Metrics of Communication Performance

Kim Cardosi and Amanda DiFiore

Metrics of voice communications between pilots and air traffic control provide important indices of NAS system performance. They help to characterize current operations, define requirements for future systems, and establish baselines against which performance of new systems can be compared. This article presents a review of studies of communication metrics in actual operations. It summarizes what is objectively known about various aspects of communication performance, including: the number of controller transmissions per minute, the characteristics of pilot responses, communication error rates, and the time required to transmit a message. Gaps in performance data are identified, empirical links between communication performance and other measures of system safety are explored, and the implications for system specification and evaluation are discussed.

Performance Metrics for Oceanic Air Traffic Management

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The Federal Aviation Administration (FAA’s) Oceanic and Offshore Integrated Product Team is developing a set of performance metrics and identifying methodologies for calculating them. These metrics will be used to benchmark and measure how well the FAA’s Oceanic Air Traffic Control Centers are meeting their goals and priorities, and delivering oceanic air traffic services and benefits.

There are many challenges that must be addressed to meaningfully measure and evaluate the oceanic system performance. Some of these challenges are the same as those for measuring the performance of the National Airspace System (NAS) as a whole. However, since many oceanic flights start or end in other countries, there are additional challenges in obtaining the data necessary to calculate the oceanic performance metrics.

The FAA’s Air Traffic Services (ATS) organization identified a set of system performance outcomes in the areas of safety and operation efficiency (e.g., predictability, flexibility, delay, and access). Oceanic airspace users indicated their priority areas as safety, on-time performance, fly as filed, flexibility, and fuel consumption. The oceanic performance metrics have been developed to measure the ATS outcomes and the users’ priorities. In addition, environmental factors (e.g., flight count, aircraft avionics equipage) that affect the service delivery are included to provide a proper context for the metrics.

The oceanic metrics are collected in a “dashboard” to provide a general picture of the overall service quality provided to oceanic airspace users. A dashboard is generated for each of the New York and Oakland Oceanic Centers, as well as for sub-regions in each Center to account for the air traffic characteristics unique to that sub-region.

This paper presents example analyses and results obtained for environmental and performance metrics for New York and Oakland Oceanic Centers, and shows how the metrics can be used to monitor the performance of air traffic management services provided to oceanic airspace users.
Post-deployment Analysis of Capacity and Delay Impacts of an Airport Enhancement: Case of a New Runway at Detroit

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We develop and demonstrate a new statistical method for estimating airport capacity and assessing the capacity and delay impacts of events such as the opening of a new runway, deployment of a new technology, or even transient events such as facility outages. The method is to estimate models of airport throughput using censored regression, recognizing that at a given time the throughput is the minimum of the capacity and available demand. The method is demonstrated for the opening of a new runway, Runway 4L/22R, at Detroit-Wayne County (DTW) Airport. Results show, over the period studied, the main effect of the new runway was to increase departure capacity during VMC conditions. Another finding is that capacity is highly variable, even controlling for visibility condition. Results are then used to estimate arrival and departure delays at DTW, using a simple spreadsheet simulation. We find that simulated delays match observed delays quite well, and the new runway decreased departure delays 15%, while having virtually no effect on arrival delays. Methodologically, we find that our censored regression model accurately depicts operational performance except when protracted periods of low capacity yield a build-up in demand accompanied by low operational counts. To address this, future work should focus on introducing autocorrelation into censored regression models.

Air Traffic Complexity Map based on Non Linear Dynamical Systems

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This paper presents a new air traffic complexity metric based on non-linear dynamical systems. Previous work has shown that the structure and organization of traffic are important factors in the perception of the complexity of an air traffic situation. The new metric captures these important aspects of complexity by identifying the organization of trajectories in a traffic pattern. This paper investigates only the features of this new metric without quantifying directly the connection between complexity and the metric. Authors of previous work in this area have proposed metrics that generally have not explicitly addressed the effects of organization in the traffic flow on complexity. In order to capture the effect of organization, the metric is based on a dynamical system which fits as closely as possible the observations given by the aircraft positions and speeds. Two approaches are presented. The first one is based on a linear dynamical system and produces an aggregate complexity metric. The second approach, uses a non-linear dynamical system model that fits the observations without error. This metric can be used to identify high (or low) complexity areas on a map, and, by capturing the organization properties of the traffic, captures some of the key factors involved in ATC complexity. A complexity map for the northwest area of France is shown as an example of the application of the model to real radar data. Such maps are an example of the usefulness of these methods for comparing the relative complexity of different regions of airspace.