International Civil Aviation Organization

Seventh Meeting of CNS/MET Sub-Group of APANPIRG and
Tenth Meeting of CNS/ATM IC Sub-Group of APANPIRG

Bangkok, Thailand, 15 – 21 July 2003

Agenda Item 13: **Review developments, research, trial and demonstration relating to CNS/ATM**

SOUTH PACIFIC FANS INTEROPERABILITY TEAM REPORT 2003

(Presented by the United States of America)

SUMMARY

The purpose of this paper is to present data gathered by the FANS Interoperability Team (FIT) regarding the current usage of controller pilot data link communication (CPDLC) and automatic dependent surveillance (ADS) in FANS-equipped flight information regions (FIR) of the South Pacific.

1. Introduction
See paragraphs 1and 2 of the report below.

2. Discussion
See paragraphs 3 through 13 of the report below.

3. Conclusion
See paragraph 14 of the report below.

South Pacific FANS Interoperability Team
REPORT
2003

SOPAC FANS INTEROPERABILITY TEAM REPORT

1. INTRODUCTION

The purpose of this paper is to present data gathered by the FANS Interoperability Team (FIT) regarding the current usage of controller pilot data link communication (CPDLC) and automatic dependent surveillance (ADS) in FANS-equipped flight information regions (FIR) of the South Pacific.

2. EXECUTIVE SUMMARY

The success of the South Pacific (SOPAC) FIT during its first five years of operation has led to the formation of similar groups that monitor FANS operations in other regions. Currently there are three other groups covering the Central and North Pacific, North Atlantic, and the Bay of Bengal. There is also some discussion about establishing another group to coordinate FANS implementation in the Polar region.

Boeing continues to act as the Central Reporting Agency (CRA) for the SOPAC FIT and has begun to fill the role of CRA Support Agency (CRASA) for the FAA element of the IPACG FIT. The CRA receives problem reports from stakeholders and coordinates problem report resolution with the respective FIT. The CRA also processes monthly system performance data. The Japan Civil Aviation Bureau (JCAB) has established a similar CRA function for aircraft flying in Japanese airspace; its supporting CRASA liaises closely with CRASA personnel at Boeing.

In the South Pacific region, four of the five air traffic service providers (ATSP) have fully commissioned FANS controller workstations offering CPDLC, ADS, and ATC Inter-Facility Ground/Ground Data Communications (AIDC) services. The fifth ATSP is currently in the process of upgrading its existing workstations to include ADS capability.

Operational problems (i.e., due to controllers or pilots failing to follow procedures) and technical problems (i.e., due to hardware or software faults) continue to be reported in the SOPAC FIRs. Overall, the number of problem reports received has decreased. End-to-end system performance is high and relatively stable, and monitoring continues.

The user-preferred route (UPR) trials have been completed and UPRs are now a normal facet of regional operations. Significant operating benefits have been realized by the participating airlines since UPRs were first introduced.

UPR procedures allow airlines to optimize flight plans per their own unique operating parameters for the type of aircraft, weight, and forecast weather at the time of departure. On long-haul flights, which are typically payload limited, use of UPR procedures enables airlines to carry additional payload, which generates additional revenue on each flight.

The SOPAC FIT continues to work on reduction of separation minima based on overall system performance and FANS equipage. CPDLC provides the communications enhancements necessary for the implementation of 50 nautical mile lateral separation in areas of convective weather activity. As other FIRs achieve full FANS functionality, FANS functions will allow a reduction of longitudinal separation to 50 nautical miles throughout the South Pacific. Further reductions in both lateral and longitudinal separation minima to 30 nautical miles remain a final goal for the team.

3. PURPOSE OF THE FIT

The SOPAC FIT was established to deal with significant technical and operational problems that were being experienced in FANS operations. Subsequently, the FIT oversees the monitoring process, which ensures that the FANS-1/A end-to-end system continues to meet its performance and interoperability requirements, and that operations and procedures are working as planned. As a result of the successes realized by the SOPAC FIT, the Informal Pacific ATC Coordinating Group (IPACG) established a separate FIT in January 2000. The two groups are now beginning to merge some of their operations. For example, both groups have now adopted the Pacific Operations Manual (POM) as the documentation standard, which has combined the previous South Pacific Operations Manual (SPOM) and the North Central Pacific Operations Manual (NCPOM). There are also plans to hold a combined FIT meeting in the future. The various FIT-type groups have similar responsibilities as follows:

PROBLEM IDENTIFICATION AND RESOLUTION

- Reviewing de-identified problem reports and determining appropriate resolution.
- Recommending interim operational procedures to mitigate the effects of problems until such time as they are resolved.
- Monitoring the progress of problem resolution.
- Preparing summaries of problems encountered and their operational implications.

SYSTEM PERFORMANCE

- Recommending system performance requirements.
- Assessing system performance based on information recorded from monthly status reports.
- Coordinating system testing.
- Identifying configurations of the end-to-end system that provide acceptable data link performance and ensuring that such a configuration is maintained by all stakeholders.

ACHIEVING BENEFITS

- Formulating plans for long-term procedural enhancements that take advantage of FANS-1/A benefits.
- Coordinating implementation of enhanced operational procedures.

4. FANS INTEROPERABILITY TEAM

The FITs gather system performance data and information on both technical and operational problems from all stakeholders in Pacific oceanic FANS operations. In the South Pacific, these operations are currently conducted in the following FIRs and oceanic control areas:

- Auckland[1]
- Brisbane[1]
- Melbourne[1, 2]
- Nadi[1]
- Oakland
- Tahiti[1]

Notes:

1. *These FIRs also offer ADS service*
2. *Melbourne's FANS coverage also extends across the Indian Ocean to 75ºE longitude.*

4.1 SOUTH PACIFIC FIT

As the area with the most mature FANS operations and the longest-established FIT, the SOPAC team concentrates on the development of operating procedures that provide economic benefits to the operators by taking advantage of the enhancements offered by FANS.

The team is a sub-group of the Informal South Pacific ATS Coordinating Group (ISPACG) and meets in coordination with ISPACG meetings annually. The last meeting was held in Auckland in March and the next meeting is scheduled for March 2004 to be held in Fiji.

Boeing continues to chair and administer FIT meetings and also to provide CRA services to the team. With the combining of the manuals of the two regions into the POM, the editorial duties have now passed to the FAA.

Annex A contains a list of SOPAC FIT stakeholders, all of whom have been active in the team.

4.2 CENTRAL REPORTING AGENCY

Since the formation of the SOPAC FIT, Boeing has assumed the role of CRA for the team. Some SOPAC FANS stakeholders have provided funding and other resources in the past, but this support has ceased. CRA activities for the SOPAC are currently performed under contract to the FAA.

Boeing also provides the FAA's CRA function for the IPACG FIT. The SOPAC and IPACG CRAs share system performance and problem report databases; problem reports highlight any areas in which problems occurred. Performance data are analyzed on an FIR-by-FIR basis and also as overall performance benchmarks for the specific region.

The JCAB supports its own CRA function for problems occurring with aircraft operating within Japanese airspace. Both the JCAB and FAA CRAs work in close coordination in support of the IPACG FIT.

Boeing supported the initial FANS Action Team for the Bay Of Bengal (FATBOB) meeting in 2001. Informal FATBOB problem reports continue to be collected and reviewed. This information will help focus the work-plan when FATBOB meetings resume. Liaison and limited support is also being achieved with the North Atlantic's FANS Implementation Group (FIG). Boeing also participated in the first Informal Indian Ocean CNS/ATM System Implementation Coordination Meeting, which was held in Johannesburg from 7 to10 AUGUST 2001.

As other regions move forward with FANS implementations, common procedures across all the regions will become an important issue. Use of common procedures was one of the early lessons learned in the South Pacific FIT. Close coordination among regions implementing FANS will help to ensure that common procedures are used to the greatest extent possible.

5. FIT PROBLEM REPORTS

5.1 PROBLEM REPORT STATUS

The status of problems reported to the FIT from 1998 to June 9th 2003 is as follows:

- 424 Problem Reports have been received by the CRA.
- 50 Problem Reports remain open.
- 334 Problem Reports have been closed.

- 26 Problem Reports have been defined as “Lessons Learned”. Some of these were closed (but are not included in the “closed” total above) while others cannot be dealt with economically or practically.
- 14 Problem Reports have a status of “Ready for FIT”. This status means that the CRA analysis is complete and the problem needs approval from the FIT to close.

5.2 OPERATIONAL ISSUES

Dealing with Unnamed Waypoints

One issue that still has not been fully resolved and which is discussed at almost every FIT meeting is the use by operators of ARINC 424 formats for waypoints. ICAO does not recognize this formatting standard and, as a result, the waypoints are represented differently in airborne and ground system navigation databases. In most circumstances, ground systems reject position reports and routing requests that include ARINC 424-formated waypoint names. However, in a small number of cases, the ground system interprets an ARINC 424 latitude/longitude position and is not always successful at interpreting correctly. Refer to last year’s report for a full discussion of this issue.

Use of Conditional Altitude Clearances

A number of years ago there were several altitude deviations resulting from flight crews misunderstanding conditional altitude clearances, (i.e., a clearance to begin climb at a downstream flight plan waypoint or time). The South Pacific FIT agreed to a procedure intended to prevent premature execution of conditional clearances. The procedure requires the addition of an instruction to maintain the currently cleared altitude prior to the conditional clearance. For example, MAINTAIN [current level], AT [time] CLIMB TO AND MAINTAIN [level]. There have been no events of this type (unauthorized altitude deviations) in recent times.

5.3 Other Training Issues

Other training-related problems continue to occur. Of these, the most frequent are the continued use of inappropriate Free Text messages in place of existing pre-formatted message elements, and logon rejections due to incorrect data field entries. The FIT continues to pursue these issues.

6. CPDLC SYSTEM PERFORMANCE REQUIREMENTS

Since the FIT recommended changes to end-to-end system performance requirements in September 1998 (see table below), data link service providers (DSP) have striven to ensure that the system meets end users’ needs. Since no objective performance requirements exist (the “requirements” levied by the FIT through ISPACG are informal), the DSPs have used the requirements as targets.

Performance Parameter	Performance Requirements
Message transit delay	95% of messages to arrive within 60 seconds (downlinks; one-way) or 120 seconds (uplinks; round trip)
System availability	99.9%
System integrity	10^{-6}
Message success rate	99% as designated by “MAS failure messages”

It will be clear from the performance data depicted in the charts below that the system is now stable and performing efficiently. As the FANS operation matures with a broader cross-section of operators (some 12 operators are routinely utilizing FANS functions in the Pacific) it will be possible to gain a new perspective on acceptability of the system's performance and therefore of the validity of the performance requirements.

The FIT will continue to monitor system performance and compare it with subjective operator satisfaction to validate the requirements. The team recognizes that system performance requirements will become more critical as traffic separation is reduced and wishes to ensure that all team members and subcontractors are prepared to account for the performance of their own system elements. All ATSUs need to recognize the importance of the FIT monitoring program since they play a key role in providing the performance data that allows the monitoring program to be successful. States whose ATSUs are not providing data should give high priority to ensuring that data provision begins as soon as possible.

7. CPDLC PERFORMANCE OBSERVED AND REPORTED MONTHLY

The following charts reflect the aggregate of 9 months of data collected from five ATS units. In the near future, we hope data will be received from all ATSPs. In the South Pacific region, there are 6 ATS units that might provide data. It is essential that all responsible agencies report performance data if a true picture of end-to-end system performance is to be achieved.

The FANS-1/A requirements against which the data for this report were measured were those indicated in paragraph 6 above. A three-month moving average has been added to all message delay charts to smooth the data for easier interpretation. Figure 1 below shows Uplink Message Delay Performance in terms of the percentage of messages that meet the associated requirements.

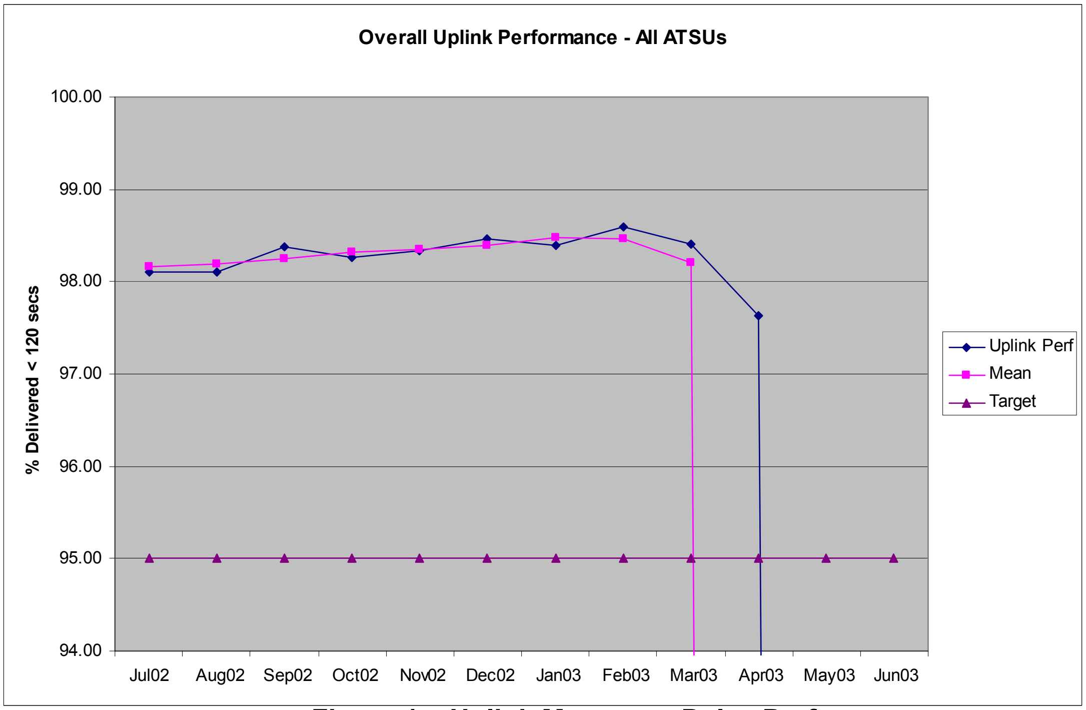

Figure 1 – Uplink Messages Delay Performance

The uplink messages delay performance remains comfortably above the 95% requirement. Since no problem reports concerning message delivery delay have been received for a considerable period, it must be assumed that the chosen performance datum meets the requirements of the end users.

Uplink round trip times are obtained by comparing the time the uplink message was sent from the ATS ground system against the time the message assurance indicating successful delivery was received back at the ATS ground system.

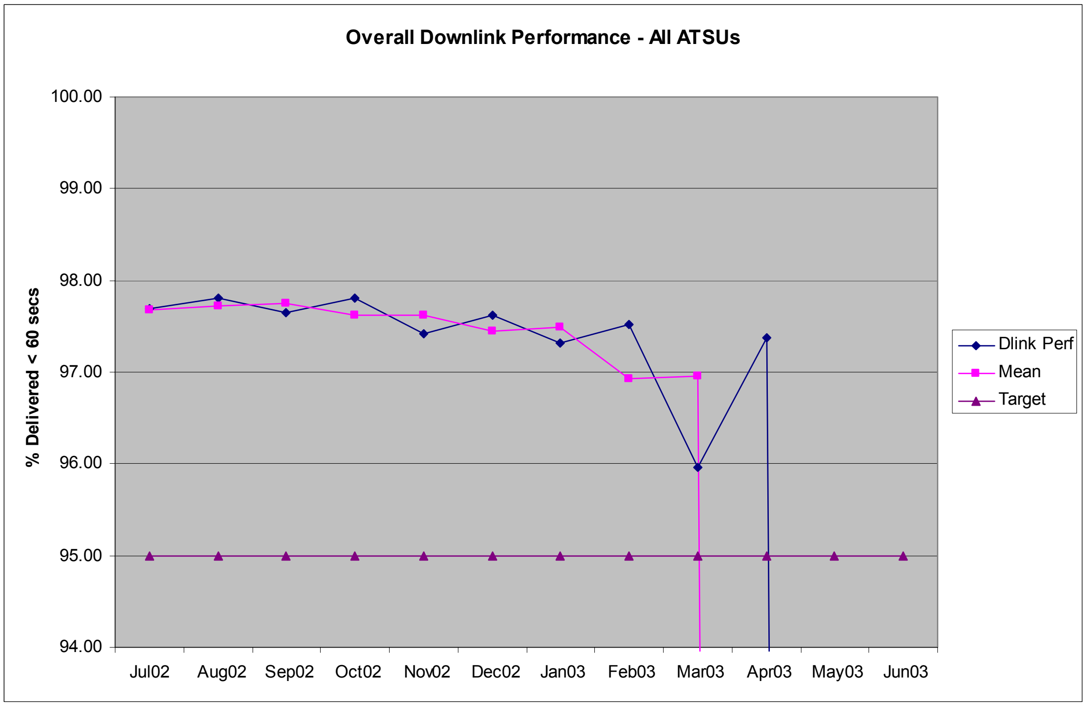

Figure 2 – Downlink Message Delay Performance

Figure 2 shows downlink message performance in terms of the percentage meeting the requirement. Performance is generally well above the requirement. The dip in performance in March was caused by an outage at the Perth GES.

8. MESSAGE SUCCESS RATE

Subjectively and practically, message success rate is as important a parameter as message latency. A success rate of 99% was set at the September 1998 meeting at which adjustments were made to end-to-end system performance parameters. This measure of success was somewhat arbitrarily set.

Reliable data can only be gathered by the system itself and, since aircraft avionics have no such function, and since message failure is defined as receipt of a MAS Failure message, it is not possible to measure success rates for downlinks. Thus, Figure 4 presents only uplink message success rate.

Uplink message success rate has also improved in comparison to a similar period last year. Although some variability in performance is shown the scale on the vertical axis should be noted.

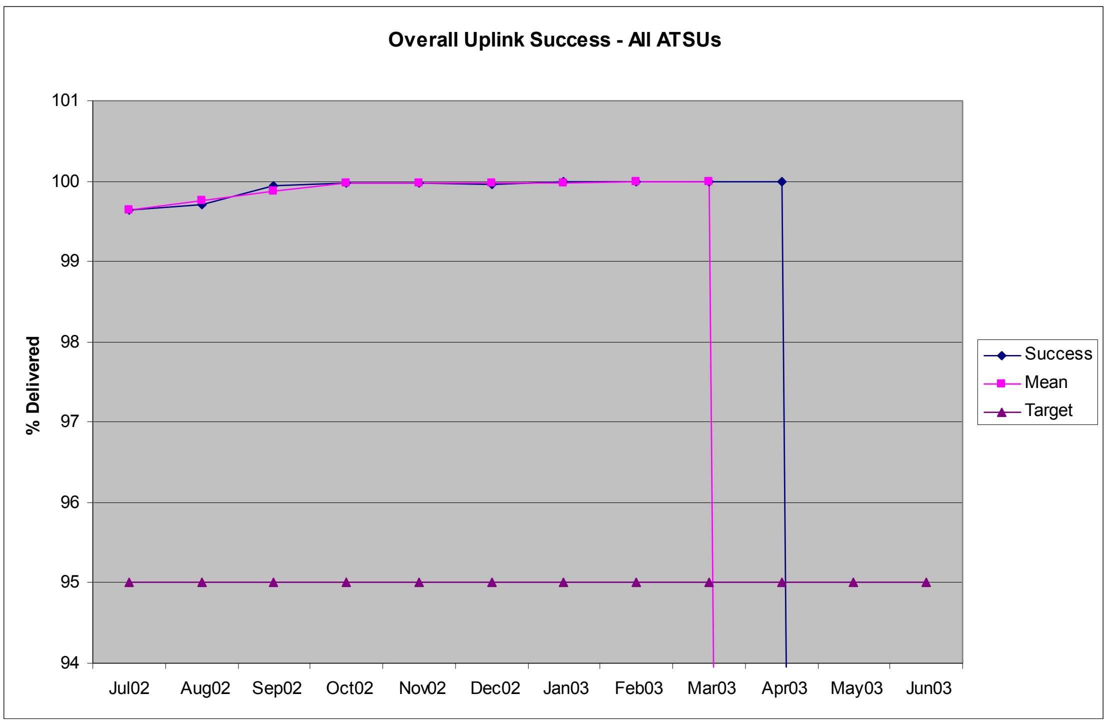

Figure 3 – Uplink Message Success Performance

Figure 3 shows uplink message performance in terms of the percentage of uplink messages successfully delivered. Despite the fact that overall system performance continues to exceed the requirements, the CRA recommends that continued monitoring be carried out. System monitoring is expected to continue as an on-going activity.

9. SYSTEM INTEGRITY

FANS-1/A system integrity is provided by utilizing the Cyclical Redundancy Check (CRC) described in ARINC 622-2. The CRC is calculated over the message's Imbedded Message Identifier (IMI), the aircraft registration (tail number), and the application data (e.g. CPDLC,

AFN or ADS message). Analysis has shown that the CRC provides for a 10^{-6} probability of an undetected bit error. This means that the probability that an undetected error will occur is one per 1 million hours of service. After six years of in-service operations, the FIT has received no problem reports that indicate that a CPDLC message received differed from that sent.

10. SYSTEM AVAILABILITY

The FIT collects system availability data for the SOPAC ATSUs as part of the routine monthly reporting process. System unavailability is included only when flight operations are affected. In other words, planned outages for maintenance are not counted against overall system availability. The FIT continues to work toward a better definition of availability, which will prevent the data's masking systemic problems. Until "availability" is better defined, no analysis will be presented here.

One of the DSPs has implemented a procedure to notify users of all planned and unplanned outages. The CRA is included on this distribution and will continue to work with other DSPs to implement a similar process.

11. CONFIGURATION CONTROL

FANS 1/A CPDLC and ADS functions use a serial system made up of a number of co-dependent elements, so overall system performance, stability, and reliability can be affected by individual components of the system. In order to ensure that FANS 1/A maintains the desired end-to-end performance, a comprehensive configuration control process, which takes into account each piece of the system, is essential. The SOPAC FIT agreed to start with an informal, non-binding procedure that facilitates the achievement and maintenance of desired performance.

The primary purpose of this "configuration control process" is to establish and maintain a database of system component hardware/software part numbers, which provide the desired end-to-end system performance. A secondary and equally important purpose of the configuration control function is to establish a process for making changes to any of the system hardware/software components in order to maintain desired end-to-end system performance for the duration of the program.

The CRA administers the FANS 1/A Configuration Control process. Specifically, the CRA maintains an up-to-date FANS 1/A system Component Configuration List (CCL). In addition to maintaining a FANS 1/A CCL and alerting stakeholders to system changes, the CRA coordinates end-to-end reviews, analyses and tests, if required to verify operational capability. In cases where end-to-end verification is not practical or required, the stakeholder requesting a change must verify that internal validation has been accomplished or reviews or analyses have shown that testing is unnecessary.

12. AIR TRAFFIC SERVICES IMPLEMENTATION

The current status of ATS providers' functional availability to support FANS 1/A operations is as follows:

Functional Availability				
ATC Center	**CPDLC**	**ADS**	**FDPS**	**AIDC**
Auckland	Operational	Operational	Operational	Operational
Brisbane	Operational	Operational	Operational	Operational
Melbourne	Operational	Operational	Operational	Operational
Nadi	Operational	Operational	Operational	Operational
Oakland	Operational	With ATOPS	Operational	Testing
Tahiti	Operational	Operational	Operational	Testing

Note: To implement AIDC, it is not necessary to use all the AIDC messages contained in the ICAO Asia Pacific Interface Control Document. Bilateral Letters of Agreement identifying the AIDC messages to be exchanged between ATC Centers are required to be concluded.

13. SYSTEM AND OPERATIONAL IMPROVEMENTS

Initial trials of the UPR procedure indicated that an average of approximately 5 minutes per flight might be saved with a maximum of approximately 20 minutes saved during the trial period. In addition to the time savings, UPR enables operators to onload additional payload that provides a significant portion of the operational benefit. In essence, this UPR procedure is a stepping stone to the next phase of DARP in which reroutes will be achieved from the UPR once new wind data arrive. The routes are economy-driven but also take account of weather systems that must be avoided, of airspace in which such operations cannot be supported and of any other limiting phenomena (e.g. volcanic activity).

The trial status of the UPR procedure was removed at the March ‘03 FIT meeting and is now part of normal Pacific operations. In addition to the implementation of UPRs, PACOTS Tracks 20, 21, X and W have been eliminated. Tracks are no longer being published, however the Oakland Center Traffic Management Unit will continue to generate the tracks and issue a Track Definition Message (TDM) to any users who have requested them. The next step for the SOPAC FIT is to begin a trial of DARP routes from a UPR once updated weather forecasts are received by the airline AOC. AIDC capability should be available to all South Pacific ATSPs by the end of 2003/early 2004.

Once all constraints have been overcome, it will be possible for operators to define the optimum track for every individual aircraft and, ultimately, to reroute on receipt of new wind data. Trials have shown that one operator’s route may be very different from another operator’s, mitigating the bunching effects brought about by customer demand for specific departure times and by landing curfews at certain destinations. Where optimum routes are close together, this bunching can be mitigated by a combination of the use of additional flight levels facilitated by RVSM and by the reduction of separation minima that FANS functions will enable.

Imposition of Required Navigation Performance RNP-10 in the Central Pacific has enabled the reduction in the lateral separation minimum from 100 nautical miles to 50 nautical miles. Unfortunately, the incidence of convective weather in latitudes south of 30° North renders the use of 50 nautical mile inter-track spacing impossible since lateral deviations by aircraft for weather avoidance are common. Similar constraints are present along the SOPAC routes and operators are cautious about opting for routings that bring their aircraft into conflict with other traffic when a deviation may be necessary.

The solution to the problem is the use of enhanced communications, which will facilitate more timely and more assured deviation clearances even when lateral separation is

minimized. Data have been gathered that show that pilots receive weather deviation clearances significantly more quickly using CPDLC than has been achieved using third-party high frequency voice radio. In addition, message clarity is far superior, and the pilot is communicating directly with the controller. The authorities are, therefore, working to accept FANS-based CPDLC as an acceptable enhanced communication medium to allow 50 nautical mile lateral spacing even in areas of convective weather.

Reduced longitudinal separation and a further reduction in lateral separation will also be facilitated by FANS and FANS-related equipage. The navigational precision afforded by the use of Global Positioning System data enables reduction in both longitudinal and lateral separation to 30 nautical miles. However, such reductions, and the intermediate step of 50 nautical mile longitudinal separation also require more stringent procedures, all of which can be supported by FANS equipage. Ultimately, CPDLC will be the medium for "Direct Controller-Pilot Communications" (DCPC), a requirement for reduced separation. ADS will allow required increases in position reporting without associated increases in workload for either pilots or controllers since ADS position reports are sent automatically. Such reductions in separation minima will facilitate increased system capacity and/or ensure weather deviation capability thus helping to reduce delay even as traffic increases.

14. CONCLUSION

Judging by the reduction in problem reports associated with system performance, the observed performance is adequate. However, as the report shows, some variability in performance continues and the need for close monitoring of the data continues. It is crucial that ATSPs continue to support the FIT's efforts by providing required data on a regular basis.

Operators are starting to realize real in-service operating benefits from the FANS system. Significant operational benefits are expected as the UPR/DARP trials begin later this year. As UPR operations mature, operators will continue to fine-tune their ground flight planning systems in order to take full advantage of particular airframe performance within airspace operating restrictions.

UPR is not, strictly speaking, an operation that requires FANS functionality. However, it is a building block to the use of the most economical routes that can be achieved (UPRs with subsequent dynamic re-routing on receipt of wind data updates and, ultimately, reduced aircraft-to-aircraft separation enabled by FANS functions). These procedures should provide the most efficient route for a particular operation within known operating restrictions.

Seamless reductions in aircraft-to-aircraft separation await the completion of planned upgrades to specific ground systems that will provide full FANS functionality. As oceanic traffic increases, such reductions will be necessary if delays are not to increase to unacceptable levels.

ANNEX A - (MEMBER ORGANIZATIONS) TO FIFTH FIT REPORT

LIST OF SOPAC FIT MEMBER ORGANIZATIONS

United Airlines
QANTAS Airways Ltd.
Air New Zealand Ltd.
Ansett Australia
Singapore Airlines
AirServices Australia
Airways Corporation New Zealand
Tahiti Oceanic Control Center
Nadi, Fiji, Oceanic Control Center
Oakland Oceanic Control Center
Service Technique De La Navigation Aerienne/Direction Generale De L'Aviation Civile
Federal Aviation Administration Headquarters
Civil Aviation Authority of Singapore
Airbus Industrie
The Boeing Company
ARINC
SITA
INMARSAT
IFALPA
IFATCA
ICAO