**THE FORTIETH MEETING OF THE**

**INFORMAL PACIFIC ATC CO-ORDINATING GROUP**

(Washington D.C, USA, 8 - 9 September 2014)

Agenda Item 5: Air Traffic Management (ATM) Issues

**Simulation Result by DARP for KSFO/KLAX**

(Presented by Electronic Navigation Research Institute)

**SUMMARY**

This paper presents the results of computer simulation of DARP for KSFO/KLAX with ATC simulations.

1. Introduction
   1. DARP trial which has been carried out since August 22, 2013 brings some benefits. At IPACG 38 and 39, ANA reported outcome from DARP trial of the arrival flight from PHNL/KLAX to RJTT/RJAA. However, the number of flight applies DARP is not so many.
   2. ENRI simulated the situation which almost flight tries DARP in the future for eastbound traffic.
2. Simulation
   1. ENRI evaluated benefits of DARP for computer simulations. Simulation scenarios were made based on actual flight plan data. In addition, it has the random routes not to satisfy requirements of UPR in these routes. First, flight time and fuel consumption were computed by using weather forecast data ( 6hours before from departure time). Secondly, several DARP routes were computed by using weather forecast data ( 6hours before from departure time). Only the route which is not increase flight time and fuel consumption of the several computed DARP route was operated as a new route. Objected routes are bound for KSFO, KLAX and PHNL.
   2. Then ATC simulations for the simulation scenario with DARP operations were carried out by using analyzed weather data depend on observed weather data. When an ATC separation estimated to loss, flight altitude was changed. RNP equipage of flights were also referred from flight plan data. Oceanic separation was kept by only altitude changed ( without exceeding the altitude of the plan) . The aircraft type used in the simulation is B747-400.
   3. Table 1 shows the constitution of scenarios. The flight bound for KSFO, KLAX or PHNL were the object of DARP operation. Red flight plan routes shows bound for KLAX.

Table 1. Scenario Constitution

|  |  |  |
| --- | --- | --- |
|  | Scenario A | Scenario B |
| Traffic type | Summer  Optimum Route is similar to Grate Circle. | Winter  Optimum Route for KSFO/KLAX/PHNL is closely. |
| Total flight | 91 | 85 |
| RNP4 equipage | 74(81%) | 73(86%) |
| Objected flight for DARP | 36 | 51 |
| Flight plan route |  |  |

* 1. Two scenario were selected to compare the characteristic days for a route configuration. Scenario A has weak jet stream, and the optimum routes for KSFO/KLAX are intertwine with the optimum route for PANC/KSEA in the northern airspace. One day of the August 2013 are referred. Scenario B has strong jet stream in the southern area, and the optimum routes for KSFO/KLAX are intertwine with the optimum route for PHNL. One day of the January 2014 are referred.
  2. When there are many slightly different UPRs in equivalence time, ATC effectiveness might decrease. DARP enables the change to the most optimum routes during in flight. Therefore, the flight plan is filed only PACOTS TRK or NOPAC TRK (without UPR) and DARP at any time in Oceanic airspace in scenario A was simulated. UPR are assigned to TRK which started from the same gate way. However, for some flights, TRK allocation was not effective. At the day, TRK2 was R591 and TRK3 starts from KALNA but not agree with G344. Therefore flight time and fuel consumption increase even if the UPR between G344 and TRK3 is allocated whichever G344 or TRK3.

1. Results
   1. Table 2 shows the benefits of DARP calculation. “UPR150E” means to file according to flight plan and to enforce DARP from 150 degrees E. And “TRK160E” means to file changing from UPR or random route to PACOTS TRK or the NOPAC route and to enforce DARP from 160 degrees E. The numerical values in the table express the value that a dispatcher judges DARP request. For Scenario A, a DARP enforcement rate at 150E was 75%, and the rate at 160E was 67% in which flight plan route including UPR. In the case of NOPAC or PACOTS track, an enforcement rate decreased. Especially, DARP benefit of NOPAC route was few effects. The reason is expected that the routes at Scenario A were north. For Scenario B, a DARP enforcement rate at 150E and the rate at the 160E were likewise high.

Table 2.DARP Benefit (calculation)

|  |  |  |
| --- | --- | --- |
|  | Scenario A | Scenario B |
| DARP(UPR150E) |  |  |
| Done DARP/Objective DARP | 27/36 (75%) | 50/51 (98%) |
| fuel benefits (average/std. dev.) | 627 lbs / 537 lbs | 1470 lbs / 1374 lbs |
| time benefits (average/std. dev.) | 2.2 min / 2.1 min | 4.9 min / 4.9min |
| DARP(UPR160E) |  |  |
| Done DARP/Objective DARP | 23/36 (64%) | 50/51 (98%) |
| fuel benefits (average/std. dev.) | 538 lbs / 548 lbs | 1009 lbs / 936 lbs |
| time benefits (average/std. dev.) | 1.8 min/ 2.0 min | 3.5 min/ 3.5 min |
| DARP(TRK150E) |  |  |
| Done DARP/Objective DARP | 25/36 (69%) |
| fuel benefits (average/std. dev.) | 640lbs / 569lbs |
| time benefits (average/std. dev.) | 2.2 min/2.0 min |
| DARP(TRK160E) |  |
| Done DARP/Objective DARP | 21/36 (58%) |
| fuel benefits (average/std. dev.) | 553 lbs / 559 lbs |
| time benefits (average/std. dev.) | 1.8 min/ 2.0 min |

* 1. To clarify the benefit and ATC operational influence by the DARP operational location, two type of simulation were evaluated. DARP started near 150E and 160E were simulated.
  2. The benefit in the calculation has a big one that when DARP in 150E (cf. Table 2). However, many DARP routes concentrate on 37E60 in DARP at 150E in scenario B. The Concentrate traffic includes both bound for PHNL and bund for KLAX. Therefore the conflict pair has more DARP in 150E than 160E. A DARP request may not be approved by the real use.

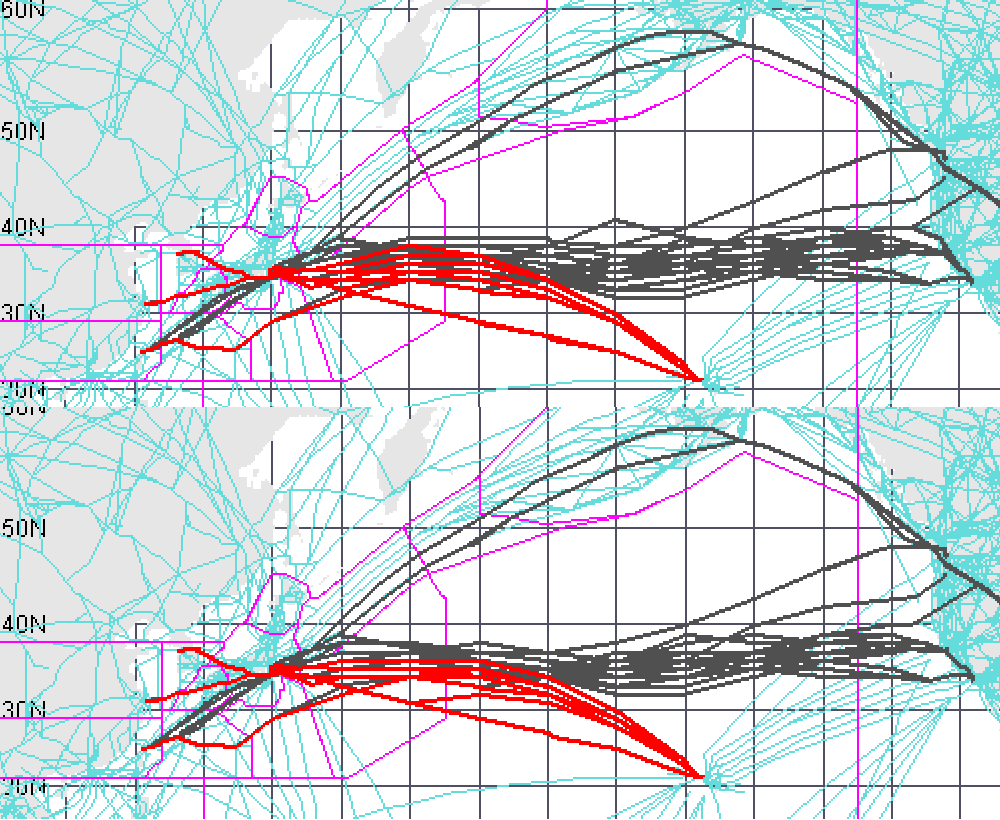


Figure 1. DARP Route (Red lines show the flight bound for PHNL) Upper:150E, Lower:160E

* 1. The case filed in TRK or NOPAC without UPR is compared with flight plan route with UPR. As the result of DARP routes were not so different. However, it may be a problem to increase deployment fuel increases when the location UPR is far from any TRK (or NOPAC) mentioned above 2.5 sub-section. It was sometimes more than 5000lbs.
  2. ATC simulations as the simulation scenario of Table 2 were carried out. Table 3 shows the benefits of DARP by ATC simulation. “Alt. changes flights” means the number of flights whose flight altitude was changed due to traffic.

Table 3.DARP Benefit (ATC simulation)

|  |  |  |
| --- | --- | --- |
|  | Scenario A | Scenario B |
| without DARP |  |  |
| Conflict Pairs / flights | 83/63 | 28/29 |
| Alt. changed flights | 39 | 17 |
| DARP(UPR150E) |  |  |
| Conflict Pairs / flights | 76/61 | 57/43 |
| Alt. changed flights | 37 | 25 |
| fuel benefits (average) | 529 lbs | 1788 lbs |
| time benefit(average) | 2.0 min | 6.8 min |
| DARP(UPR160E) |  |  |
| Conflict Pairs / flights | 77/62 | 56/39 |
| Alt. changed flights | 38 | 23 |
| fuel benefits (average) | 691 lbs | 1356 lbs |
| time benefit(average) | 2.4 min | 5.5 min |
| DARP(TRK150E) |  |  |
| Conflict Pairs / flights | 77/61 |
| Alt. changed flights | 36 |
| fuel benefits (average) | 441 lbs |
| time benefit(average) | 1.9 min |
| DARP(TRK160E) |  |
| Conflict Pairs / flights | 73/61 |
| Alt. changed flights | 36 |
| fuel benefits (average) | 638 lbs |
| time benefit(average) | 2.4 min |

[Scenario A]

A number of conflict flights when flight plan according to original plan is same as the value when flight plan changed to TRK. in the calculation, DARP benefit on 150E is larger than it on 160E. however the benefit on 160E is larger than it on 150E as the simulation result. DARP on 150E seemed to centralize traffic flows and then benefit decreased by altitude changes to keep separations.

[Scenario B]

DARP operation increases conflict especially on 150E. Benefit on 150E is larger than it on 160E both in calculation and simulation result.

* 1. This simulations were done by approving all the best DARP requests. This result generally shows the benefit of DARP operation. High RNP4 equipage made benefit even if ATC simulation. ENRI would examine the simulation including non-approval applying to the ATC issue of DARP.

1. **Conclusion**

The meeting is invited to note the information provided.