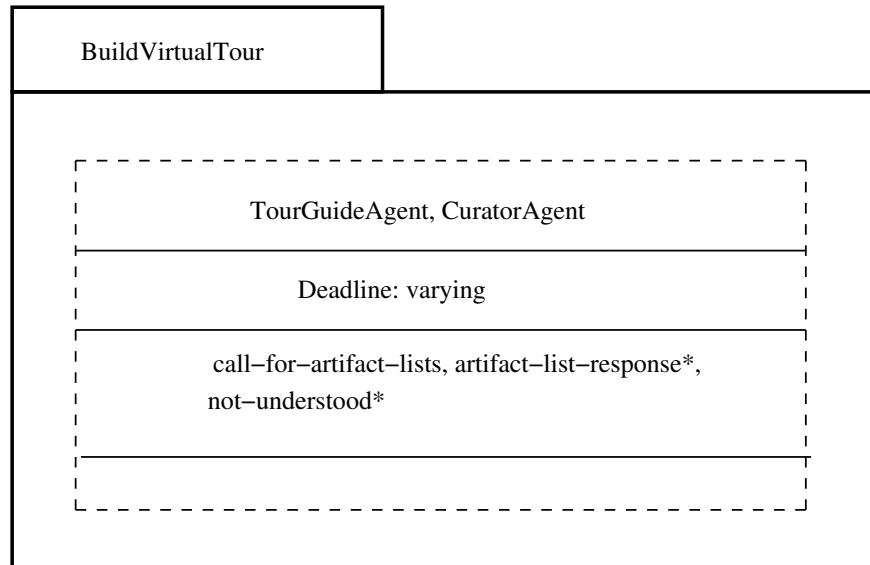


Figure 24: BuildVirtualTour package

I.4 FindVirtualTour package

High-level overview of the protocol where ProfilerAgents searches for virtual tours and rejects or selects the virtual tours.

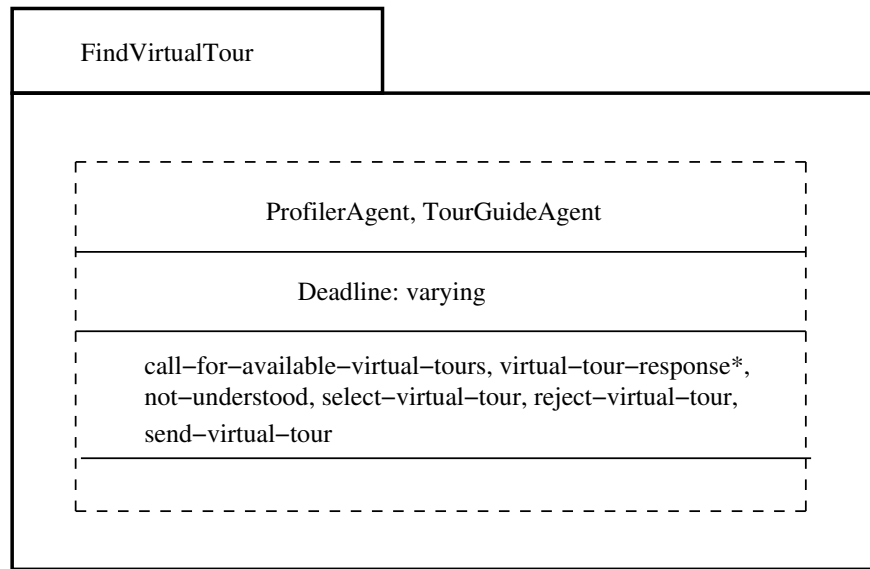


Figure 25: FindVirtualTour package

I.5 VisitArtifact package

High-level overview of the protocol where ProfilerAgents visits artifacts from a virtual tour.

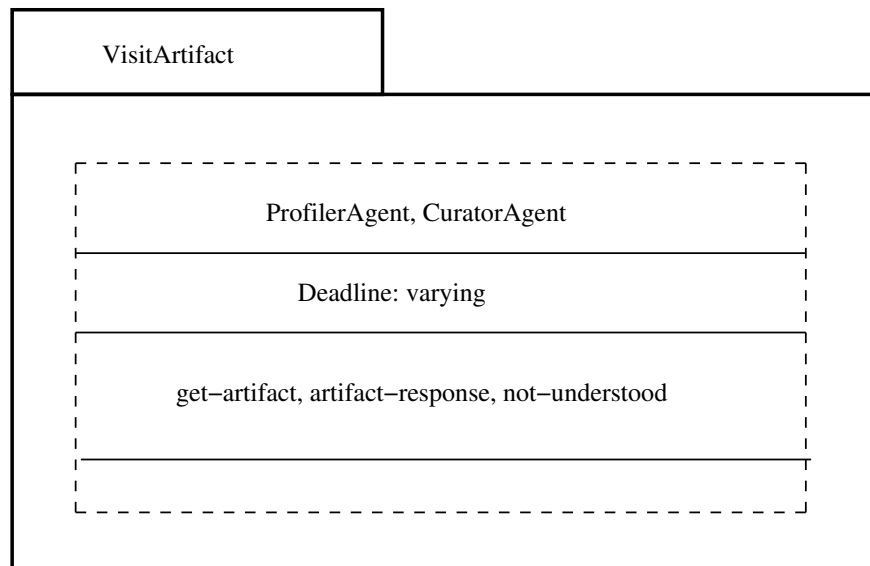


Figure 26: VisitArtifact package

II. Interactions Among Agents

II.1 ArtistManagerAgent Auction

Sequence diagram over the ArtistManagerAgent Auction protocol. When invoked the ArtistManagerAgent sends an *inform – start – of – auction* message to n number of CuratorAgents, then it sends a call for proposal with the current price, $cfp - 1$ to n CuratorAgents. CuratorAgents can then either not respond at all or respond with either *not – understood* or *propose*. The diamond and X indicates that one of the two choices, exclusive, need to be taken. The ArtistManagerAgent will then correspondingly take different action based on which response it receives. If it receives a *not – understood* response it does nothing, if it receives a *propose* response (bid) it will either reject or accept it. Finally if the ArtistManagerAgent didn't receive any bids for a certain amount of time it can either send out another *cfp* or close the auction by sending a *inform – end – of – auction* message in case the reservedPrice was reached.

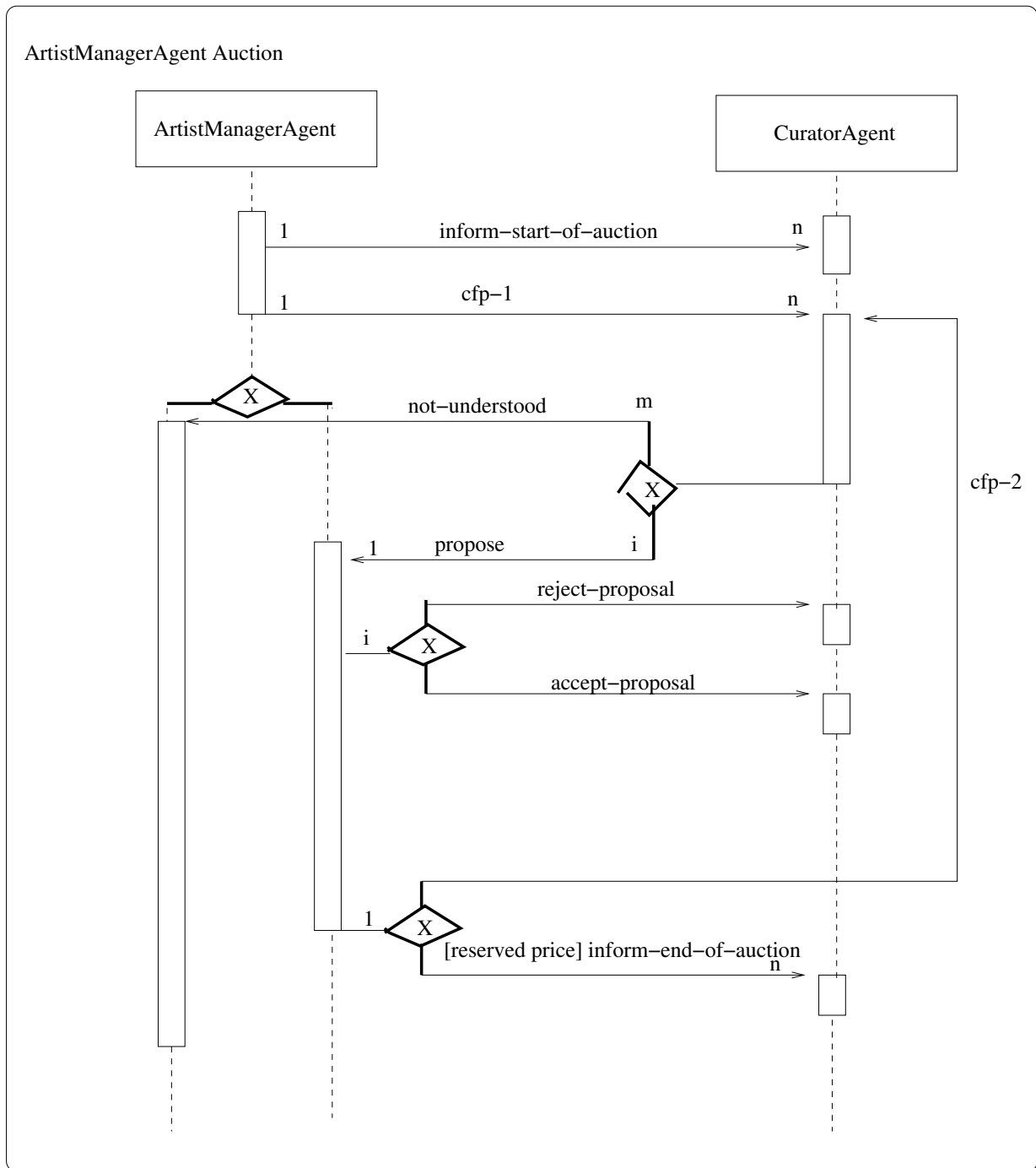


Figure 27: Sequence diagram over the interaction for ArtistManagerAgent Auction

II.2 CuratorAgent Auction

Sequence diagram over the CuratorAgent Auction protocol, this protocol follows the same dutch auction protocol as ArtistManagerAgentProtocol.

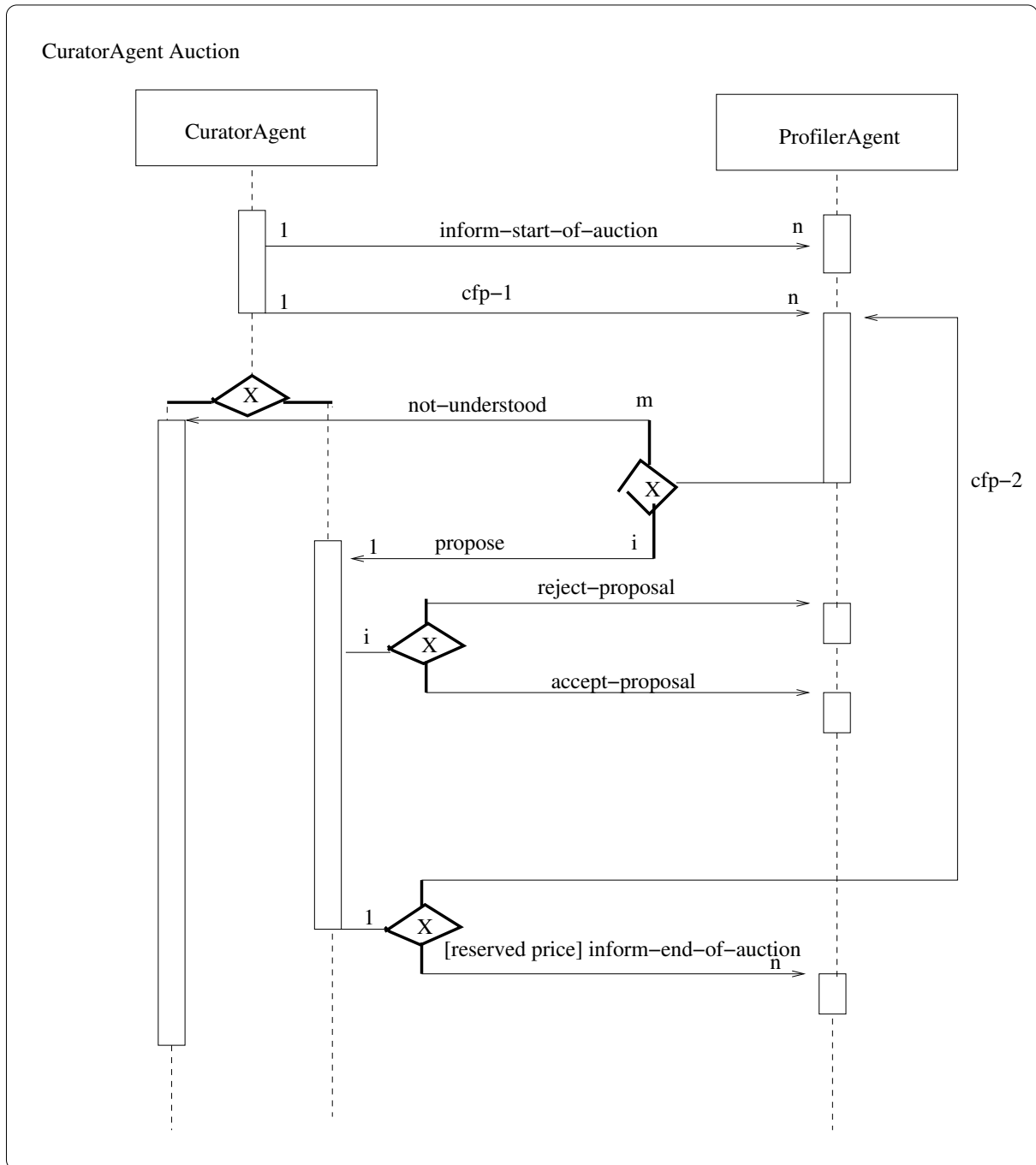


Figure 28: Sequence diagram over the interaction for CuratorAgent Auction

II.3 BuildVirtualTour

Sequence diagram over the BuildVirtualTour protocol. When invoked the TourGuideAgent sends a *call-for-artifact-lists* to n CuratorAgents. CuratorAgents can then choose to not respond or respond with either *not-understood* or *artifact-list-response*.

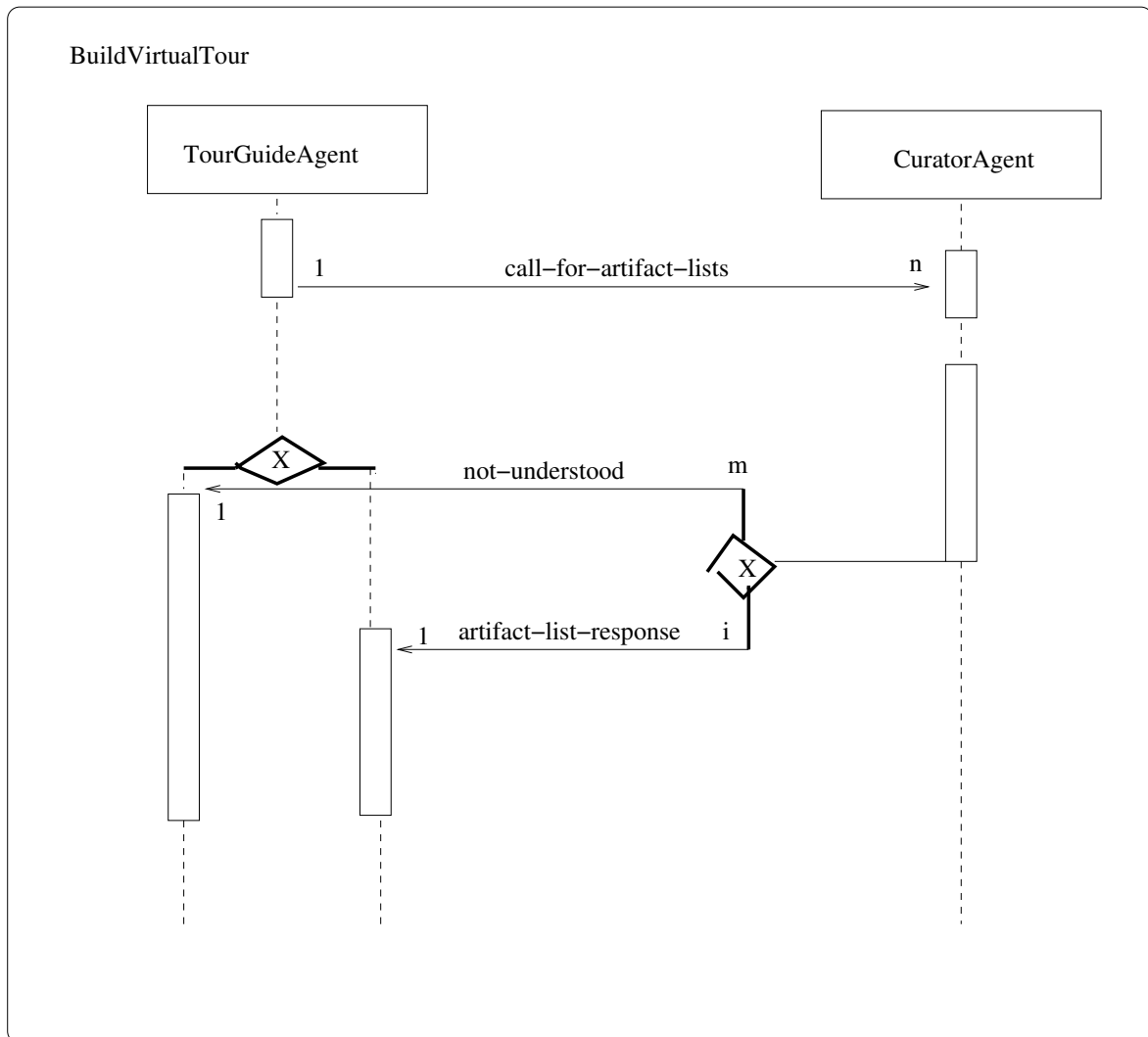


Figure 29: Sequence diagram over the interaction for BuildVirtualTour

II.4 FindVirtualTour

Sequence diagram over the FindVirtualTour protocol. When invoked the ProfilerAgent sends a *call-for-available-virtual-tours* to n TourGuideAgents. TourGuideAgents can then choose to not respond or respond with either *not-understood* or *virtual-tour-response*. If the ProfilerAgent receives a *not-understood* message it does nothing, if it receives a *virtual-tour-response* it either responds with *select-virtual-tour* upon the tourguide responds with the full

virtual-tour, or *reject – virtual – tour*.

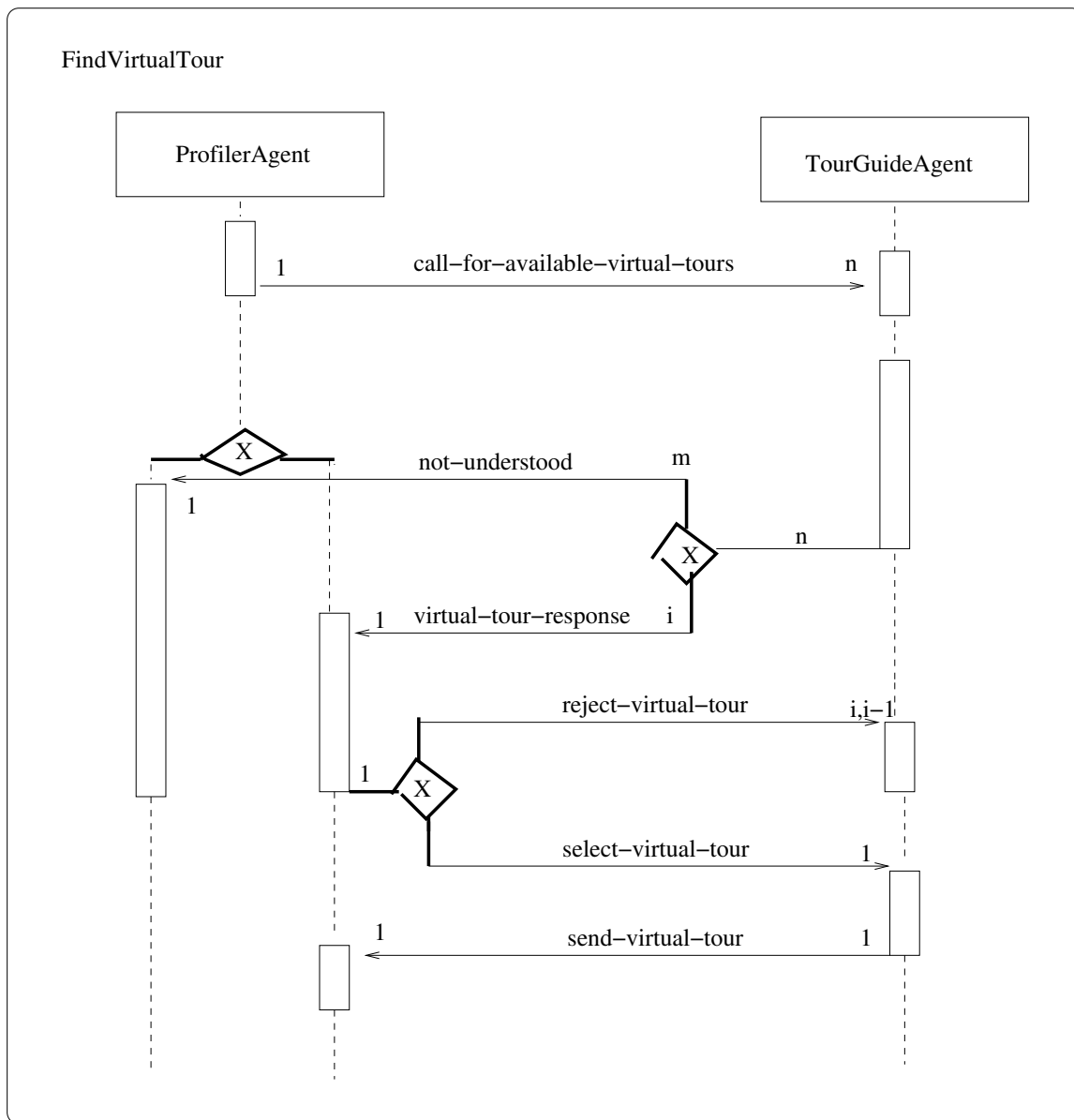


Figure 30: Sequence diagram over the interaction for FindVirtualTour

II.5 VisitArtifact

Sequence diagram over the VisitArtifact protocol. When invoked the ProfilerAgent sends a *get – artifact* message to 1 CuratorAgent. The CuratorAgent can then choose to not respond or respond with either *not – understood* or *artifact – response*.

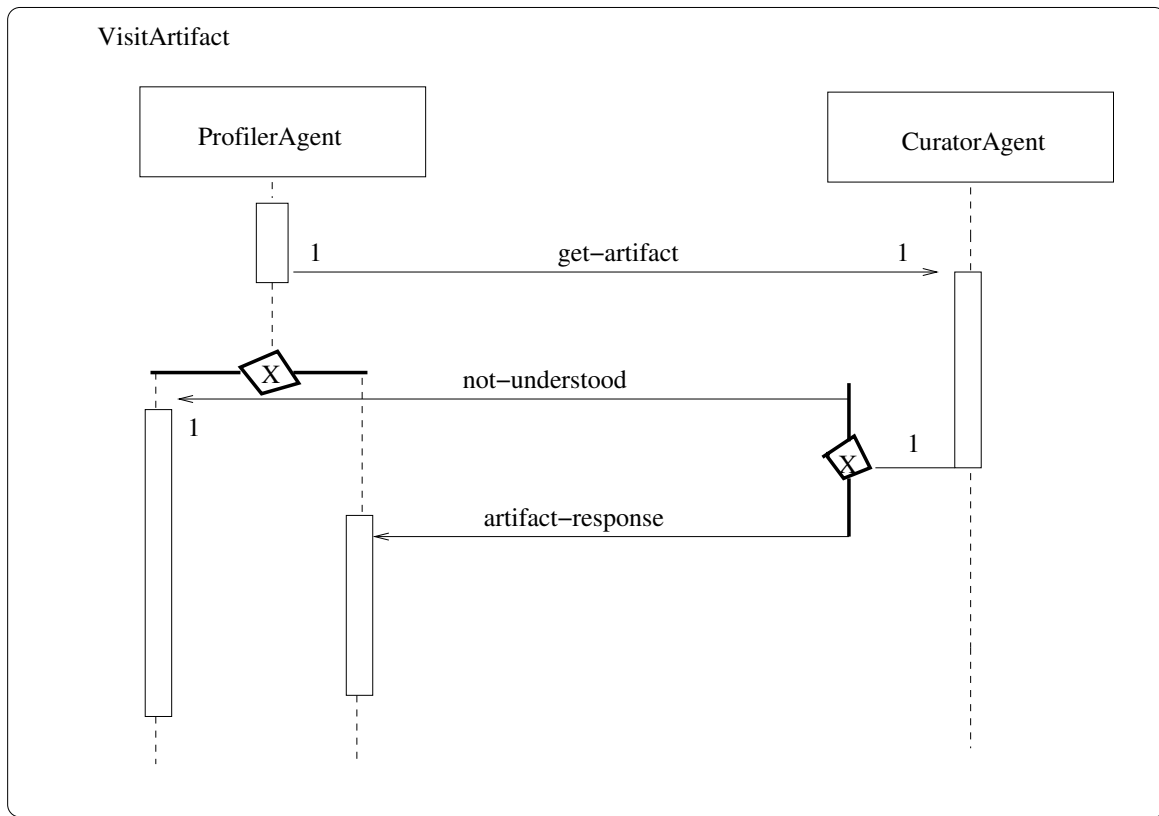


Figure 31: Sequence diagram over the interaction for VisitArtifact

III. Internal Agent Processing

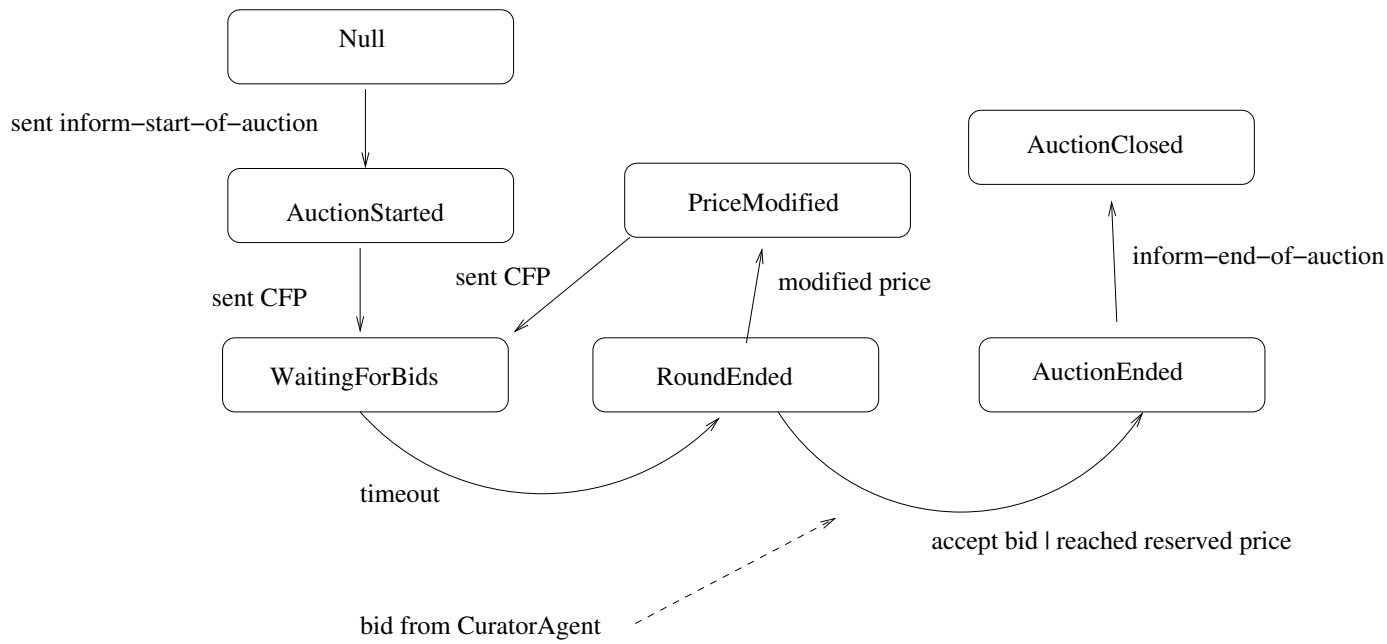


Figure 32: Statechart diagram for ArtistManagerAgent

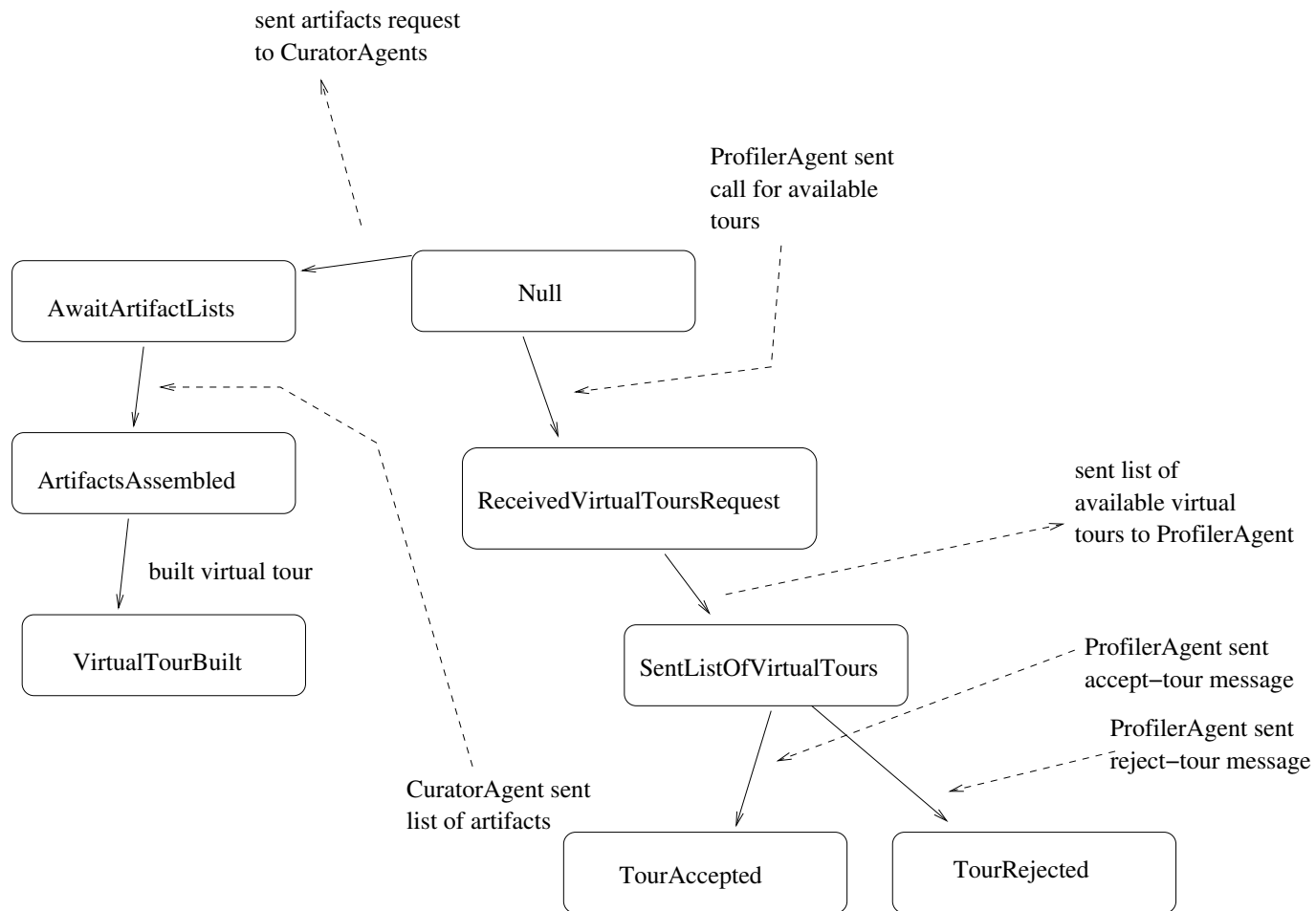


Figure 33: Statechart diagram for TourGuideAgent

REFERENCES

- [1] Michael Wooldridge, Nicholas R. Jennings, and David Kinny. The gaia methodology for agent-oriented analysis and design. *Autonomous Agents and Multi-Agent Systems*, 3(3):285–312, September 2000.