Novel Negotiation Protocol to support CDM Process in a Layered ATM System

GRUPO DE INVESTIGACIÓN DE NAVEGACIÓN AÉREA

L.K Asante, F.J Sáez Nieto & E. Garcia

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Introduction

If an RBT is available and seen by all, it will be possible to conceive a different operating method than the current ATM system. Exchange of information will involve new actors (human or automatic) and trajectory services providers or a network. It is recognized that trajectory services and actors [1] will have varying time horizons and varying accuracy requirements.

However there is a need to describe in more detail the 'mechanisms' by which actors (ATC, Network Management, Flight Crew and Airline Operation Centre) will negotiate revisions to the RBT.

For example, an actor (possibly a sector controller or any actor with a wider scope in terms of look-ahead or area of responsibility) with the assistance of appropriate tools can monitor an assigned set of indicators. The goal of this process is as in the current situation: to identify issues or hotspots that need to be analysed. The major change in the new ATM model is that a new task will take place, the negotiation between actors, before an action can be implemented (**Figure 1**).

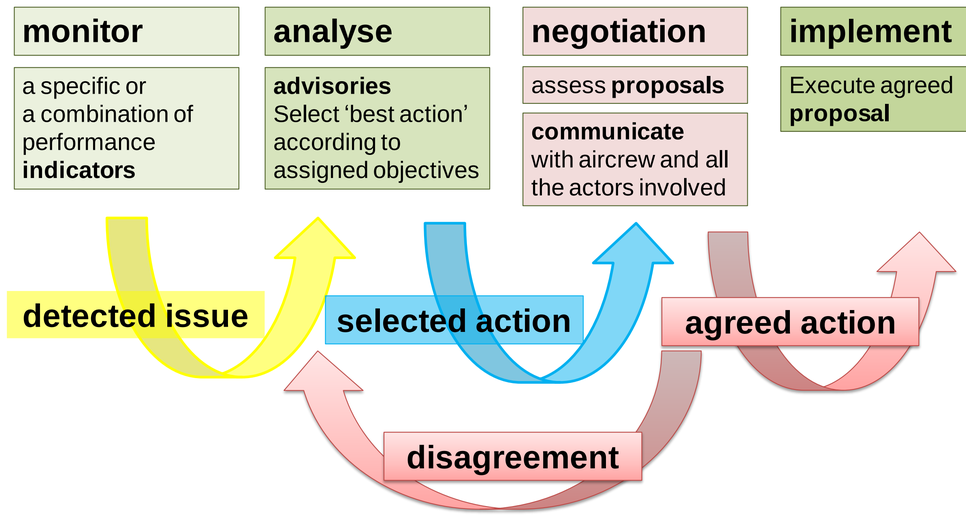

Figure 1: ATC Tasks in the New ATM Model

NEGOTIATION IN A LAYERED ATM MODEL

The objective of the research is to develop a goal-oriented negotiation model to support multiple issues and actors in an ATM environment. A proposed collaborative negotiation process is presented in **Figure 2**.

Figure 2: Negotiation Process

When building autonomous negotiation agents which are capable of flexible and sophisticated negotiation three broad areas are considered:

- **Negotiation protocols**– these are the rules which govern the interaction i.e. the structured communication module for sending, and receiving proposals and informing about acceptance and rejection of proposal.
- **Negotiation issues** - the range of issues over which agreement must be attained.
- **The agent reasoning models** – the agent employed to act in line with the negotiation protocol in order to achieve the negotiation objective.

The main challenge in this research is to appropriately define all ATM related issues and developing a comprehensible protocol for negotiating on the issues. After establishing these two areas a selfless reasoning agent that will facilitate the negotiation process by finding pareto-efficient solution in all negotiation will then be developed. This negotiation model is targeted at filling a gap in trajectory management process by providing a pre-tactical measure for ensuring efficient use of ATM resource with a look-ahead time of 2h+.

Viewing the ATM system as a function of constraints, we propose the use of Constraint based programming for modelling the reasoning agent. The negotiation problem is represented as a constraint satisfaction problem in a form of a tuple P = (X, D, C) which is defined as follows:

- A set of variables $X = \{x_1, \ldots, x_n\}$
- And for each x_i a finite set of domain $D = \{D_1, \ldots, D_n\}$,
- A set of m constraints $C = \{C_1, \ldots, C_m\}$

Following the principles of constraint-based programming and continuous feeding of the system with agents constraint, the decision block (**Figure 3**) shall provide a list of solution to achieve the objective of the instigator.

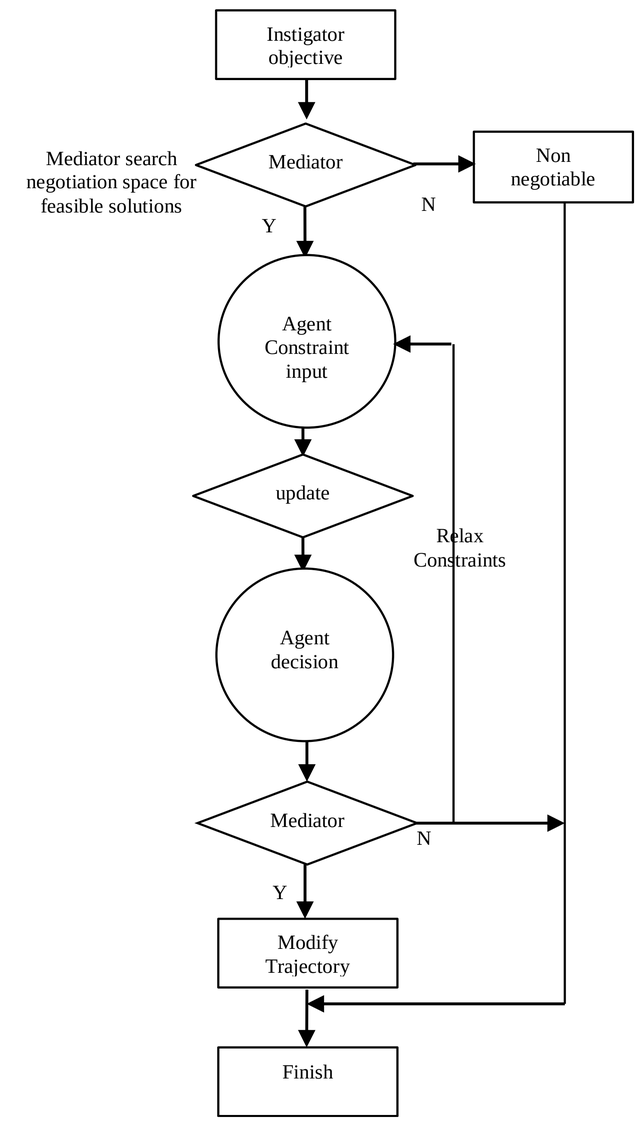

Figure 3: Decision Block Process

CONCLUSION AND FUTURE WORKS

This negotiation process could fill a gap identified in the Collaborative Decision Making process by providing a common language and comprehensible process for negotiating trajectory changes in the mid term. Work done so far on the decision block represents a preliminary test with limited parameters to evaluate the computational capability of such a mechanism to support ATM trajectory negotiation. Further testing are ongoing.