A Multi Agent Based Model for Ground Handling Management at Airports

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Overview

Introduction

- In recent year, there is increasing number of air flights as well as passengers using air transport to travel to the foreign countries.
- This increase of passenger and flight volume has generated a permanent challenge for civil aviation authorities, airlines and airports to supply sufficient capacity to provide a safe transportation service with acceptable quality standards.

Introduction

- Ground handling addresses the many services required by a transportation aircraft while it is on the ground, parked at a terminal gate or a remote position in an airport, either at arrival from a last flight or at departure for a new flight.
- This includes the processing of boarding/de-boarding passengers, baggage and freight, as well as the aircraft itself (fuelling,cleaning, sanitation, etc).

Introduction

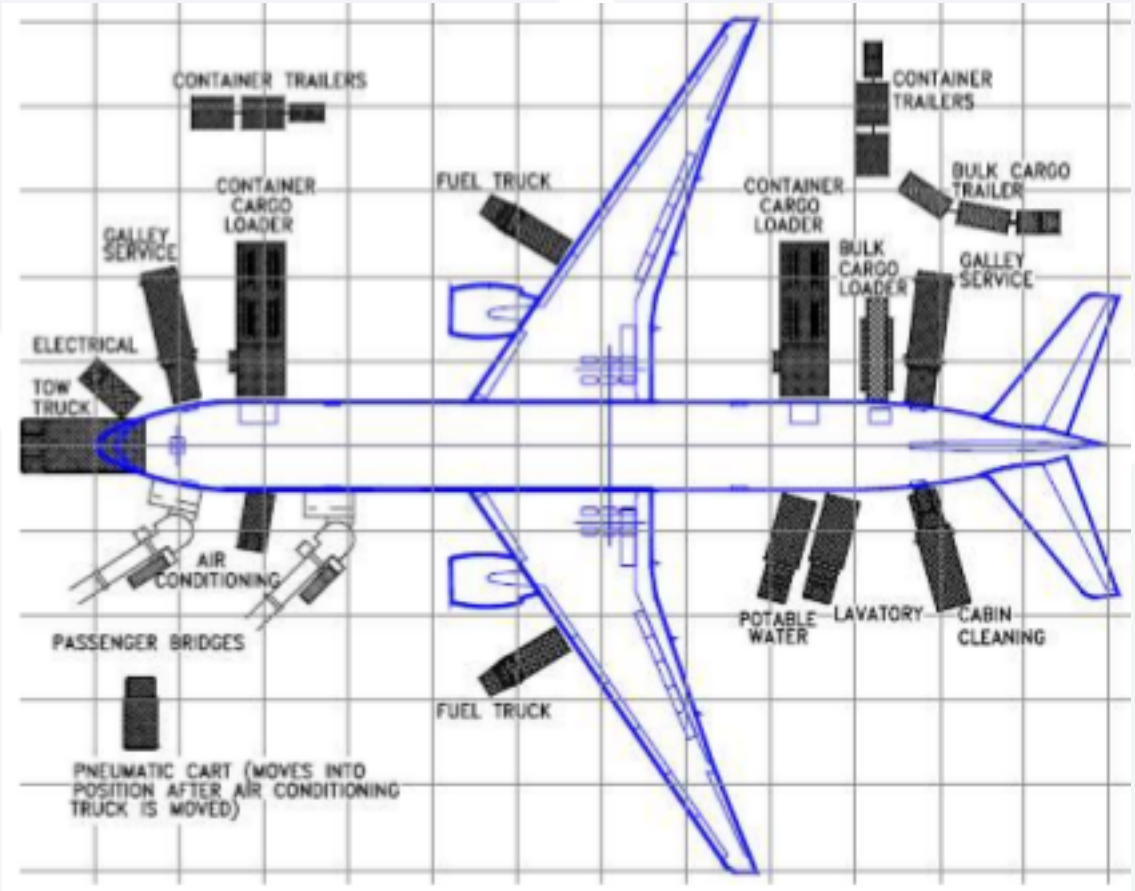

Figura: Aircraft servicing arrangement – Typical handling operations Boeing 777-300ER [Boeing, 2009]

Introduction

- In the last decade, new traffic management practices, such as A-CDM, based on multi-agent and collaborative decision making concepts have been introduced at airports.

Figura: The airport partners involved in the A-CDM [ARC, 2014]

Motivation

- The ground handling management of aircraft has not been developed specifically in the CDM approach,even if it has an important role in the fluidity of the aircraft ground movements at airports *.
- While among the overall airport operations costs, ground handling costs represent a rather small portion, their dysfunction can generate huge extra costs for airlines and airports as well as high discomfort for passengers.

Goal

Main Goal

To plan and to allocate a total number of different kinds of airport ground resources to aircraft in order to reduce the time of aircraft on ground.

Problem description

- There are total N flights need to be served and n, specific flights, $n \in N$.
- n have a estimated arrival time ETA_n and estimated departure time ETD_n.
- Considering we have 3 types of resources: Cleaning resources X, $x \in X$ where x, the number of Cleaning resources, Boarding resources Y, $y \in Y$ where y, the number of Boarding resources and Catering resources Z, $z \in Z$ where z, the number of resources.

Problem description

- T_{xn} is the service time of the Cleaning resources x for flight n, T_{yn} is the service time of the Boarding resources y for flight n, T_{zn} is the service time of the Catering resources z for flight n.

Problem description

- The objective is to plan and to allocate the total number of different kinds of Ground handling operations resources such:

$$\sum X_N + \sum Y_N + \sum Z_N$$

where

$$\sum X_N = x_1 + x_2 + ... + x_N$$
$$\sum Y_N = y_1 + y_2 + ... + y_N$$
$$\sum Z_N = z_1 + z_2 + ... + z_N$$

Methodology

- Our work proposes agent-based approach to deal with the problem.
- According to the flowchart, the environment of the model will be firstly build, including a platform for agents to communicate and interact in order to have more realistic simulation of the model.

Multi-Agent Model

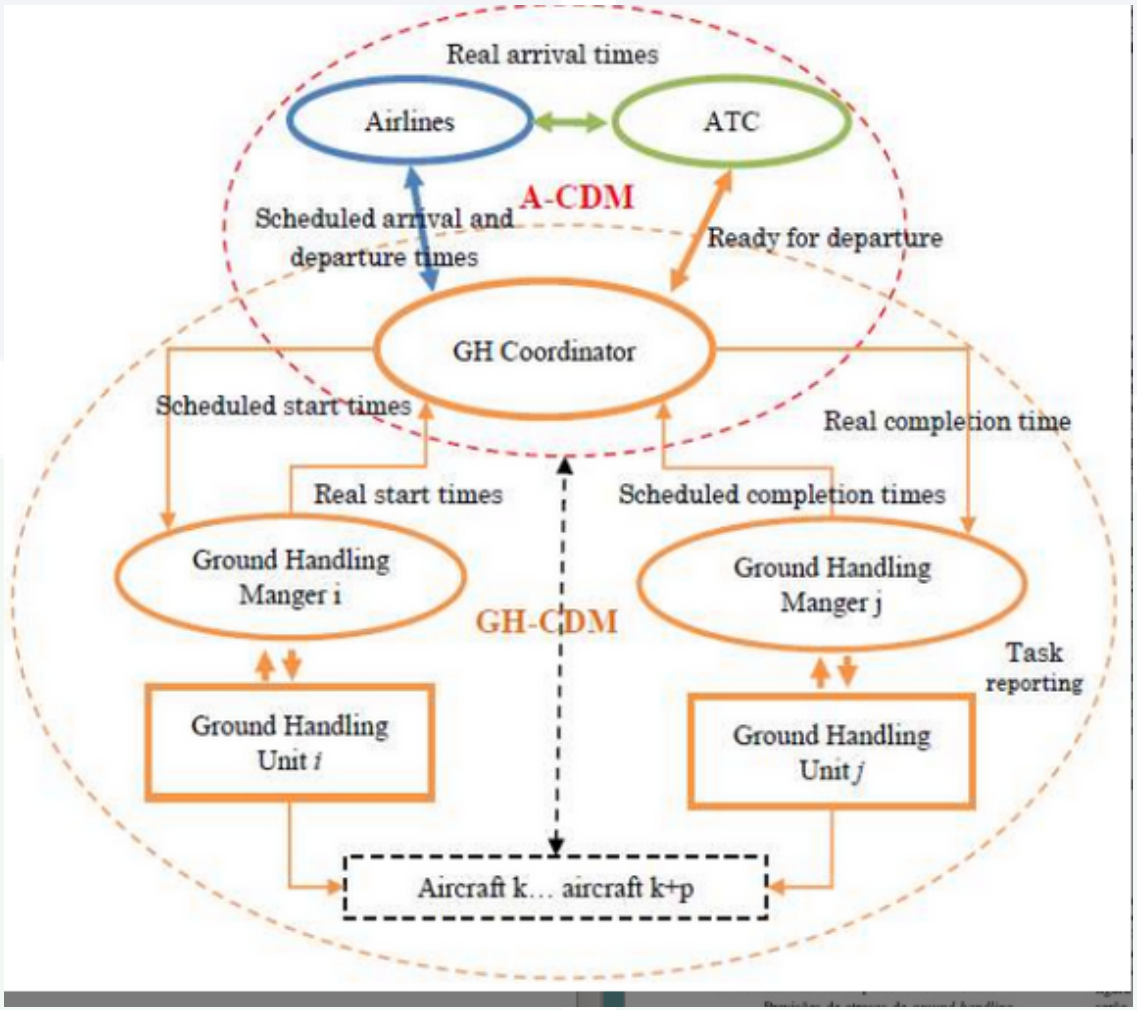

Figura: Connection of A-CDM with Ground Handling [Salma, 2015]

Pre-established sequencings of ground handling process

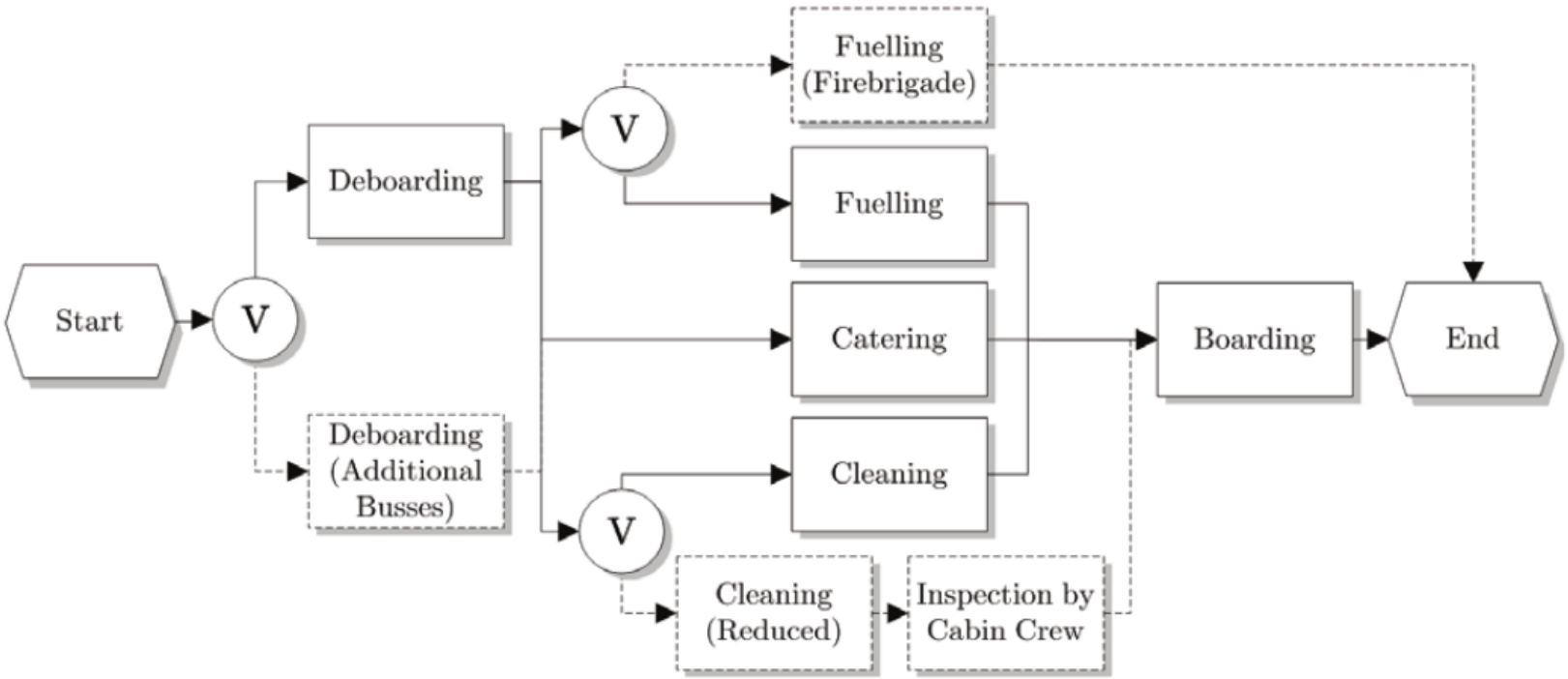

Figura: Flowchart of ground operations processes (Simplified) [Kuster and Jannach, 2006]

Model Assumptions

The followings are the assumption of the multi-agent model:

- There is no breakdown of any types of the maintenance vehicles;
- There are no accidents, weather and other external factors which affect the operation and traffic of the airport;
- Pre-emption of the services is not allowed, which the operations of services cannot be interrupted since it starts;
- All of the resources needs all of the factor, including operators, vehicles,tools and materials, in order to perform their services;
- The due times are fixed;
- All of the process times and transportation times are determinable and known in advance;

Model Assumptions

- Each maintenance resource can serve one of the aircrafts at any point of time;
- Each of the services must be successfully performed, since the service starts, the service must be finished successfully and no reprocess is needed.
- Each of the services must be performed by one maintenance resource only;
- There are no cancellation of flights;
- There is no restriction of the routing of the vehicles;
- All of the resources are identical with their same type which performance of doing the service is the same;

Model Assumptions

- All of the aircrafts are identical physically, i.e. services requirement is the same;
- All of the aircraft requires performing all of the three services, including cleaning, Boarding and Catering services before aircrafts' departure;
- The arrival pattern of aircrafts is solely based on the aircraft arrival rate. There is no variance of arrival pattern during one trial.

Agents

- There are six agents need to be set in the model in order to simulate the situations. There are the Airlines, ATC, GH coordinator, Cleaning resources, Boarding resources and Catering resources.
- In the model, the number of Cleaning resources, Boarding resources and Catering resources available for allocation is unlimited.

Implementation

- Since our system is still in development, we create only 3 agents in order to simulate the exchange of information between them. They are:
  - Airlines Agent,
  - ATC Agent,
  - GH coordinator Agent.

Implementation

- We use the JADE to implement our 3 agents.
- JADE (Java Agent DEvelopment Framework) is a software Framework fully implemented in the Java language.

Results achieved

```
INFORMAÇÕES: ---------------------------------------
Agent container Main-Container@10.0.1.24 is ready.
--------------------------------------------
Agent Airlines REGISTERED WITH THE DF
Agent GHC REGISTERED WITH THE DF
Agente GHC pede os Horários programados de Chegada e Partida de Aeronaves
Agente Airlines enviou os horários programados de Chegada e Partida de Aeronaves
GHC enviou <obrigado>
Agente Airlines respondeu <de nada>
Agent Airlines DEREGISTERED WITH THE DF
Horários programados de Chegada e Partida de Aeronaves são :

"UAE"   " 9912" "0"     "G"     "SBKP"  "GOOY"  "09/12/2014 23:16"      "10/12/2014 19:02"      "10,
"UAE"   " 9912" "0"     "G"     "SBKP"  "GOOY"  "02/12/2014 23:16"      "02/12/2014 18:22"      "03,
"UAE"   " 9912" "0"     "G"     "SBKP"  "GOOY"  "16/12/2014 23:16"      "17/12/2014 18:16"      "17,
"RIO"   " 5973" "0"     "L"     "SBGR"  "SBSV"  "18/12/2014 03:20"      "18/12/2014 03:38"      "18,
"RIO"   " 5973" "0"     "L"     "SBGR"  "SBSV"  "20/12/2014 03:20"      "20/12/2014 03:40"      "20,
"AZU"   " 2505" "0"     "N"     "SBSM"  "SBPA"  "30/12/2014 05:10"      "30/12/2014 04:55"      "30,
"AZU"   " 2505" "0"     "N"     "SBSM"  "SBPA"  "19/12/2014 05:10"      "19/12/2014 04:57"      "19,
"AZU"   " 2799" "0"     "N"     "SBSG"  "SBCF"  "29/12/2014 03:00"      "29/12/2014 02:46"      "29,
"AZU"   " 2799" "0"     "N"     "SBSG"  "SBCF"  "05/12/2014 03:00"      "05/12/2014 02:47"      "05,
"RIO"   " 5973" "0"     "L"     "SBGR"  "SBSV"  "03/12/2014 03:20"      "03/12/2014 04:18"      "03,
"RIO"   " 5973" "0"     "L"     "SBGR"  "SBSV"  "24/12/2014 03:20"      "24/12/2014 04:19"      "24,
"RIO"   " 5973" "0"     "L"     "SBGR"  "SBSV"  "04/12/2014 03:20"      "04/12/2014 04:07"      "04,

Agent GHC DEREGISTERED WITH THE DF
Agente ATC é lançado
Agente ATC foi gravado no DF (Directory Facilitator)
Agente ATC terminou e foi deletado do DF (Directory Facilitator)
```

Figura: Exchange of information between Airlines and GH coordinator Agents

Results achieved

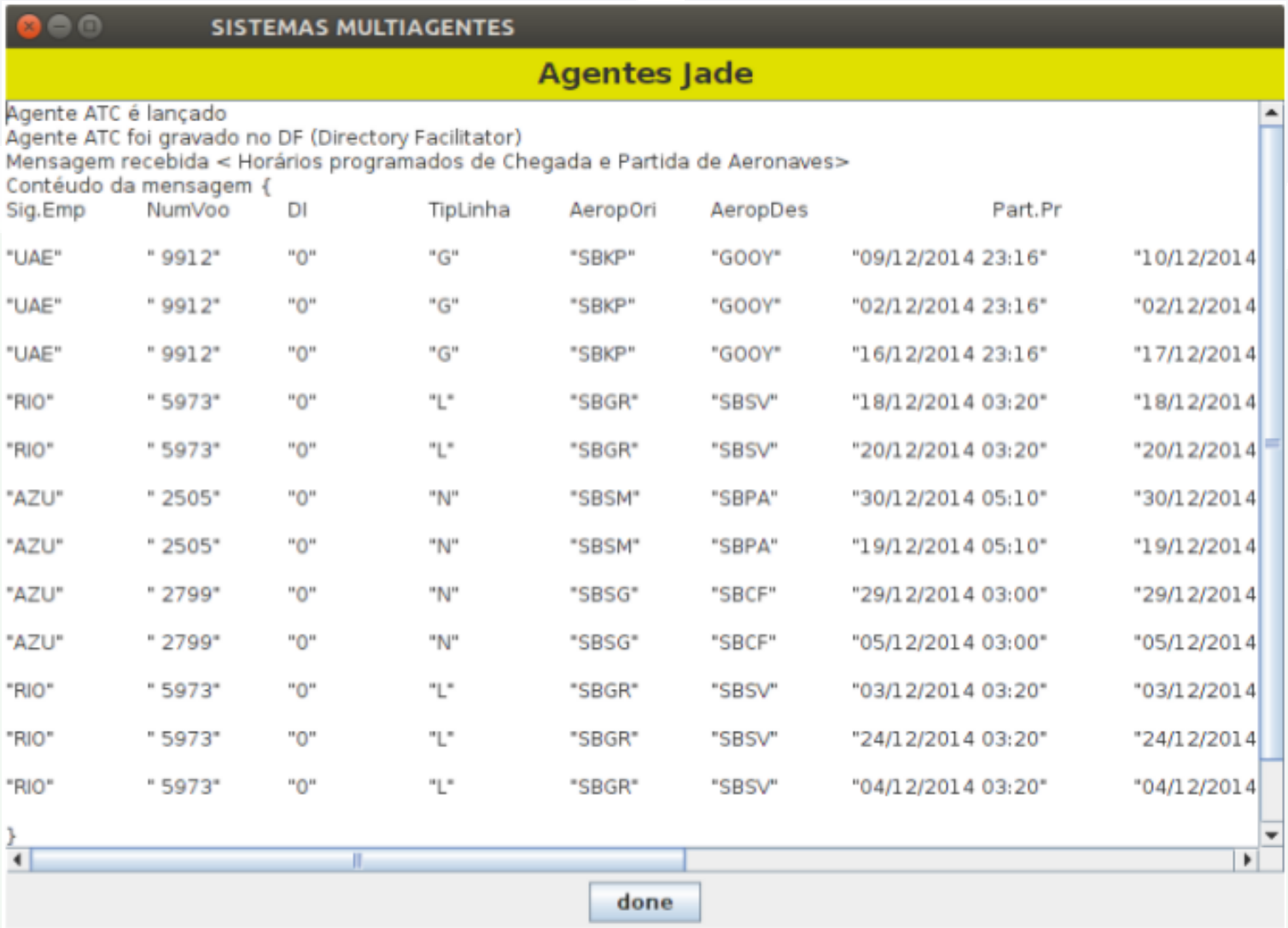

Figura: Graphic interface printing times

Future works

- It will be done an inspection to see how the Ground Handling operations works in the Brasilia airport
- It will be added to other agents that represent the tasks (or operations) of Ground Handling.
- It will create a global modeling of all agents and implements them in Jade.
- It will be used on automated planning concept to allocate Ground Handling resources to aircrafts.

Conclusions

- Aviation is one of the most important industries in the world.
- In order to meet the increasing demand, the ground service efficiency must be increased in order to reduce the ground time in airport in any day.
- A multi-agent model has been built.
- Some agents are designed according to the architecture and also the agents' communications has also being built.

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