OCAT – The Oceanic Conflict Advisory Trial

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ABSTRACT

The Oceanic Conflict Advisory Trial (OCAT) is a year-long FAA operational trial designed to help airlines to fly more of their preferred oceanic routings while additionally reducing air traffic controller and pilot workloads. By using a standalone service that allows dispatchers to "pre-probe" potential routing changes[1] against the current oceanic environment, OCAT partner airlines[2] will have the ability to determine if their desired changes would be potentially acceptable to Air Traffic Control (ATC) without requiring either controller or pilot involvement. In the future, the OCAT oceanic pre-probing service could be extended to Air Navigation Service Providers (ANSPs) and other authorized users.

This paper describes the operational concepts and technology behind the OCAT system and its planned operational trial.

KEY WORDS
OCAT, ATOP, Ocean21, conflict, probe, trial, ocean, web service, AIRE, ASPIRE

Introduction

"As aviation services continue to grow, we can anticipate an increase in the industry's carbon emissions. This is happening against a background of (1) emission reductions from some sources other than aviation, and (2) the rising values we place on environmental quality. If not successfully addressed, environmental issues may significantly constrain air transportation growth in the 21st century."[3]

The Asia and Pacific Initiative to Reduce Emissions (ASPIRE) and Atlantic Interoperability Initiative to Reduce Emissions (AIRE) were instituted to help address the aviation community's concern over the expected increase in carbon emissions. Procedures such as the Dynamic Airborne Reroute Procedure (DARP) have also be introduced to allow airborne flights to modify their routings to achieve fuel savings by taking advantage of favorable winds and avoiding adverse weather. The on-going ASPIRE and AIRE trials have demonstrated that allowing airspace users to fly their optimal preferred oceanic routes does result in fuel savings as well as reduced engine emissions[4,5].

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[1] Any valid combination of vertical, lateral, and/or speed changes.
[2] At the time of this paper, the official OCAT partner airlines have not yet been finalized.
[3] Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) *http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/enroute/oceanic/documents/IPACG/IPACG28/IP10_ASPIRE.doc*
[4] E. Kelly, *"Aspire makes progress on improving air traffic management efficiency"* *https://www.flightglobal.com/articles/2010/08/09/345834/aspire-makes-progress-on-improving-air-traffic-management.html*
[5] J. McDaniel, *"Atlantic Interoperability Initiative to Reduce Emissions (AIRE) Briefing to the ICNS"* *http://i-cns.org/media/2009/05/presentations/Session_L1_FAA_Incentives_or_Mandates-Military/01-McDaniel.pdf*

However, since airlines typically only have insight into their own operations and not into the complete current oceanic situation, requests to alter a flight's current route can frequently result in oceanic conflicts being predicted by the FAA's Ocean21 automation system. Such requests are subsequently denied by Air Traffic Control. While these denials serve to safely keep the required separation, they reduce potential flight efficiencies. Additionally, the need to constantly repeat such requests leads to increased frustration for both controllers and pilots alike. Once a request is denied due to a conflict, the airspace users frequently do not request alternatives due to workload and time constraints, so the potential reduction in fuel and emissions are not realized.

The Oceanic Conflict Advisory Trial (OCAT) is a year-long operational trial designed to address this problem while additionally reducing the controller and pilot workload associated with such requests. Using operational data and algorithms from the FAA's current Ocean21 automation system, the OCAT system allows partner airlines and other authorized users to pre-probe potential routing changes.

OCAT makes the Ocean21 conflict probe capabilities available via a standard web service. During the operational trial, the OCAT system will assist users in determining which of their potential routing options are currently conflict-free and therefore more likely to be acceptable to oceanic air traffic control. Using the automated OCAT web service allows users to attempt various routing options to determine the candidate that best meets their business priorities without affecting either the pilot or air traffic control. Once determined, the pre-probed, conflict-free OCAT requests may then be submitted through the normal communication paths to the oceanic controller. Since the request had been pre-probed in OCAT, it should now have a much higher probability of being conflict-free in Ocean21 thus allowing the requesting aircraft to fly its preferred route without further modification or controller interaction.

Oceanic Environment

By their very nature, oceanic flights are long-duration flights crossing vast airspaces with minimal surveillance monitoring. To ensure the safe separation of oceanic traffic, the FAA's Advanced Technologies and Oceanic Procedures (ATOP) program positioned Lockheed Martin's Ocean21 systems in New York, Oakland, and Anchorage. The Ocean21 systems use Adacel's Aurora software to model the cleared and proposed trajectories of all known oceanic aircraft using the most up-to-date weather information. Whenever a change to an aircraft's current routing is proposed, its proposed trajectory is modeled and "probed" against the other aircraft and oceanic airspace reservations to determine whether the change would result in any predicted violations of separation. This capability is referred to as the ATOP conflict probe. Complex probing algorithms are utilized to enforce the dozens of site-specific and equipment-specific oceanic separation rules.

Because oceanic flights are typically planned many hours in advance, the weather currently affecting a flight could drastically differ from that originally forecasted. Due to the long durations of these flights, airlines have found that making even minor modifications to an aircraft's route to take advantage of the current weather conditions or to avoid blocking traffic can result in significant fuel and time savings thereby reducing emissions and operating costs.

However, Airline Operations Centers (AOCs) typically only have insight into their own flights and not into the other flights sharing the airspace, the separation standards applicable to those flights, the current airspace reservations, and the latest Ocean21 weather. Therefore, while AOCs may know the routes they would prefer to fly, they have no way of knowing if those new routings will be acceptable to oceanic Air Traffic Control (ATC).

In the current environment, when an AOC or aircraft would like to fly a more advantageous route, the pilot requests the new clearance from the oceanic controller using either Controller-Pilot Data Link Communications (CPDLC) or a high-frequency (HF) radio request. The controller uses the Ocean21 system to probe the proposed request against the current oceanic traffic and if conflict-free, clears the aircraft on the requested route. However, if the request results in a predicted conflict with other aircraft or airspace reservations, the controller would then need to either take additional actions to determine a different, conflict free alternative (resulting in additional controller workload and a potentially undesirable route from the airline's point-of-view) or the controller simply denies the request. A denial would result in the flight remaining on the current, undesired routing or force the entire request process to start again. Multiple request cycles result in additional ATC, pilot, and AOC workload and lead to frustration and increased delays and communication costs.

Overview of OCAT

OCAT allows airlines to pre-probe their proposed changes against the current oceanic situation using a "shadow system" utilizing the latest Ocean21 conflict probe algorithms. OCAT is planned as a year-long trial scheduled to start in the third-quarter of 2011 in which partner airlines are provided with a secure connection to the OCAT web service. Airline dispatchers can use the OCAT web service to pre-probe any number of proposed flight alternatives. Dispatchers can determine those routings that will be the most beneficial from the airline's point-of-view while also being likely to be conflict-free when probed by the oceanic controller. Since all OCAT probe requests are performed against an automated web service, this "pre-probing" process requires no controller or pilot involvement. The automated responses from the OCAT system are nearly instantaneous and delivered over the internet so no unnecessary delays or satellite or HF radio operator communication charges are incurred. Once an acceptable routing has been determined, the AOC can then relay the pre-probed request to the pilot who simply follows the normal oceanic procedure to make the request of ATC. However, since this request had been pre-probed in OCAT, the chances of it now being denied by ATC have been greatly reduced. While a change in the oceanic environment could cause the OCAT and ATOP probe results to differ, these differences should be minimal due to the relatively infrequent nature of oceanic changes. The aircraft will then be permitted to fly on its requested conflict-free route. In addition, controller and pilot workload is reduced since the repeated request-denial-request cycles are no longer necessary.

Figure 1 illustrates the differences between the current re-route procedure and the proposed OCAT procedure.

Today versus OCAT

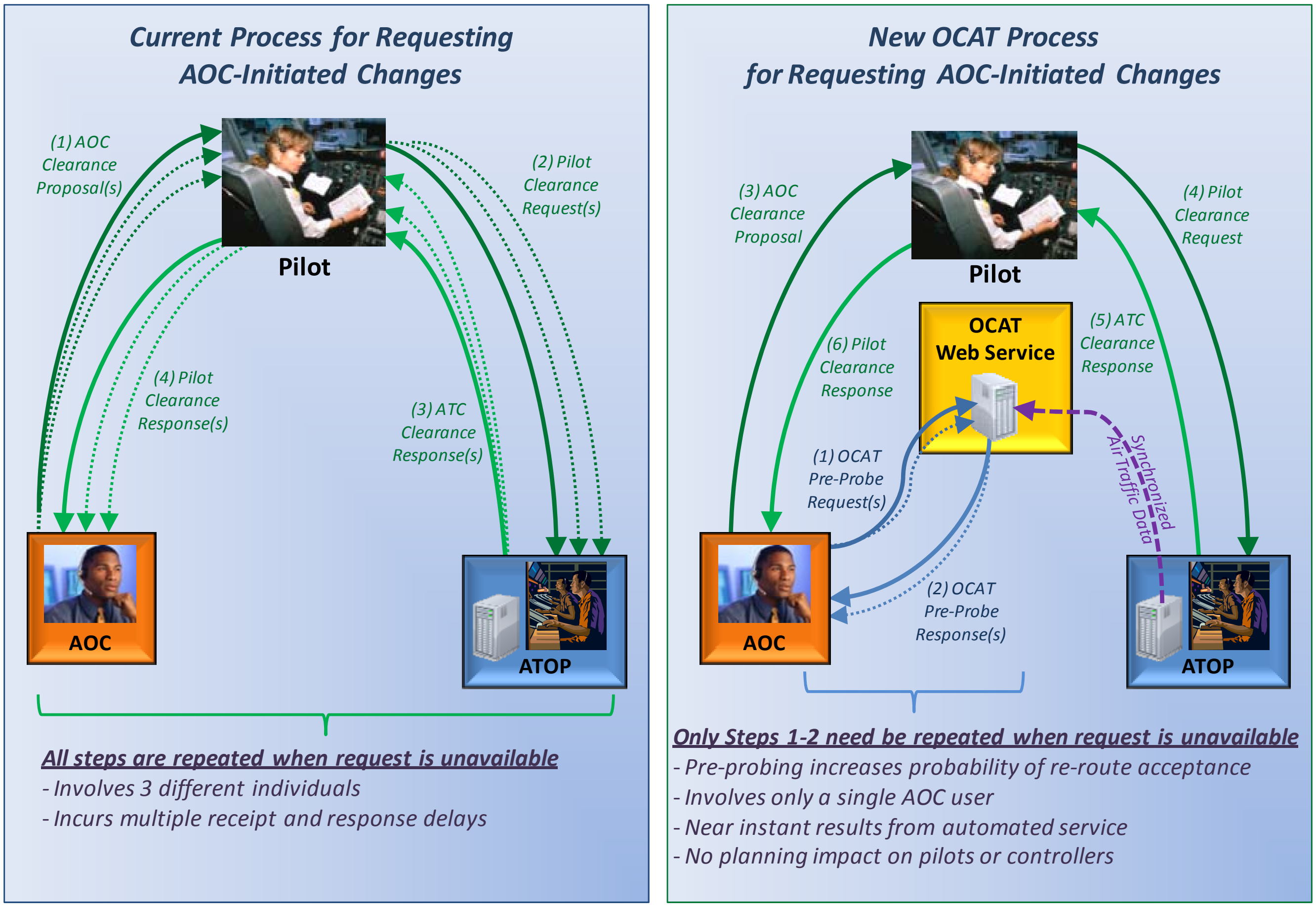


Figure 1 AOC Re-routing before and after OCAT

Background – ATOP and Ocean21

One of the key elements in the OCAT concept is consistency. If the OCAT system was not capable of producing the same probe results as the ATOP Ocean21 system, its usefulness would be diminished. Additionally, it was crucial that the OCAT system not impact the operational ATOP ATC systems. Therefore, some background on the ATOP Ocean21 system design is necessary to explain how the OCAT system will meet the overall goals of being consistent with ATOP without adversely affecting it.

The ATOP Ocean21 system is designed as a dual-channel system. Each channel is fully-redundant and independent. Only one channel is ever active at a given time. The second channel may be isolated from the active channel for maintenance purposes or it may be linked using a redundant set of processors referred to as Synchronization (SYNC) servers. The active channel continuously streams updated information to the SYNCs. When the second, isolated channel is brought to backup mode, the SYNC transfers the data from the active channel to the backup channel using a process referred to as "reconstitution". Once the reconstitution of the backup channel has completed, the SYNCs simply forward all active channel updates to the backup channel as they occur in real-time. This process ensures that the active and backup channels of each operational ATOP system process the exact same information. The data transfer is always unidirectional – from the active channel to the backup channel. No data is ever sent from the backup channel to the active channel.

Each channel performs its processing of the ATOP data independently. This means that the backup

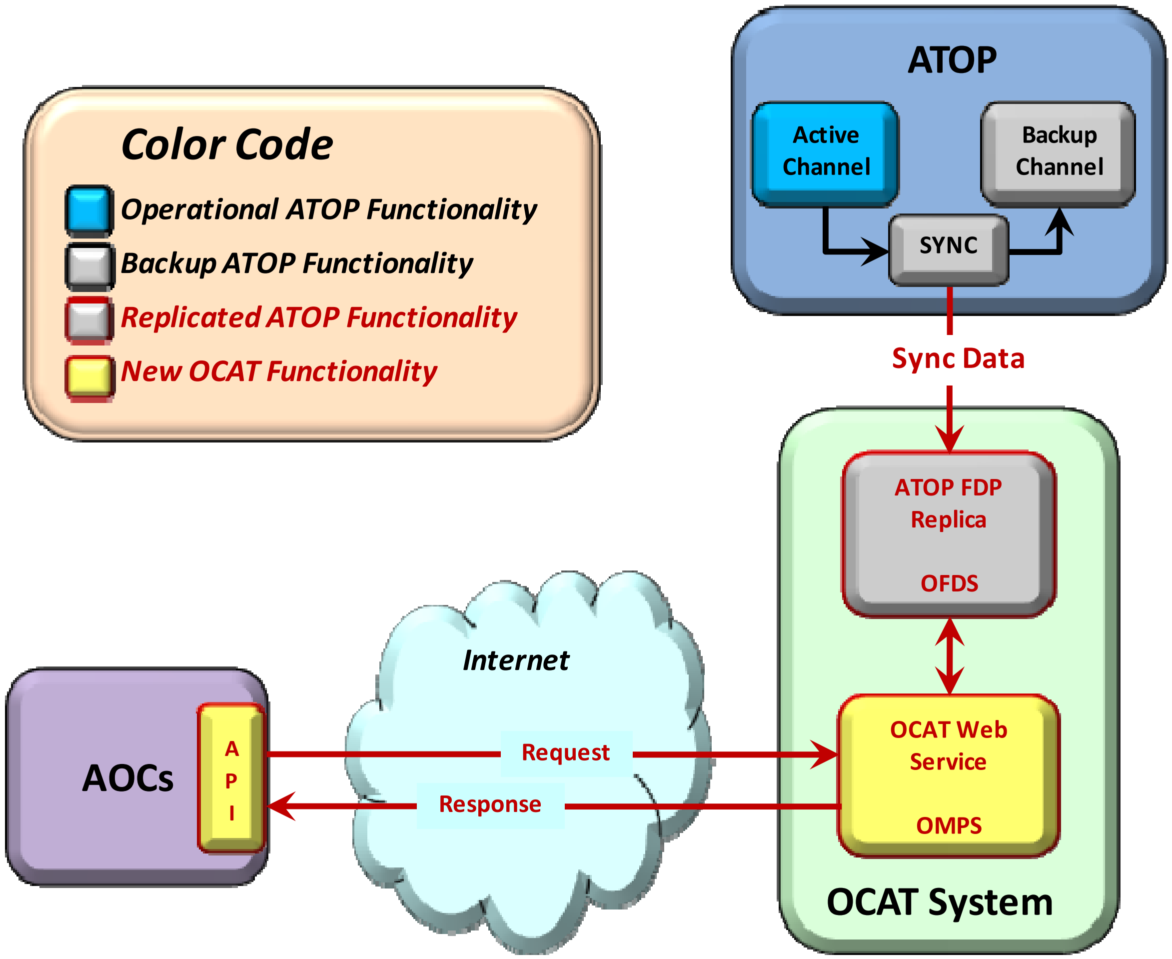


Figure 2 High-level Representation of the OCAT Concept

channel is fully capable of performing trajectory modeling, conflict probing, and all other ATOP-related processing.

OCAT to ATOP Interface

As depicted in Figure 2, the OCAT concept takes advantage of the dual-channel nature of the ATOP system by essentially converting it into a three-channel system. With only minor modifications to the operational SYNC servers, a second instance of the synchronization database and processing has been added to support a third channel. This third channel behaves identically to the backup channel – it can be brought up independently of either of the other channels; it reconstitutes from the SYNC server; and subsequently receive all active channel updates from the SYNC just like a second back up channel. This "third-channel" does not affect the operation of either the active or backup channels on the operational ATOP system and the additional processing load on the SYNC servers is negligible. Once this "third-channel" synchronization capability is in place, we now have the ability to "shadow" the operational ATOP data in a fully independent system without affecting the operational system.

By instantiating the current ATOP processing in a single processor, a simple "third-channel" can be replicated. This processor, referred to as the OCAT Flight Data Server (OFDS), is essentially an "ATOP-in-a-box" running the ATOP processes and current adaptation required to ensure consistent processing results with the operational ATOP system. It is important to note that the OFDS processes include the same executables and adaptation files used by the operational ATOP system.

It is envisioned that each operational ATOP site participating in the trial[6] will have an OFDS temporarily installed to support the operational trial. This means that new ATOP software/adaptation releases will simply be deployed to the OFDS just like any other ATOP processor thereby ensuring consistency of OCAT results.

By combining the identical flight data/conflict processing and adaptation with the active channel synchronization of all current flight plan, airspace, and weather data, we have the ability to create an independent OCAT system. OCAT is fully capable of producing ATOP probe results with minimal software development and most importantly, without impacting the operational ATOP systems.

OCAT to AOC Interface

Since OCAT is intended to be a year-long operational trial with multiple airline partners, the security and access concerns associated with connecting to an operational FAA site prevent the users from making direct connections with the OFDS. To allow multiple partners to easily access and freely use the OCAT system during the operational trial period, a secure, common web service is provided for all potential users. The OCAT web service not only provides a common interface for all users, but also acts as a single interface to each of the OFDS processors at the operational sites further isolating them from the external users. This provides the ability to have greater control over individual users' capabilities and the ability to govern the overall usage of the OCAT system.

Since airlines capabilities vary greatly, an early decision was made to keep the OCAT-to-user interface at a web service Application Programming Interface (API) level and not include an actual User Interface (UI) as part of the OCAT system. This allows each participating airline to decide how much, or how little, they would like to invest in modifying their systems to interface with OCAT. Some airlines could choose to fully integrate the OCAT web service API into their existing flight planning systems while other airlines could choose to simply implement standalone, text-based UIs.

The web service will be housed in a single OCAT Message Processing Server (OMPS) processor at the Florida NextGen Test Bed (FNTB) in Daytona Beach and is designed using industry standard WSDL and SOAP protocols. In the future, the OCAT web service's XML-based messaging can be easily converted to be compatible with the FAA's System Wide Information Management (SWIM) infrastructure.

OCAT User Capabilities

The OCAT web service is designed to ensure that users only have access to the data for which they have been authorized. For example, Airline X can probe their own flights in OCAT against all oceanic traffic; however, requests to probe Airline Y's flights will be rejected as "unauthorized". This access is controlled through the use of a configured "ACID mask" for each participating airline. ACID masks are specified by the airlines, but configured by the FAA. An example of the ACID mask for Airline X could be: XAL*; QXY*; DEF*. Only probe requests for flights with call signs matching the one of the requestor's configured ACID masks will be accepted. Similarly, the web service uses the ACID masks to filter the probe results. All conflict results are still provided back to the user; however, the call signs for the conflicting aircraft are only provided to the API if they too match the requestor's ACID mask. Non-matching call signs will be replaced with generic names (e.g., AIRCRAFT-1).

Providing airlines with call sign information concerning conflicts with their other owned flights allows the airlines to make more educated conflict resolution decisions. The AOC may determine that it could be more beneficial to change the conflicting flight than the one originally probed.

OCAT users are not necessarily limited to airlines. The OCAT web service can be made available to all authorized users including the FAA en route facilities and international Air Navigation Service Providers (ANSPs). The FAA is the controlling entity for the authorized list of all OCAT users and their permissions.

To prevent potential misuse of the OCAT system during the operational trial, the web service also has the ability to limit on a per-user basis, the number of requests that a particular user group can make in a 24-hour period. The amount of time the airspace associated with a given request is reserved within the OCAT system is also configurable on a per user group basis. Additionally, each OMPS and OFDS request and response will be recorded for monitoring and accountability.

[6] It is currently envisioned that one or more ATOP sites will participate in the OCAT trial.

ATOP and OCAT Probing

In ATOP, all probing of potential routing changes are performed by the responsible controller using the Ocean21 user interface capabilities. When a downlink request is received from a pilot, the controller is presented with an associated set of potential uplink clearance options. The controller selects one option and probes the uplink. The ATOP system creates a proposed trajectory (referred to a 2nd profile) associated with the probed uplink (or set of uplinks). To ensure separation is maintained, the flight's cleared trajectory (its 1st profile) is not affected by this request; however the airspace associated with the flight's 2nd profile is additionally reserved in the ATOP system. The 2nd profile airspace is reserved until the probed clearance is either sent to and accepted by the pilot or cancelled. If the clearance is accepted, the 2nd profile becomes the new cleared profile and the airspace associated with the original 1st profile is released. If the probe is cancelled or rejected by the pilot, the 2nd profile is simply deleted and its associated airspace released.

Since the OCAT system uses ATOP processing for profile management and conflict probing, the OCAT probe processing is nearly identical to ATOP. The difference being that the OCAT system does not involve either the pilot or the controller. For OCAT, the OCAT Message Processing (OMP) software acts as both the pilot and the controller. Since the OCAT web service is envisioned to be used by various personnel most of which are unfamiliar with air traffic clearances, the OCAT system is designed to provide a simple, clearance-independent interface to its conflict probe capability. For example: If a user wanted to probe a requested climb to flight level 350 beginning at the point named "FIXA" with the climb completing by 1230Z, the user need simply send the OCAT web service a probe request containing the following information:

<Type> Climb
<Alt1> 350
<AtTimePos> FIXA
<ByTimePos> 1230

When OMP receives the airline probe request from the web service, it is validated and a configuration-driven table is used to determine and automatically initiate the OCAT probing of the request's associated uplink(s). For the above example, OMP would automatically convert the received web service request into the following uplink clearance elements for probing by the OFDS:

UM22-AT FIXA CLIMB TO AND MAINTAIN F350
UM26-CLIMB TO REACH F350 BY 1230

In addition, since OCAT is a standalone service with no controller or pilot to release its probed airspace, OMP starts a timer to automatically cancel the probe at a configured time. Maintaining the probed airspace in OCAT for a set amount of time allows airlines to receive accurate results when probing the changes for multiple flights against each other and against those proposed by other OCAT users.

OCAT probes the request using the synchronized ATOP data, the current adaptation, and the Ocean21 conflict algorithms, and provides the result back to the requestor via the web service API. The web service probe results contain a formatted version of the same conflict information normally provided to a controller in the ATOP system.

To help ensure that airline's requests to the air traffic controllers are equivalent to the pre-probed conflict-free OCAT requests, OMP additionally provides the corresponding recommended downlink requests. These recommended downlinks are provided in both a textual form for dispatchers to verbally relay to their pilots and a parsed form that could potentially be automatically uplinked to the aircraft by the AOC. Since the OCAT system acts as *both* the pilot *and* the controller, OCAT additionally includes a controller capability to probe restricted requests to help resolve conflicts. The ability to request a restricted clearance is not normally available to pilots.

For example, a normal pilot request of *"Request Climb to 350"* could result in a conflict, while a controller-entered restriction of *"Climb to reach 350 by 2252"* for the same flight would not. Since the intent is use OCAT to avoid potential conflicts, OCAT supports the probing and requesting of restricted clearances; however, CPDLC messaging does not support restriction requests in the defined aircraft downlink messages. To address this shortfall, OMP includes free text "restrictions" as part of the recommended downlinks returned to OCAT web service. For the above example, the OMP recommended downlinks provided to web service user would be:

DM9-REQUEST CLIMB TO F350
DM67-RESTRICTION – F350 BY 2252

If the aircraft includes the OCAT-recommended free text restriction in their ATC downlink request, the restriction will be displayed to the ATOP controller through the normal Ocean21 User Interface. This will assist the controller in determining the best uplink option to probe. By observing this OCAT free text as part of the normal downlink procedure, the controller will know that the restricted request was pre-probed and conflict-free in OCAT, and therefore probing the same restricted clearance in ATOP will most likely result in the request being conflict free in Ocean21 as well.

OCAT Profile Requests

In addition to the probing of potential routing changes, the OCAT system can also be used to provide current ATOP profile information to authorized users. Since the OCAT system profiles are built from the synchronized ATOP data, the profiles in the OCAT system reflect the latest ATOP flight profile information as updated by controller clearances and weather updates. Authorized users may use the OCAT web service to request the current profiles for flights matching their ACID mask to see the latest cleared oceanic route including the estimated times at each point. The updated 2nd profile information associated with a request is also included as part of the probe response, so airlines can compare various profile requests against a flight's current profile and against each other to determine the most beneficial routing based on the current conditions.

OCAT User Interface

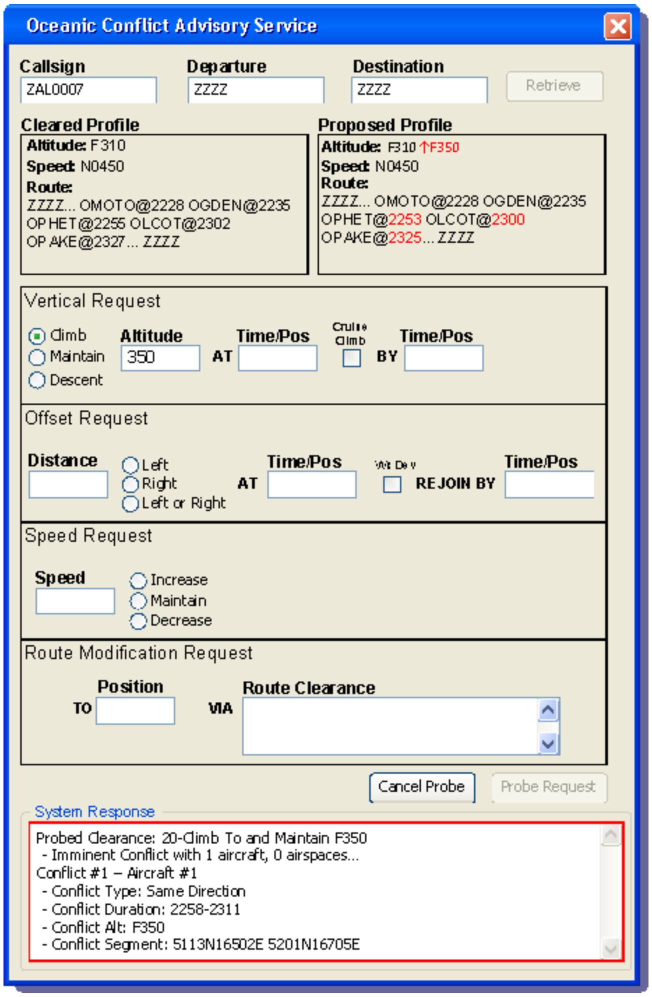
Although as described above, no "official" user interface is being provided as part of the OCAT system, to help better the envision OCAT capabilities, an example of a potential representative OCAT user interface is provided in Figure 3.

This representative UI includes potential displays for both the unrestricted conflict response (left side) and the restricted conflict-free response (right side) cases. It also illustrates all the capabilities provided by the OCAT Web Service API.

OCAT Operational Trial

The OCAT system is designed to support a limited number of potential airline partners for a year-long trial planned in both the Atlantic and Pacific oceans beginning in the third quarter of 2011. During this trial, airline partners will use a secure VPN internet connection to the OCAT web service in the FNTB. The web service will use the FAA Telecommunications Infrastructure (FTI) to securely connect to the OFDS processors located at the operational ATOP site(s) participating in the OCAT trial.

OCAT partner airlines will make use of the OCAT web service to request flight profiles and pre-probe desired routing changes during the trial period. Specific metrics such as the number of OCAT requests, the number of OCAT-supported ATC requests, and the overall success rate will be tracked to determine the usage, accuracy, and benefits of the OCAT system during this trial period and to identify any desired changes in the OCAT capability. Interim and final benefits analyses will be performed to assess the usefulness and savings associated with the trial. The recommendation for implementation of the OCAT system into permanent operations is expected to follow shortly after the successful completion of the trial.



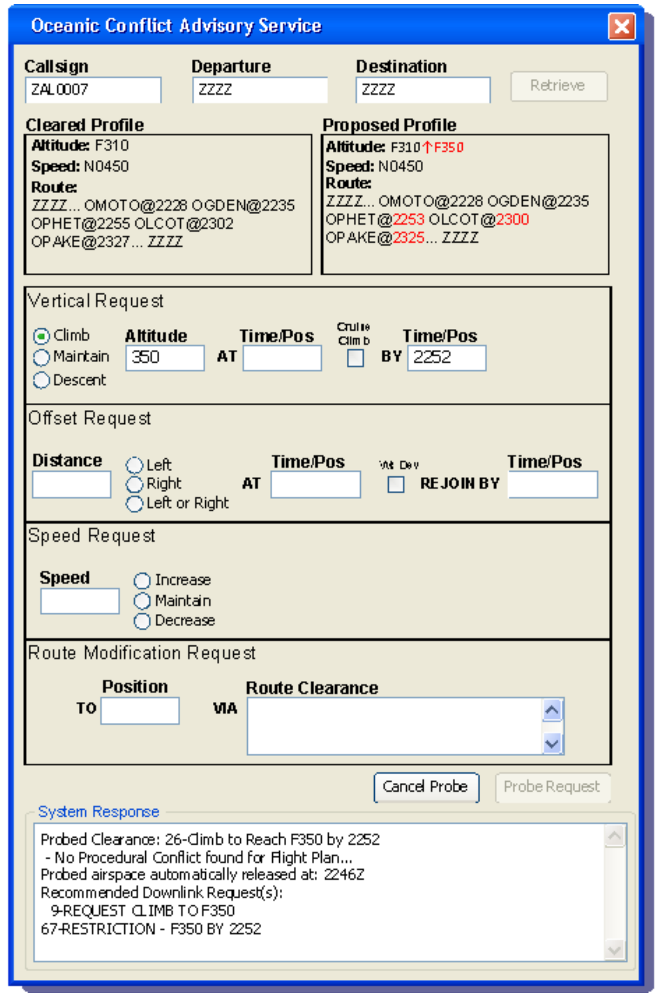


Figure 3 Representative OCAT User Interface

Future OCAT capabilities

Although the OCAT system is being put into place to support a specific operational trial associated with the probing of routing changes, the concepts introduced by OCAT offers numerous future possibilities. With the OCAT system in place, authorized users will have the ability to access live ATOP data without affecting the operational ATOP system.

For the purposes of the OCAT trial, the OFDS will run the same software release as the operational system; however in the future, the OFDS could be used to unobtrusively test new ATOP capabilities using synchronized live data. New oceanic concepts such as SWIM, flight data objects, and 4D trajectories, and new capabilities such as pre-flight planning and pre-defined conflict resolution strategies could all be validated using live oceanic data without ever affecting ATOP operations. In addition, new decision support tools such as the Collaborative Flight Planning and Monitoring (CFPM) tool could be integrated with OCAT to provide gate-to-gate services. By providing a secure, externally accessible, independent system that is capable of running operational ATOP software and synchronizing with live oceanic data, the OCAT system provides unlimited investigative possibilities for potential future concepts and capabilities.

Conclusion

In the oceanic environment, making even the slightest changes in aircraft's route of flight to take advantage of the current conditions can result in significant savings in fuel consumption while bettering the environment by way of reduced emissions. However, since airline requests are typically made from only the requesting airline's perspective with no insight to the other competing traffic in the ocean, it is frequently difficult for air traffic controllers to grant the airline requests for such routings.

In today's economic and environmental climate, airlines are looking for every advantage, so providing an efficient means of making such routing changes is becoming more and more critical. As the number of these requests grows in the future, the number of associated potential conflicts will also increase. This means that the controller and pilot workload involved in resolving those conflicts will likewise increase.

The goal of the Oceanic Conflict Advisory Trial is to address the above issues by providing authorized users with a web-accessible capability to pre-probe potential oceanic routings to see if they will be acceptable to air traffic control beginning in late 2011. The secure OCAT service will allow airline personnel to probe any number of route variations to determine the ATC-acceptable route that best meets their business and/or environmental needs without impacting either their pilots or the oceanic controllers. In addition, the OCAT capability opens vast opportunities to investigate new oceanic ATC concepts and capabilities using live data without impacting oceanic operations.

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