A Brief Overview on an Air Transportation System (ATS)

Salman Arif, Jason Atkin, Geert De Maere
Department of Computer Science
University of Nottingham

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Abstract

The worldwide Air Transport System (ATS) has a huge impact on the global economy and is expected to grow annually in size and operational costs. This impact has led the ATS to attract the attention of researchers worldwide. This article aims to provide an operational insight into the ATS by discussing the major stages of the flight planning process, which is commonly known as airline scheduling, and elaborates how the traversal of flights takes place in the ATS after the filing of flight plan. The reader will also see references to other research which can provide further information, in the hope that this article can be of use to those who are beginning to look into this area.

Keywords: Flights, Air Traffic, Airspace, Flight Networks, Operational Costs, Flight Levels, Stakeholders

1 Introduction

Transportation via airspace takes place through the Air Transportation System (ATS), which has contributed to almost 2.5% of the world's Gross Domestic Product (GDP), making US$ 880 billion in 2004 [1], rising up to US$ 1.8 trillion in 2013 [2]. This system is expected to grow annually in terms of both increased transportation [3] and operational costs [4, 5]. The major reason for its huge impact on the world's economy lies in its influence on global commerce, as so many different industries such as airlines, navigation service providers, aircraft manufacturers and many other business enterprises are directly and indirectly affected by the ATS. The worldwide network for routes connected to different airports in the ATS, known as the Air Route Network (ARN) [6], facilitates economic growth by offering connectivity to different regions of the world [1, 7].

Numerous flights operated by different airlines, traverse in the airspace through the ARN. However, before a flight begins its traversal, a flight plan is filed by the airline, which is designed as a sequence of stages. These stages of flight planning provide a strategic foundation for the transportation to operationally take place in the ATS at a tactical level, and therefore, have been a major focus for optimisation by much previous research studies [8].

2 Major Stages in Airline Scheduling

Designing of the Flight Schedule: The planning for a flight initially begins with designing of the flight schedules for individual flights. The flight schedule not only determines the departure and destination airport of the flight, but also calculates the timing for the departure and arrival at its respective airport, in order to minimize the operational cost for airlines [9].
Fleet Assignment: The designing of a flight schedule is followed by fleet assignment, where it is determined which aircraft types on which routes will maximize the overall revenue for the airlines [10].
Aircraft Maintenance Routing: Fleet assignment is followed by the redesigning of flight networks, in which the flight networks are first decomposed to subnetworks, and then each subnetwork is assigned an individual aircraft, in order to satisfy the maintenance requirements of the aircraft. More details for aircraft maintenance can be found in [11].
Crew Scheduling: Finally, multiple day schedules are generated for the crew of the flights with the main focus on minimization of operational costs, constrained by the working time rules and regulations, that are defined by the regulatory agencies and the bargaining agreements [12].

3 Traversal of Flights in the ATS

After a complete flight plan has been developed, it is filed by the airline and submitted to the central agency responsible for the regulation of air traffic, for example the Network Manager, Eurocontrol in Europe or the Federal Aviation Administration (FAA) in the US [13, 14]. After the approval of the flight plan by the central agency, the flight takes off according to its schedule from the destination airport at the specified time and climbs following a departure route. This departure route, also known as a Standard Instrument Departure (SID) route lies in the lower portion of airspace around an airport, below the altitude of 24,500 feet, which is called the Terminal Manoeuvring Area (TMA) [15]. The enroute airspace begins at 24,500 feet [16].

After the flight finishes its traversal of the SID, it starts its cruising phase in the enroute airspace, which is divided into multiple sectors. The flight enters and leaves the enroute airspace sectors via the entry and exit points of these sectors respectively, and traverses within these sectors by visiting a sequence of waypoints while following its route [17, 18]. It must also be noted that the enroute airspace is vertically stratified into multiple flight levels [19], where each one is vertically separated by a distance of 1000 feet. Therefore, flights also change their flight level as required due to shortage in airspace capacity, while cruising through the enroute airspace [20].

After the flight finishes its cruising phase, it leaves the enroute airspace and begins its traversal of the arrival route, which lies inside the TMA of the destination airport and is known as the Standard Arrival Route (STAR). Inside the TMA, the arrival and the departure of flights are tactically supervised by the team of Air Traffic Controllers (ATCs), which is often located in the ATC tower at the airport [21]. However, the cruising flights inside the enroute airspace sectors are tactically supervised by the team of ATCs for their respective

sectors, located in the Area Control Centres (ACCs) [22, 23].

4 Conclusion

The ATS is a worldwide transportation system that operates at a global level, and has a huge impact on the world's economy. This system is divided into different higher altitude sectors at the enroute level, with lower level airspace near to airports being used for arrivals and departures to/from airports. Flights traverse a source TMA, a number of enroute sectors and then a destination TMA, under the guidance of different controllers in each area. Different stakeholders in this system like flight crew, the Network Manager, FAA and the ATCs have different objectives, and interact with each other differently at different operational levels. Furthermore, some stakeholders, for example airlines, solve a number of different but interacting problems to arise at a final solution. With the continuous growth of the ATS, it is important to not only focus on the impact of interaction between these stakeholders on the transportation, but also integrate research problems in the ATS at different operational levels while considering these stakeholders. In the near future, we shall focus on elaborating how they interact with each other and how their decision making can impact the flow of air traffic in the ATS.

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