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| Role Schema: MANUFACTURER |
| Description: Manufacturer role creates products and provides products. |
| Protocols and Activities: CreateProduct, ProvideProducts, AwaitRequest |
| Permissions: **reads supplied** orderDetails //reads request for availableproducts  **geneates** productsList **//** generates list of available products |
| Responsibilities:Liveness: Manufacturer=(CreateProduct)ω||(AwaitRequest.ProvideProducts )ω Safety:  * **true** |

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| Role Schema: INVENTORY |
| Description: Inventory keeps list of available products. |
| Protocols and Activities: AvailabilityRequest, ProvideProductsAvailability, ReadProductsOrder, GetProducts, UpdateProductsList |
| Permissions: **reads supplied** productsOrder //reads products  **supplied** newProductsList //reads new products list  **changes** availableProducts //updates list of available items |
| Responsibilities:Liveness: Inventory = (AvailabilityRequest . ProvideProductsAvailability )ω ||[ReadProductsOrder.GetProducts .UpdateProductsList] ω Safety:  * infoAvailable(availableProducts) |

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| Role Schema: PRICING |
| Description: Pricing role tells a price of a selected product. |
| Protocols and Activities: ICNPResponce, checkProductAvailability, calculatePrice |
| Permissions: **reads supplied** productAvailability //checks product availabilty  **geneates** productPrice **//** generates price for a given product |
| Responsibilities:Liveness: Pricing = (checkProductAvailability. calculatePrice. ICNPResponce)ω Safety:  * productsAvailable=0→ price=null |

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| Role Schema: MONITORING |
| Description: Monitors the quantity of the products and order from manufacturers when needed. |
| Protocols and Activities: MonitorAvailability, GenerateProductOrder, RequestProducts, InformIncomingProducts |
| Permissions: **reads** availabilityLimit //the lower availability for the product  **supplied** currentAvailability //the availability that the inventory has  **generate** productOrder //the order that will be sent to manufacturer |
| Responsibilities:Liveness: Monitoring = ((MonitorAvailability . [SendOrder])ω  SendOrder = GenerateProductOrder, RequestProducts . InformIncomingProducts Safety:  * availabilityLimit < currentAvailability → productOrder = null |

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| Role Schema: YELLOWPAGES |
| Description: Accepts subscriptions of “shops”, in order to be able to provide information about the available “shops” and their location. |
| Protocols and Activities: SubsctriptionRequest, SubscribeShop, AvailableShopsRequest, AvailableShopsResponse |
| Permissions: **reads** **supplied**  shopDetails //the details of a shop that wants to subscribe  **supplied**  CustomerRequirements //the requirement for selecting shops  **update** shopsList //the availability that the inventory has  **generates** specificShopList //the shop list for this case |
| Responsibilities:Liveness: YellowPages = ((SubsctriptionRequest . SubscribeShop) ||  (AvailableShopsRequest . AvailableShopsResponse))ω Safety:  * infoAvailable(shopDetails) |

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| Role Schema: CUSTOMER |
| Description: The one that wants to buy a product, initializes the whole buy process |
| Protocols and Activities: MakeCall, GiveRequirements, ReceiveBestOffer |
| Permissions: **reads** **supplied**  result //the results for the shopping request  **generates** customerRequirements //the requirements for the request |
| Responsibilities:Liveness: Customer = (MakeCall . GiveRequirements .ReceiveBestOffer)+ Safety:  * infoAvailable(customerRequirements) * customerRequirements != null |

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| Role Schema: SHOPPINGMANAGER |
| Description: Accept the request form a client and starts the buying process by finding the possible shops and take care that the protocol will run “on” them |
| Protocols and Activities: AwaitsRequest, RequestRequirements, FindShopsDetails, InitiateShopperModules, AwaisForResponses, CalculateBestOffer, InformClient |
| Permissions: **reads** **supplied**  customerRequirements //the requirements for the request  **supplied**  shopsDetails //the details of all available shops that can be //explored  **supplied**  shoppingResults //the results from all shops  **generates** specificRequest //the specific data that it will provide to the //agents that will search for the price  **generates** bestOffer //the best offer found |
| Responsibilities:Liveness: ShoppingManager = (AwaitsRequest . RequestRequirements . FindShopsDetails . [((InitiateShopperModule)+) . ((AwaisForResponses)+) . CalculateBestOffer . InformClient])ω Safety:  * customerRequirements != null * shoppingResults != null → bestOffer != null * shopsDetails = null → bestOffer = null |

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| Role Schema: SHOPPING |
| Description: Moves to the shop place, gets the best price possible, returns back to the starting location announcing the best price found |
| Protocols and Activities: Initialize, MoveToLocation, ICNPInitiate, MoveBack, AnnounceResults |
| Permissions: **reads** **supplied**  specificRequest //the requirements for the request and //specifically the target price and location  **updates** currentLocation //the location in which it resides  currentOffer //the offer that is currently negotiating  **generates** bestOffer //the best offer found |
| Responsibilities:Liveness: Shopping = (Initialize . MoveToLocation . ICNPInitiate . MoveBack . AnnounceResults)ω Safety:  * infoAvailable(specificRequest) * currentLocation != null |

### SHOPPINGMANAGER

### RequestRequirements

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| RequestRequirements | |  |  |
| SHOPPINGMANAGER | CUSTOMER |  |  |
| Ask for the requirements of the customer | |  |  |

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| GiveRequirements | |  |  |
| CUSTOMER | SHOPPINGMANAGER |  |  |
| Provide the requirements | |  | customerRequirements |

### InitiateShopperModule

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| SelectShopper | |  |  |
| SHOPPINGMANAGER | SHOPPING |  |  |
| Select the agent that will send to a specific shop | |  | customerRequirements  shopsDetails |

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| Initialize | |  |  |
| SHOPPINGMANAGER | SHOPPING |  | specificRequest |
| Initialize the agent | |  |  |

### FindShopsDetails

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| AvailableShopsRequest | |  |  |
| SHOPPINGMANAGER | YELLOPAGES |  |  |
| Ask for the available shop agents | |  | customerRequirements |

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| AvailableShopsResponse | |  |  |
| YELLOPAGES | SHOPPINGMANAGER |  | customerRequirements  shopsList |
| Provide the available shop agents | |  | specificShopList |

### MONITORING

### MonitorAvailability

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| AvailabilityRequest | |  |  |
| MONITORING | INVENTORY |  |  |
| Ask for the availability of the product | |  |  |

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| ProvideProductsAvailability | |  |  |
| INVENTORY | MONITORING |  | availableProducts |
| Provide the availability | |  | currentAvailability |

### RequestProducts

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| AwaitRequest | |  |  |
| MONITORING | MANUFACTURER |  |  |
| Request to the manufacturer to provide products | |  | productOrder |

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| ReadProductsOrder | |  |  |
| MONITORING | INVENTORY |  | productOrder |
| Informs the inventory that it will receive products from manufacturer | |  | productsOrder |

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| GetProducts | |  |  |
| MANUFACTURER | INVENTORY |  | orderDetails |
| It sends the products | |  | newProductsList |

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| **Agent** | **Service** | **Inputs** | **Outputs** | **Pre-condition** | **Post-condition** |
| Customer Agent | Place an order | customerRequirements | result | customerRequirements != null | true |
| Shoppingmanager Agent | Accept request | null | customerRequirements | true | customerRequirements != null |
| Shoppingmanager Agent | Find available shops | customerRequirements | shopsDetails | customerRequirements != null | true |
| Shoppingmanager Agent | Promote the order | shopsDetails | shoppingResults | shopsDetails != null | true |
| Shoppingmanager Agent | Calculate the best offer | shoppingResults | bestOffer | shoppingResults != null | bestOffer != null |
| Shoppingmanager Agent | Inform the user about the result | bestOffer | null | bestOffer!= null | true |
| Shopping Agent | Prepare for negotiation | specificRequest | currentLocation, currentOffer | specificRequest != null | currentLocation != null, currentOffer != null |
| Shopping Agent | Negotiate | specificRequest | bestOffer | specificRequest != null | true |
| Shopping Agent | Finish negotiation | bestOffer | null | true | true |