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Air traffic in European airspace is coordinated centrally by the air traffic flow management services – Network Management Operation Centre (NMOC). Their main task is to compare resources (number and capacity of air traffic control sectors) and needs (size of the planned and actual traffic). If it is found that the planned traffic exceeds the capacity of available airspace, corrective actions should be carried out. They consist in changing the take off time, or changing aircraft routes so as to avoid congested sectors or even cancelling the flight. Unfortunately, determining only the traffic volume is not sufficient to identify the needs, because very important are also: aircraft trajectories, manoeuvres performed, types of aircraft, their speed and other restrictions. Indeed, these factors determine the possibility to control the traffic by air traffic controllers. This makes it necessary to seek another indicator characterizing the traffic that must be handled.

A relatively new concept leading to better utilisation of available airspace is to improve air traffic smoothness. It seems that the increase in air traffic smoothness should improve the capacity of the airspace, as the air traffic controller can handle a larger number of planes as they pass through the sector evenly and smoothly. This is primarily because such a traffic does not require much of the coordination by the controller.

Dissertation proposes to use the notion of air traffic smoothness as a new, universal measure for characterizing the quality of air traffic. The dissertation presents a new method for determining the air traffic smoothness, which uses both flight plans, their current implementation and the so-called favourable flight plans.

The air traffic controller occupancy is the basic factor determining the safety of flight operations. The aim of this research was to develop a simulation method for assessing the controller occupancy. The method presented in the dissertation uses a mathematical model that simultaneously considers the air traffic and the work of the controller. The model created as a colored timed Petri net, allows for estimating the controller occupancy for various parameters of the traffic flow, infrastructure and support systems. As part of simulation experiments, the quantitative dependence of occupancy on the traffic volume was demonstrated. It has been shown that maintaining the traffic in accordance with a predetermined flight plans reduces the controller's occupancy, and granting clearances for direct flights, although beneficial for flight economics, increases occupancy and, therefore, may affect traffic safety.