The PHOENIX Multi-Radar Tracker System for Air Traffic Control Applications

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The German air navigation service provider "Deutsche Flugsicherung" (DFS) has been developing the PHOENIX project since October of 2001. PHOENIX is a distributed client-server-based multi-radar tracking and air situation display system, primarily for use in ATC towers and as a fallback Radar Data Processing System in Area Control Centers. The PHOENIX system is designed to handle up to 50 radar systems and up to 3,000 tracks. This text describes the selected system architecture, the tracker design decisions, and presents the observed accuracy and performance results.

The multi-radar tracker is based on a 4+2 variables Kalman Filter, and uses multi-plot fusion instead of multi-track fusion. Combined with accurate projection corrections these techniques provide a precise and powerful air situation display, which has been proven to cope with about 1600 tracks of live traffic from 28 radars in an area of interest that covers the whole of Germany. For this performance the tracker utilises less than 5% of the available resources of LINUX-based PCs used for this application. Even for this volume of airspace, the positional accuracy is good enough to meet existing ATC requirements.

Estimating One-Parameter Airport Arrival Capacity Distributions for Air Traffic Flow Management

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During instances of capacity-demand imbalances, efficient planning and decision-making in air traffic flow management is contingent upon the “goodness” of the capacity distributions that estimate airport capacity over time. Airport capacities are subject to substantial uncertainty as they depend on stochastic weather conditions. In this paper, we develop models in the form of probabilistic capacity forecasts, which take into consideration the stochastic nature of weather. To assess the improvements that could be gained by using the probabilistic capacity forecasts, the seasonal capacity distributions developed in this paper for San Francisco’s International airport (SFO) are input into an existing static, stochastic, ground holding model, which uses probabilistic capacity forecasts and determines the amount of ground delay to assign to incoming flights. Experimental results show an 8.6% reduction in expected delay minutes.
Effectiveness of the Ground-Based Transceiver Parrot System for Monitoring GPS Integrity for Alaska ATC “Radar-Like Services” Using ADS-B

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In January of 2001, the Federal Aviation Administration (FAA) commissioned the first use of Automatic Dependent Surveillance Broadcast (ADS-B) based on the Global Positioning System (GPS) to support Air Traffic Control (ATC) “radar-like services (RLS).” These services are available via ATC to nearly 200 equipped aircraft operating in the vicinity of Bethel, Alaska as part of the FAA’s Capstone program to improve aviation safety in Alaska. RLS allow ATC to support Instrument Flight Rules (IFR) separation of 5 nautical miles based only on ADS-B surveillance. Since ADS-B information is being used by ATC for aircraft separation, some method to verify the integrity of the GPS/ADS-B data must be continually provided. The ADS-B concept, as defined in RTCA standards, relies on aircraft to “self-report” the integrity of the navigation data reported in the ADS-B message. System evaluations leading to commissioning of RLS showed the ADS-B data to be easily equivalent to radar surveillance in terms of accuracy, latency, and update rate. However, it highlighted some difficulties with the self-reported integrity concept for this “first generation” of ADS-B avionics, due mainly to excessive Receiver Autonomous Integrity Monitoring (RAIM) holes—from the ATC perspective. The resulting excessive number of false integrity alerts led to an FAA decision to disregard ADS-B self-reported integrity in the Bethel area and, instead, to monitor GPS integrity through a network of new ground position “parrot” monitors implemented along with the existing ADS-B receiving stations. The objective of this paper is to determine how effective this monitor system is at detecting integrity failures of the GPS satellites that could cause Hazardously Misleading Information (HMI) over the Bethel, Alaska area. Although our results show that the existing parrot system is generally effective for conducting RLS in the Bethel area, we offer recommendations to the FAA to improve the performance of integrity monitoring in the area.

Effectiveness Analysis for Aviation-Safety Measures in the Absence of Actual Data

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Sometimes, it seems likely that a technological advance will improve aviation safety, but it is not clear by how much. Uncertainty might be especially great when the innovation strengthens the capabilities of an existing system rather than creates entirely new capabilities. For example, newly-available “name tags” can enhance ground surveillance systems by displaying for air traffic controllers the identity of each plane on the runway. But, when two such planes are in danger of colliding, how much benefit arises because the controller knows that they are (say) United #306 and American #424?

Focusing on an example about added functionality for a ground collision avoidance system, we describe a method for generating probabilistic estimates of benefits for a technology not yet deployed. The effort starts with a group activity involving technology experts and system users, in which relevant past events are studied and discussed one at a time. Then key participants are asked individually to assess the probability that the new technology would have “saved the day” in each situation, while other available measures would not. A major challenge is to avoid confusion and anxiety for participants, while preventing some individuals from exerting excess
influence on group decisions (as can arise in consensus-based procedures). We present effectiveness estimates for added functionality, as well as approximate margins of error for these estimates. We also discuss the limitations of the approach used, and alternative methods of making effectiveness estimates.