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Crew Recovering from Airline Operational Problems

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***Abstract*— Airline companies do not collaborate when dealing with problems that arise during their own operational control plan. The Airline Operations Control Centre (AOCC) tries to solve unexpected problems during the airline operation. An airline schedule very rarely operates as planned. Aircrafts, crew members and passengers are common actions towards the solution of these problems are usually known as operations recovery or disruption management. This paper presents the implementation of a crew recovery agent that represents as an AOCC. This paper applies that the software agent implement heuristic solutions based in operations research mathematic models of artificial intelligence algorithms. This system can support to find the best solution of the crew event. It can serve the possibility of having a "kind of electronic market" for available crew members among airlines companies. This system is developed by JADE (Java Agent Development Framework).**

***Index Terms*— Airline Operations Control Centre, Crew recovery agent, Multi-criteria algorithm**

I. Introduction

One of the most important concerns in an airline company is the Operations Control. The airline company monitors all the flights checking if they follow the schedule that was previously defined by other areas of the company. Those problems are related with crew members (for example, a crew member that did not report for duty), aircrafts (for example, a malfunction or a delay due to bad weather) and passengers. The Airline Operations Control Centre (AOCC) is composed by teams of people specialized in solving the above problems under the supervision of an operation control manager. Each team has a specific goal (for example, to guarantee that each flight has the necessary crew members) contributing to the common and general goal of having the airline operation running with few problems as possible [1].

The problems are related with aircrafts (for example, a malfunction or a delay due to bad weather) .Airline disruptions management, the current (almost) mode of the first prototype of a multiple resource decision support system.

Nowadays, each airline company tries to solve the operations recovery problems (Castro and Oliveira, 2005) with their own resources. If they have an OPEN position for a specific type of crew in a flight, they try to find a suitable one from their own staff. The same happens with aircrafts. The companies always try to find a solution using their own aircrafts. Sometimes, airline companies have to rent aircrafts and their crews from other companies to solve the problem. Airline companies rent aircrafts and crew members when needed, but through a direct contact with charter airline companies. To use only crew members (without being part of the aircraft) from other companies it is not a usual practice.

In crew recovery system, it is details and subdivides the recovery problem into four categories: misplacement problems, rest problems, duty problems, and unassigned problems. This crew recovery agent deals with operational base and for the type of operation problems it has several specialized software agents that implements heuristic solutions and other solutions based in operations research mathematic models and artificial intelligence algorithms [2].

In this system, we approach this problem so that it can be solved by a crew recovery agent that represents the Operational Control Center of the airline company, use specialized JADE agents. This system can present the specialized agents of computer to find the best solution for crew recovery problem of airline operation and show that crew recovery agent of Airline Operations Control Center (AOCC) possible to find valid solutions in less time and with a smaller cost for crew recovery problem. This system implements the crew recovery problem of an airline company.

II. Recovery approach

The goal of this section is to present a brief comparative summary of recovery approach. We also classify each work according to the dimensions they are able to deal with, that is, integrated recovery, crew recovery and general steps of crew recovery agent.

A. Integrated recovery approach

Airline disruption management the current (almost manual) mode of dealing with recovery is presented. They also present the results of the first prototype of a multiple resource decision support system. The proposed model addresses each aircraft type as a single problem. They formulate the problem as a Set Partitioning master problem and a route generating procedure. The main reason for this is the fact that the passenger problems can be minimized if we solve the aircraft and crew problems [8].

B. Crew recovery approach

AOCC (Airline Operations Control Center), with the current tools are available, to find the solutions. The user uses software that shows the roster of each crew member in a Gantt chart for a specific period. The user can scroll down the information, filter according to the crew rank and base, and sort the information by name, month duty, etc. Far less work is published on the crew recovery problem. The problem is far more complex due to the number of cabin crew and more complex rules and regulations for crew. [9]

All flight is covered at a minimum cost while minimizing the disturbances of crew number. Based on the detailed information regarding the current plan and pool of problems, the recovery problem is solved in steps. Several means are used for recovery, including delaying, swapping, deadheading (extra crew) and the use of standby crew. The crew recovery actor has the main objectives of ensuring that every flight has all the necessary crew members to operate. For the actor *Crew Recovery* the goal *ensures every flight* as a crew is decomposed into *monitor's roster* and *assigns crew members* to *open flights*. These two goals must be achieved so that *ensures every flight* has crew will be fulfilled [3].

Goal decomposition can be closed through a means-end analysis with the objective of identifying plans, resources and soft goals that provides means to achieve the goals. Far less work is published on the crew recovery problem. The problem is far more complex due to cabin crew and the more complex rules and regulations for crew. The model repairs broken pairings and assigns crew to flights that are not covered. It is assumed that crew is only licensed to one aircraft type [9].

The system [6] is able to present the controller with multiple different solutions. To solve the crew recovery problem and all flights are covered at a minimum cost while minimizing the disturbances of crew members. This is done by solving the crew pairing and crew assignment problems simultaneously denoted the "personal pairing" problem. Disrupted pairings and some additional pairings are dissolved and personal pairing problems are solved using the flight legs of the dissolved pairings. As this is done within a tight time frame the problem size is smaller than the original pairing and assignment problems. In a preprocessing step a subset of crew schedules are extracted for rescheduling [6].

C. General steps of crew recovery agent

Each user has a specific way of trying to find the solutions. However, we have observed that, in general, they follow these steps:

1) First:

Open the roster for a one month period, starting two days before the current day.

2) Second:

Filter the roster by crew rank and base, where the base is equal to the base where the crew event happened and crew rank is equal to the crew member that did not report for duty.

3) Third:

Visually, they scroll down the information until they found a crew member with an open space for the period of time that corresponds to the duty to be assigned. This period of time takes into consideration the start and end time of the duty and also the time required for resting (ready date time).

4) Fourth:

If they do not found a crew member in the base specified, they try to find it in another base, filtering the information accordingly.

5) Fifth:

They assign the duty to the first crew member they found [1].

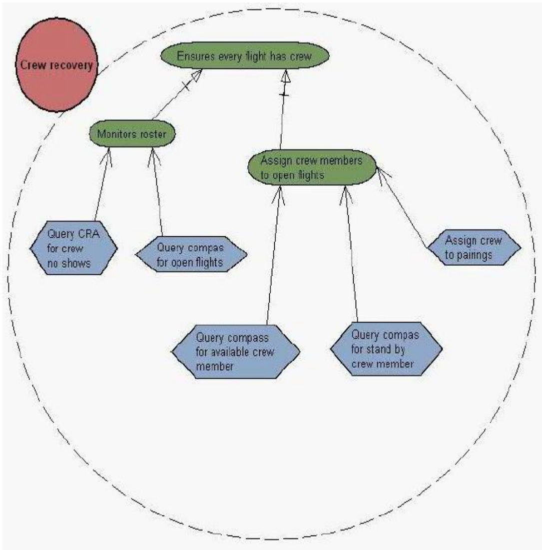

Figure 1 Crew recovery goal diagram

III. Materials and Methods

In this paper, we apply the Crew Recovery problem for an airline company. Traditionally, the aircraft crew scheduling problem and the recovery problem are approached using OR methods and tools. In the flight crew recovery problem for an airline with a hub-and spoke (a system of air transportation in which local airports offers air transportation to a central airport where longdistance flights are available) network structure is addressed.

The crew recovery system is solved in steps. Several means are used for, including delaying, swapping, dead heading (extra crew) and the stand by crew. The agent class *OpMonitor* is responsible for monitoring any crew events, for example, crew members that did not report for duty or duties with open positions, that is, without any crew member assigned to a specific role on board (e.g., captain or flight attendant). When an event is detected, the service *MonitorCrewEvents* will initiate the protocol *Informcrew-event* (FIPA Request) informing the *OpCrewFind* agent. The message will include the information necessary to characterize the event. This information is passed as a serializable object of the type *Crew Event*. In figure 2 shows the overview of crew recovery agent, it can be find the crew event condition and that is related with aircraft recovery problem. That diagram is especially need for the crew recovery system of the airline operation [3].

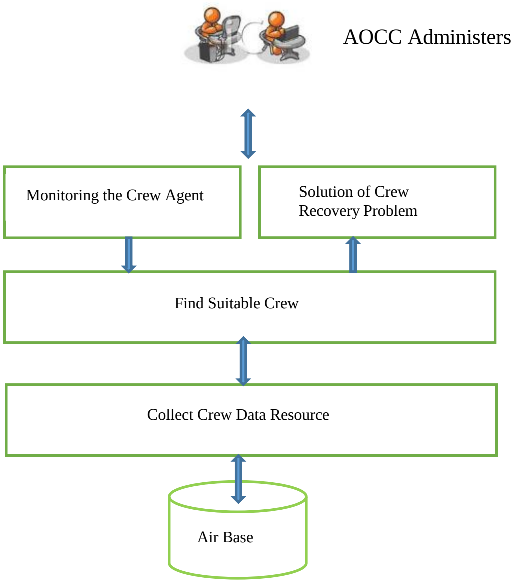

Figure 2 Overview of crew recovery agent

The *OpCrewFind* agent collects all the proposals received and chooses the best one according to the following algorithm. It is implemented in the service *SendCrewSolution* and produces a list ordered by the cost (a multi-criteria cost) that each solution represents.

MULTI-CRITERIA ALGORITHM

```
foreach item in CrewSolution list
  totalDuty = monthDuty+credMins
  if (totalDuty-dutyLimit) > 0
     credDuty = totalDuty-dutyLimit
  else
     credDuty = 0
  end if
  perdiemDays = (endDateTime-dutyDateTime
  perdiemPay = perdiemDays*perdiemValue
  dutyPay = credDuty*(hourSalaryValue/60)
  cost = (dutyPay+perdiemPay)*baseFactor
end foreach
order all items by cost desc
select first item on the list
```

IV. DISCUSSION AND IMPLEMENTATION

We approach the system, when a crew member is event that system will be finding the suitable crew in order to AOCC administrator. To use this system, user input the flight schedule and crew data to the data entry following the figure 3.

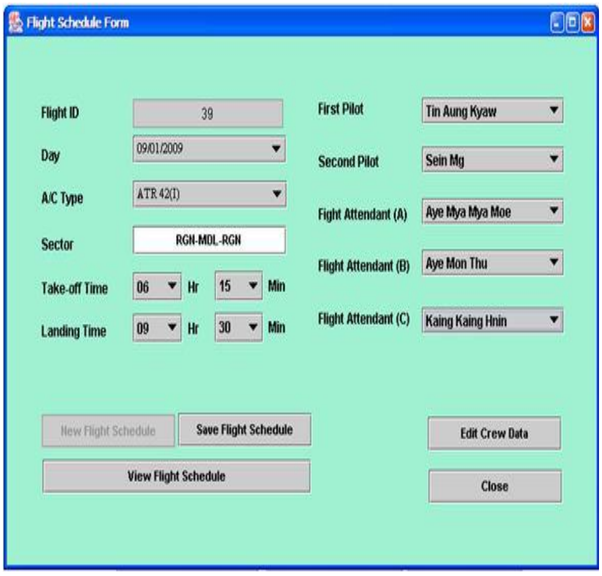

Figure 3 Data entry system for flight schedule

If a crew is event for open flight, administrator can type the event crew data over the monitoring as the following figure 4.

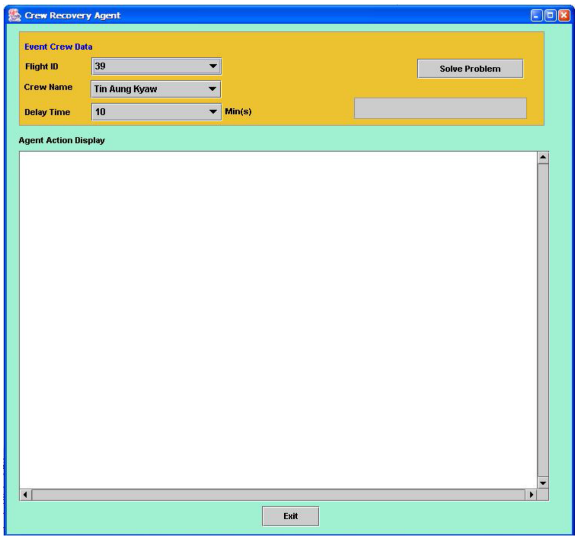

Figure 4 Crew recovery agent

To solve the problem, user use the solve problem item. The crew recovery agent fined the suitable crew by the Multi-criteria algorithm and creates in the JADE agent. After the system solution by algorithm and found the suitable crew from the air database, it shows the results to monitoring that are as following figure 5.

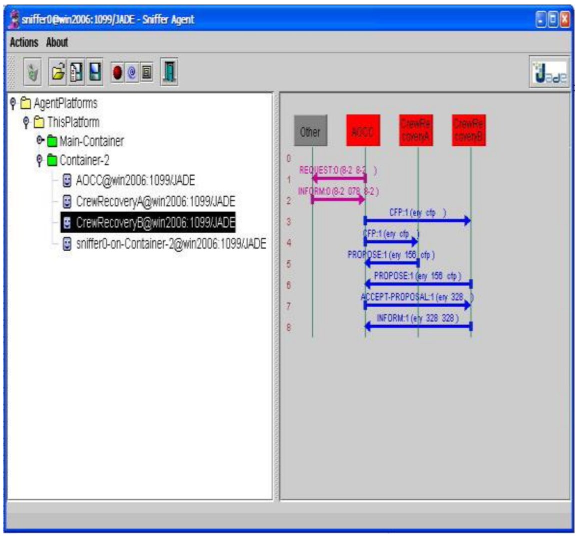

Figure 5 Create the suitable crew

The system chooses the suitable crew and shows that crew over the monitoring. To obtain suitable crew, we use the system in JADE Agent. The final result can see in the figure 6.

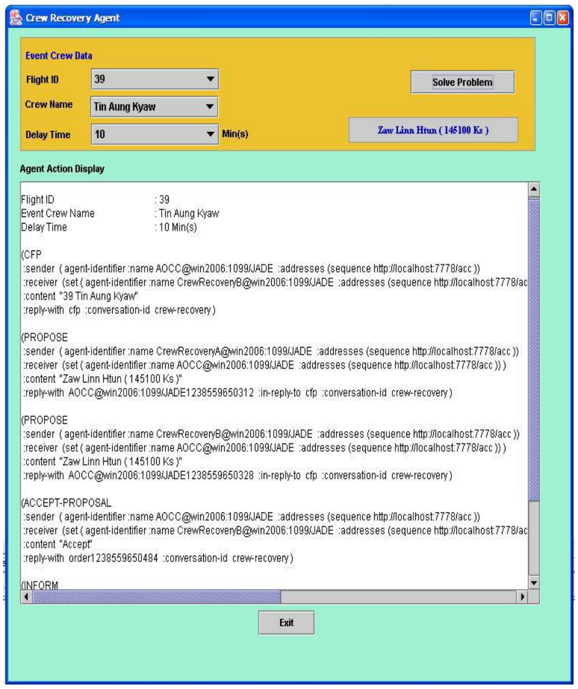

Figure 6 the final result of the system

V. Conclusion

From that implementations we can see that our agent with develop JADE obtains valid solutions faster and with less cost. This paper has presented to solve crew recovery problems. A simple example was presented step-by-step. Manages the resource crew. Monitors the crew check-in and check-out, updates and changes the crew roster according to the disruptions that might appear during the operation. Regarding crew recovery problems, we predict that if we take into account payroll information like hour salary and periderm value of each crew rank, and costs related with hotels and extra-crew travel at the operational base, the solution will be less expensive. In addition, this paper supports the user how to make decision making. In this case study, taken from real data in an airline company. We have shown that our system produces faster and less expensive solution.

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