

Multi-Agent Coordination - Practical Work

Trip Planner

Cyber-Physical Social Systems (CPS2 - M2)

Submitted by

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1 Introduction

In this report, we are describing the implementation of our multi-agent system for planning holidays for different tour operators, services companies, and consumers. We can understand the process of how we develop agents, which communication protocol we used to make communication between the agent, the organization implementation, and the artifacts we used to implement the project work in the following sections.

2 Components

2.1 Agents

For this MAS project, we have developed three types of agents.

1. **Tour Operator agent (toa)** This agent acts on behalf of a tour operator agency. The tour operator has several predefined holiday packages with different services and costs, to sell to the consumers. In our project, we have three agents to play the role of tour operator with names toaA, toaB and toaC. We took only one holiday package per tour operator with different services for simplification. So, every tour operator has a one-holiday package for one destination with different services and different costs.
 - (a) **toaA** For toaA, we defined a holiday package with ID "HP1", the destination is Istanbul, and operator will provide five different services with different cost for each service.
 - (b) **toaB** For toaB, we defined a holiday package with ID "HP2", the destination place is Paris, and operator will provides four different services with different costs for each service.
 - (c) **toaC** For toaC, we defined the holiday package with ID "HP3", the destination place is London, and operator will provide three different services with different costs for each service.
2. **Consumer agent (ca)** This agent acts on behalf of a consumer. The consumer agent books a holiday package offered by the tour operator agent with respect to consumer preference services, costs, and the destination place he wants to visit.
3. **Services company agent (sca)** This agent acts on behalf of a services company. Each company offers different services with different costs in different places. In our project, We have five agents to play the role of services company with names scaA, scaB, scaC, scaD, and scaE.
 - (a) **scaA** scaA will provides three different services with different costs and each service is provided in different destination places.
 - (b) **scaB** scaB will provides four different services with different costs and each service is provided in different destination places.
 - (c) **scaC** scaC will provides four different services with different costs and each service is provided in different destination places.
 - (d) **scaD** scaD will provide three different services with different costs and each service is provided in different destination places.
 - (e) **scaE** scaE will provide five different services with different costs and each each service is provided in different destination places.

2.2 Artifacts

In our project, we developed two artifacts for the environment. These are programmed and deployed in the shared environment to support the agents.

1. **Holiday Package artifact** It is used for the final delivering phase of each Service in a Holiday Package provided by the tour operator agents.
2. **Service artifact** Tour operator creates the service artifact for each (Service, Destination) provided by the tour operator and takes care of the bidding process between service agents and tour operator agents.

2.3 Organisation

In multi-agent systems Organization is used to make coordination between the agents and the workflow is defined in the organization. It aims at ensuring cooperation in the execution phase of the holiday package. The declared specifications are accessible to all the agents in the system. We used three types of specifications in the organization. We expressed each holiday package as a separate organization in our system. So it is used to coordinate the contracted scas in the delivery phase execution of services participating in the holiday package. We have three holiday packages in our project and we defined three separate organization files according to the package.

1. **Structural-specification** In this, we define the roles and groups of the system. Each agent will play one or more roles and each role is involved in the group. Depending upon the holiday package, the respective involved agents will play the roles and they will communicate with other role agents. In our organization files, in group specification tour operator will communicate(link) with services provide agents and the consumer will communicate(link) with tour operator.

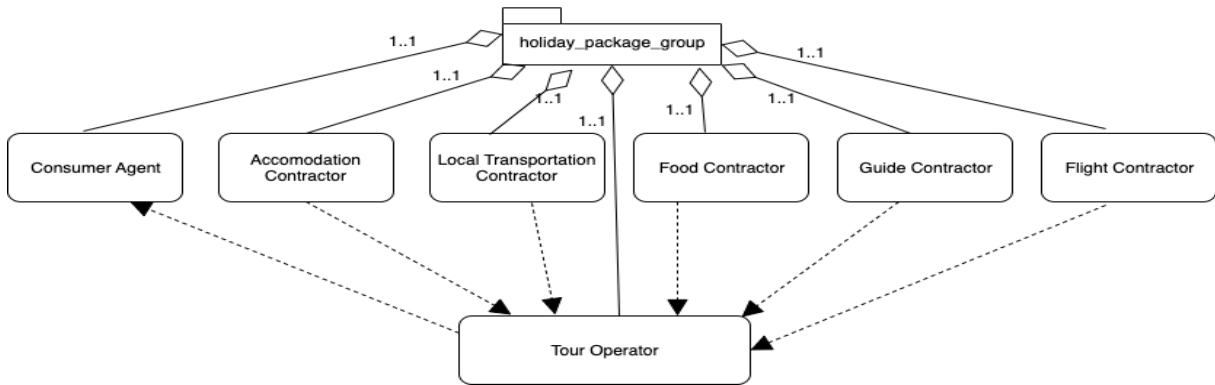


Figure 1: Structural specification of the system

2. **Functional specification** In this, we define the workflow of the system. That means missions and the goals of the agents in the system, and also the time/days to complete the mission to reach the goal. So in our system, the services provided by agents are involved in the functional specification to provide services throughout the holiday package delivery phase.
3. **Normative-specification** It is used to distribute the tasks of the workflow to the roles. It means depending upon the missions the goals(services) are assigned to the roles. Each role is related to at least one mission in the system.

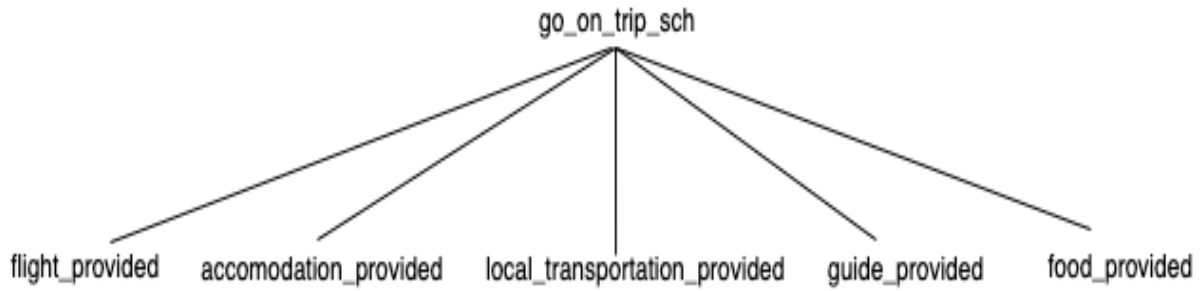


Figure 2: Functional specification of the system

3 Implementation

We have different agents to play different roles in the system. In this section we will explain the different phases we followed for making one successful holiday trip organized by the agents.

3.1 Contracting Phase

In this phase, tour operator agent and service company agent will communicates with each other.

1. **toa to sca** Tour operator creates service artifacts for each (Service, Destination) pair. All the service companies discover and join only those service artifacts based on their inventory of (Service, Destination). The service companies start bidding their bids and whichever service company has the best bid wins. the Tour operator contracts the service to the winning service company.
2. **sca to toa** While bidding, the service companies bid based on their criteria of bidding. One service company can win multiple contracts if they are providing multiple services in multiple destinations. Each service company can contract multiple services in multiple destinations.

3.2 Purchasing Phase

In this phase, the tour operator shares their external description to the customer agent(ca). The external description consists of (HPId, Destination, Budget, and Reputation) of itself. Customer agent gathers information from all the tour operators and checks if the offered price is equal to lower than it's budget or if the reputation of the tour operator agent is above "0.06". If either requirement satisfies, the customer agent sends "accepted" belief to the respective tour operator. Once the tour operator receives this belief, it proceeds to execute the Delivery phase.

3.3 Delivering Phase

In this phase, every agent will work according to their contracts. The tour operator is the main supervisor in this phase and he executes the holiday package. Once the tour operator accepted the consumer message to confirm the booking, then he executes the delivery phase. The service agent will provide the services according to the contract in that particular holiday package and the consumer involves in that holiday package to visit the places.

4 Design Specification

4.1 Interaction

We program our system to support agent-centric coordination. In this, tour operator agents send their external description to the customer agents in the purchasing phase. In the contracting phase, communication happens via the environment. The tour operator agents create artifacts in the environment that are discovered by the service agents and the bidding for the contract also happens via the environment. There is no direct communication between tour operator agents and the service agents.

5 Reference

We used the reference from the building house example provided during the course lectures. In particular, the environment-based interaction, and workspace creation were taken as inspiration for our project.