Automation for "Direct-to" Clearances in Air-Traffic Control

Air-traffic controllers can be more productive and flight times can be reduced.

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A method of automation, and a system of computer hardware and software to implement the method, have been invented to assist en-route air-traffic controllers in the issuance of clearances to fly directly to specified waypoints or navigation fixes along straight paths that deviate from previously filed flight plans. Such clearances, called "direct-to" clearances, have been in use since before the invention of this method and system. Usually, they are issued when requested by pilots; less frequently, controllers issue them on their own initiatives.

A typical flight-plan trajectory consists of multiple straight segments. As such, it cannot minimize flight time because it deviates from both a great circle and from the shortest-flight-time non-great-circle trajectory that could theoretically be generated if the wind field at every point in space and time could be predicted and taken into account in assessing alternative trajectories. Given these complications, it is sometimes possible to save time by flying along an alternative straight-line segment that bypasses a flight-plan waypoint: this is the main reason for seeking and issuing a direct-to clearance.

The primary requirement guiding the design of the present system was to increase the productivity of controllers and the efficiency of aircraft trajectories within the constraints of the current air-traffic-control environment. This requirement ruled out dependence on such new infrastructure as automated two-way air/ground data links. It also eliminated from consideration the specification of curved or multi-segment trajectories that provide the minimum time to fly to destinations in spatially varying wind fields: neither the infrastructure of today's air-traffic control system nor the navigation equipment on most aircraft support the specification of such types of trajectories to aircraft while in flight.

The system utilizes four-dimensional (time plus three spatial coordinates) trajectory information generated by the Center-TRACON (terminal radar approach control) Automation System (CTAS), which is in current use by air-traffic controllers. The CTAS trajectory computations utilize all known information about an aircraft, including its capabilities, its current three-dimensional coordinates and velocity, and meteorological conditions (including winds) specified on a grid that spans the entire airspace of the continental United States.

The system first finds all aircraft flying on inefficient routes, then determines whether it is possible to save time by bypassing some route segments, whether potential direct-to fixes lie within a rectangular geographical area that contains the air-traffic-control center using the system, then finally determines whether the improved route is free of conflicts with other aircraft (see Figure 1). Aircraft that survive these tests are considered to be eligible for direct-to clearances. The system displays a list of all eligible aircraft in order of decreasing

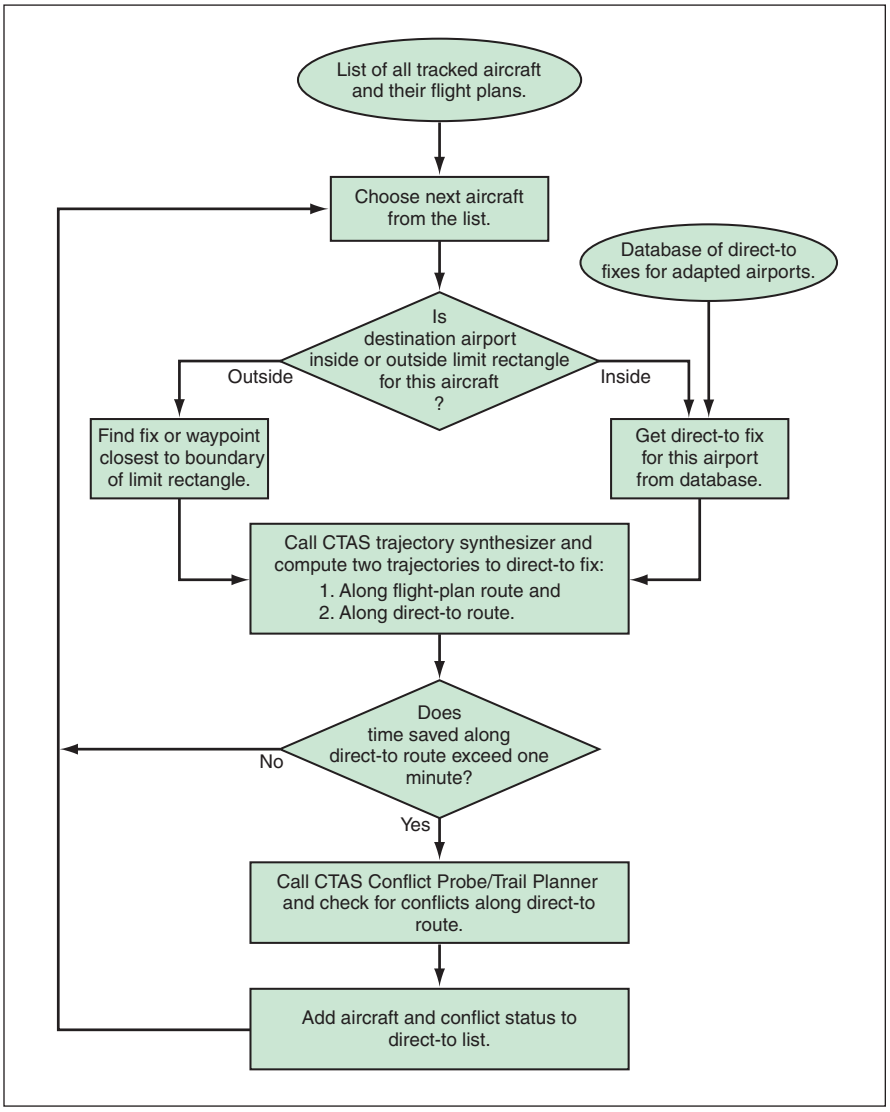

Figure 1. The **Flowchart** illustrates the steps of computation and decision in the automated generation of a list of aircraft eligible for direct-to clearances.

Figure 2. **This Display** helps the controller identify and work with the highest-pay-off aircraft.

potential time savings. This list enables an air-traffic controller (see Figure 2) to easily identify and work with the highest-pay-off aircraft, thereby contributing to a significant increase in the productivity of both the air-traffic controller and the aircraft. Another display generated by the system is a graphical user interface, through which the air-traffic controller can issue the direct-to clearance to the aircraft by a simple point-and-click action on a computer mouse.

This work was done by Heinz Erzberger and David McNally of **Ames Research Center**. *Further information is contained in a TSP (see page 1).*

This invention has been patented by NASA (U.S. Patent No. 6,314,362). Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-2954. Refer to ARC-14359-1.