International Civil Aviation Organization

Fifth Meeting of the Asia/Pacific Air Traffic Management Automation System Task Force (APAC ATMAS TF/5)

Chengdu, China, 5 – 7 June 2024

Agenda Item 4: ATM Automation System Implementation Experience by States

4.5 Development of New Technology

TEST AND APPLICATION OF WIDE AREA MULTILATERATION SYSTEM IN ATMAS

(Presented by China)

SUMMARY

To improve regional surveillance capabilities and air traffic control efficiency, CAAC has promoted the testing and application of wide area multilateration (WAM) in the ATMAS. This paper will share the testing and application experience of WAM in the ATMAS.

1. INTRODUCTION

1.1 According to the ASBU plans and the CAAMS, integrating the WAM technology with radar and ADS-B technology provides controllers with more accurate and real-time aircraft surveillance information, reduces blind areas in airspace surveillance, and enhances the perception of aircraft spacing. This approach supports more flexible and efficient route design and flight management, improves airspace capacity and efficiency.

1.2 China is widely applying the multilateration technology for airport surface surveillance, and it is also committed to promoting the application of the WAM technology. Currently, China has conducted validation of the WAM system in various scenarios, including terminal areas, busy airways, mountainous regions, and ocean areas.

1.3 Drawing from phased testing and application results of WAM systems in the Sanya flight information region(Hainan) and the Shanghai terminal area, this paper exemplifies the application effectiveness of the WAM system in ATMAS and proposes upgrade and improvement suggestions for the ATMAS. The site distribution and surveillance coverage areas of the WAM systems in the Sanya flight information region and the Shanghai terminal area are shown in Figures 1 and 2.

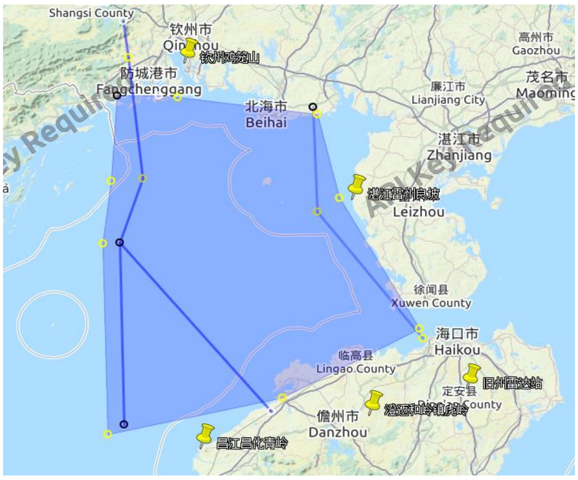

Figure 1:Layout of WAM Stations and Surveillance Coverage Area in Sanya FIR

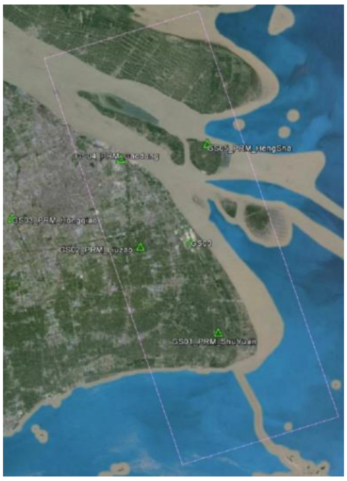

Figure 2: Layout of WAM Stations and Surveillance Coverage Area in Shanghai TMA

2. DISCUSSION

<u>APPLICATION EFFECTIVENESS OF WAM SYSTEM IN ATMAS</u>

2.1 After integrating WAM data into the ATMAS, it is conducive for controllers to utilize the advantages of WAM's high accuracy and fast update rate to assist in determining spacing allocation, thereby enhancing their perception of airspace situations. Specifically, it manifests in the following aspects:

2.1.1 Multi-source Surveillance

By fusing the WAM data with various surveillance sources, such as radar and ADS-B, the following benefits can be achieved:

a) Improve the stability of system track updates.
b) Reduce regional blind area, as shown in the illustrated areas in Figure 3.
c) Provide more comprehensive and accurate flight data, including SSR codes, call signs, and 24-bit address codes of targets, as shown in Figure 4, which enhances the automatic correlation and coupling capability between tracks and flight plans, thereby assisting controllers in better identifying, controlling, and managing flights.

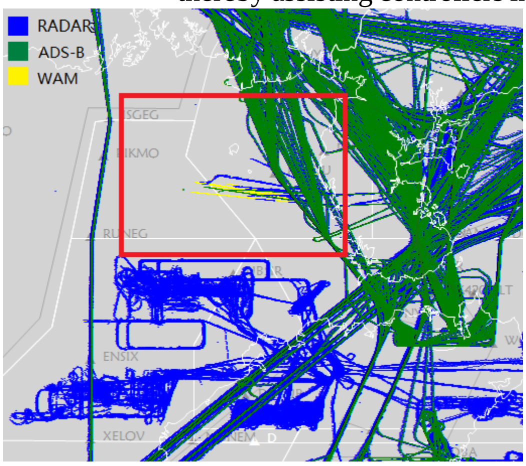

Figure 3: Illustration of Blind Area Compensation Coverage for Sanya FIR WAM

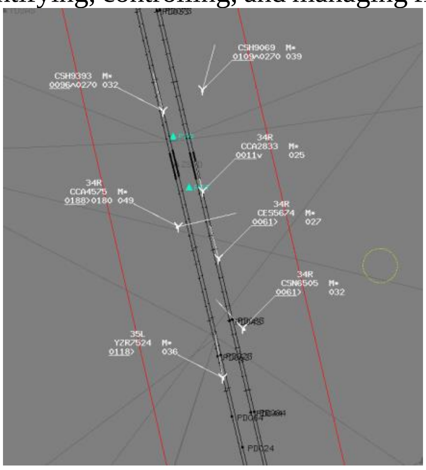

Figure 4: Illustration of Single WAM Tracks

2.1.2 Faster Update Rate

WAM technology provides a higher update frequency for target reports, improving the update rate and continuity of the system tracks in the ATMAS. This results in smoother and more stable system tracks, especially during traffic patterns and aircraft turns.

For example, to fully utilize the fast update feature of WAM, a surveillance zone with a fast update rate has been created in the ATMAS of the Shanghai terminal area. In this zone, the system tracks are generated by fusing WAM data with radar data, and the update cycle has been reduced from the original 4 seconds to 1 second. The faster target update rate enables terminal controllers to capture target flight dynamics more promptly, judge whether the target is flying according to the instructed route, thereby further reducing the flight intervals and improving airspace capacity.

By comparing the track trajectories of the WAM and radar in the Shanghai terminal area, it can be observed that the WAM exhibits better track continuity and stability in the illustrated areas in Figures 5 and 6.

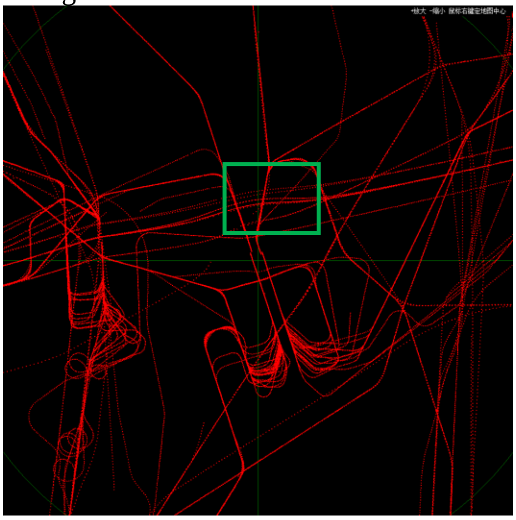

Figure 5: Radar Track Map of Shanghai TMA

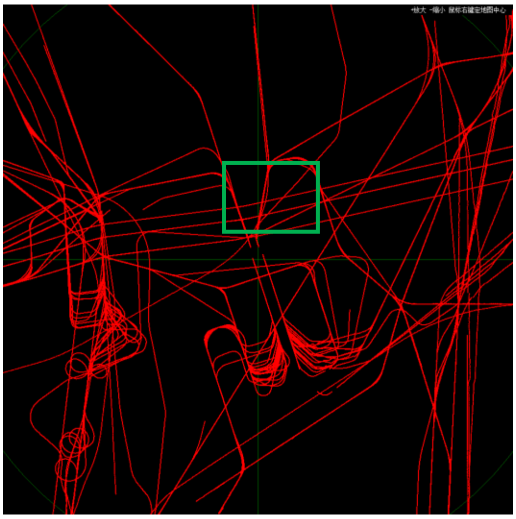

Figure 6:WAM Track Map of Shanghai TMA

2.1.3 Higher Positional Accuracy

CAAC has conducted verification tests on the horizontal position accuracy of WAM, utilizing flight inspection and data statistics.

Based on the statistical analysis results of airborne high-precision horizontal position data and WAM horizontal position data of verification aircraft on the W169 route of the Sanya flight information region, as shown in Figures 7 and 8. It was concluded that, even in areas where the positioning effect of the WAM system is not the best, the root mean square error of the calibrated aircraft target horizontal position and the airborne high-precision horizontal position data in the Sanya flight information region is approximately 45m, surpassing the 350m of route target horizontal position accuracy required by ED-142 and the industry standards of the CAAC.

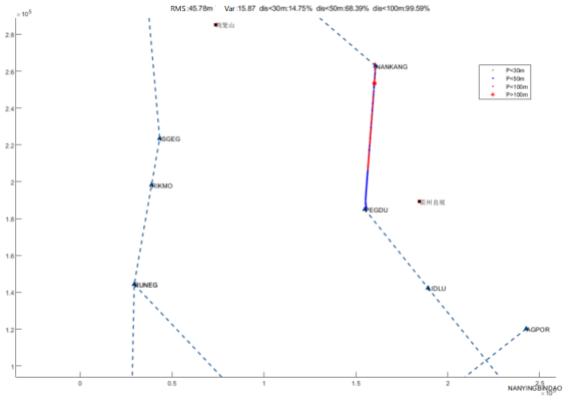

Figure 7: Distribution of WAM Position Accuracy for the Verification Aircraft in Sanya FIR

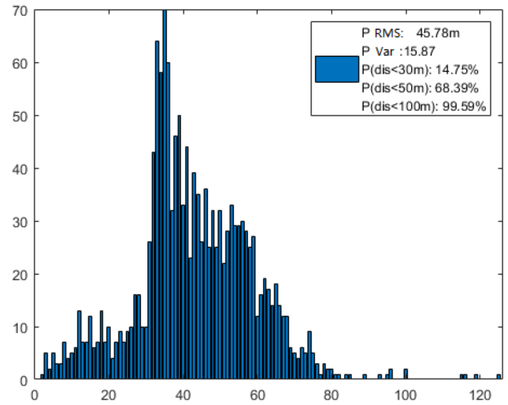

Figure 8: RMS of WAM Position Accuracy for the Verification Aircraft in Sanya FIR

According to the statistics of the horizontal position accuracy of multiple actual aircraft during the acceptance of the WAM system in the Shanghai terminal area, the results showed that the root mean square error of horizontal position accuracy was less than 18m, surpassing the target horizontal position accuracy of 150m required by ED-142 and the CAAC industry standards for the terminal(approach) area, as shown in Table 1. This is conducive for terminal controllers to utilize the high-precision characteristics of WAM to monitor the flight dynamics of aircraft in the approach area and reasonably determine the allocation of flight intervals.

Table 1: Statistics of Horizontal Position Accuracy of WAM Targets in Shanghai TMA

Horizontal Position Accuracy	Prescribed [RMS]	Results [RMS]
Target Of Opportunity 1-7800FF	≤18m	9.45m
Target Of Opportunity 2-89639B	≤18m	16.68m
Target Of Opportunity 3-7808EF	≤18m	5.34m
Target Of Opportunity 4-86CE8E	≤18m	9.93m
Target Of Opportunity 5-78122F	≤18m	7.16m
Target Of Opportunity 6-A2E25E	≤18m	5.44m
Target Of Opportunity 7-780B2F	≤18m	4.62m
Target Of Opportunity 8-780016	≤18m	6.26m

RESEARCH ON THE UPGRADE AND IMPROVEMENT SCHEME FOR ATMAS

2.2 China's WAM systems are still in the testing and verification stage and have yet to be officially put into operation. There is still room for improvement in the ATMAS's processing of WAM data, which necessitates upgrading and improving the ATMAS. Based on current research results, the main improvements include the following aspects:

a) Enhancing the ability to process abnormal data. Support for processing exceptional WAM data, including filtering or discarding of abnormal format and delayed data, as well as filtering or discarding based on various precision items within the target message.
b) Enhancing fusion processing capabilities. Support the integration of WAM data with various surveillance sources, such as radar and ADS-B, fully leveraging the advantages of the higher positioning accuracy and update frequency of the WAM system. Optimize fusion algorithms and fusion weights to improve the system track update rate. Make full use of the airborne downlink data from the WAM system to provide controllers with more comprehensive and accurate flight dynamics data, assisting controllers in better identifying, controlling, and managing flights.
c) Optimizing system track symbol. Based on the current design of ATMAS, it is

difficult to intuitively distinguish the coverage of signals from different surveillance sources through the system track symbols from multiple surveillance sources. By optimizing the system track symbols and enhancing their discernibility when signals from different surveillance sources overlap, controllers can adopt different control procedures based on the surveillance source coverage.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

d) note the information contained in this paper; and

e) discuss any relevant matter as appropriate.

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