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JPDO "Snap Shot" Series: Trajectory-Based Operations

The most fundamental requirement of the Next Generation Transportation System (NextGen) is to safely accommodate significantly increased air traffic—and to do this in airspace that is already congested. The transformation to Trajectory-Based Operations (TBO) will be key to achieving NextGen's goals. In fact, TBO will greatly enhance the capacity of our National Airspace System (NAS) by allowing planes to fly to their destinations faster and closer together, without sacrificing safety.

Currently, air traffic controllers help an aircraft along its route based on several pieces of critical information (e.g., weather conditions, separation between aircraft, ground-based location). This process is called Clearance-Based Operations. However, very little automation exists with modern Clearance-Based Operations, due to outdated procedures and technology.

TBO Takes Air Traffic Control to the Next Level

With NextGen, TBO will allow aircraft to fly on precise, four-dimensional pathways (or trajectories). The cornerstone of TBO is Flexible Airspace Management. Aircraft will be able to fly directly to their destination, automatically separating from other aircraft and adjusting to weather conditions as required. TBO equipped aircraft will fly with more precision with respect to their flight path and relative to other aircraft. Once changes in position are made, avionics (onboard flight data equipment) send and receive real-time flight data throughout the system, giving controllers and other aircraft the information they need to know precisely where every aircraft is and, as a result, adjust automatically.

TBO and Aircraft Separation

In the modern air traffic management system, aircraft separation is handled by controllers using radar screens to visualize the paths flights must take (trajectories) and make necessary adjustments. Some automated decision support exists today to help identify and resolve future conflicts. In addition, flights are managed primarily by voice communication, while clearances and vector coordinates are distributed by two-way radio. As industry business models change and traffic continues to increase, this approach must evolve to ensure our pilots and controllers have the tools to operate the system with continuing safety and greater efficiency and capacity.

In the TBO environment, the traditional roles of pilots and controllers will evolve due to automation, support, and integration. Aircraft will digitally transmit and receive precise data, to include aircraft routes and the times aircraft will cross key points in the airspace. Individual aircraft trajecto-

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ries and entire flows of aircraft can be dynamically adjusted to take advantage of opportunities and avoid constraints safely and efficiently.

Separation Management

A major element of TBO is trajectory-based Separation Management (SM), which uses automation and shared trajectory information to better manage separation among aircraft and airspace hazards, such as weather and terrain. Trajectory-based SM also allows delegation of separation tasks to the flight crew in certain conditions. The benefits envisioned depend on reducing the impact of weather. Improved information sharing, improved sensors and forecasting, and better integration of weather into automated decision support tools help reduce the impact of weather on the entire system.

Where TBO is used, SM relies significantly on automation for predicting conflicts and identifying solutions. Use of automation also allows SM to move away from fixed human-based standards to ones that allow variable separation—factoring in aircraft capabilities, encounter geometries, and environmental conditions. Controllers and flight crews approve the recommended conflict resolution before it is implemented, whether it is generated on the ground or in the cockpit.

The Benefits of TBO

TBO presents major benefits to aviation. Aircraft will fly more efficient, user-preferred routes. Increased system precision and enhanced automation will allow aircraft to fly routes that maximize airlines' goals for fuel efficiency, aircraft operations and scheduling. Reduced separation standards will also result in increased capacity within congested and constrained areas, allowing more aircraft to fly through those areas, rather than being rerouted or delayed to avoid them.

Safety will be increased through the system's continuous checks for problems. Once a conflict is identified, the system will continue to provide information and reminders about the problem until it is resolved. Planning and problem-resolution tools will inform a controller if a particular action taken may create a loss of separation, allowing the controller to choose or develop an alternative, safer resolution. Controller productivity will increase as automation will perform routine tasks, and predict potential problems. Also, electronic communication will lower controller task load, and automated problem prediction will allow the controller to handle more aircraft by reducing the number of situations that will demand multiple time-critical actions.

New Avionics and Flight Management Systems

Aircraft and aircraft operators will need a range of new or enhanced navigation, surveillance, communication, and flight management avionics, as well as flight planning and management systems to operate in the TBO environment. It is understood that air navigation and support providers will have to service aircraft of differing capabilities; however, the operators that adequately equip their fleets to conduct TBO will be better situated to exploit the advancements to achieve available benefits.