International Civil Aviation Organization

The Fifth Meeting of Air Traffic Management Automation System Task Force of APANPIRG (ATMASTF/5)

Chengdu, China, 5 – 7 June 2024

Agenda Item:4 ATM Automation System Implementation Experience by States

4.1 Development of New Technology

RESEARCH ON INTERATING WEATHER RADAR DATA INTO ATMAS

(Presented by China)

SUMMARY

By fusing data from various weather radar sources and integrating it into ATMAS, the synchronous processing and unified display of weather echoes and aircraft tracks can be achieved. This integrated approach facilitates air traffic controllers in establishing a more comprehensive situational awareness, thereby enabling them to provide more optimized flight services to aircrews.

1. INTRODUCTION

1.1 Research on integrating weather radar data into ATMAS is a promoted by ATMB of CAAC to enhance the operational safety. It is to enable synchronized processing and unified display of weather echoes, aircraft tracks, and other relevant information in ATMAS. This integrated approach aims to facilitate controllers in building a more comprehensive situational awareness, thereby enabling them to provide better air navigation service.

1.2 In 2023, ATMB of CAAC conducted the research and validation in Guangzhou ACC and Sanya ACC, which have complex and dynamic weather conditions, .

2. DISCUSSION

2.1 Requirement analysis

2.1 The impact of severe weather is becoming a critical factor affecting aviation safety. Also, statistics show that abnormal weather accounts for 41% of global airport flight delays, which also affects customer satisfaction.

2.2 ATMAS in China only support the processing and display of weather data from primary surveillance radar (PSR) in the CAT008 and CAT009 data formats. However, the main purpose of PSR is not weather detection. Therefore, the coverage area and detection clarity of PSR are far worse than dedicated weather radars, resulting in low-quality and lacking detail in the obtained echo images. At the same time, to get large-area cloud imagery, ATMAS need to combine weather data from

multiple PSRs, which would increase the system processing workload and could lead to issues like system performance problem.

2.3 As a result, controllers currently rely on looking at supplementary weather information systems shown on auxiliary screens. Controllers need to monitor both the ATMAS displays and auxiliary screens, significantly increasing their workload, particularly during complex weather situations.

2.2 Overview

2.2.1 To get large-area cloud imagery, it have to combine weather data from various sources, such as airport weather radars and regional weather bureau radars. Taking the Guangzhou Air Traffic Control Center as an example, a total of 96 weather radars have been used to cover all the controlled sectors.

2.2.2 To handle the different weather radar data formats from diverse sources, pre-processing servers have been added to receive and process the data.

2.2.3 These servers generate cloud imagery tailored to what controllers need, capable of offering different echo intensity levels and refresh rates. The processed imagery can output in multiple data formats.

2.2.5 The cloud imagery data is integrated through layer overlays on the Human-Machine Interface (HMI) of ATMAS. It can be personalized and defined by individual controllers.

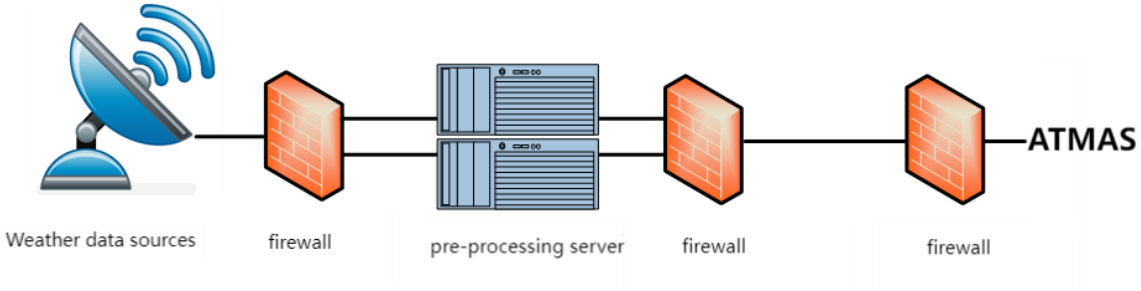

Figure 1-architecture of the research system

2.3 Capability of pre-processing server

2.3.1 The pre-processing server supports decoding and standardized processing of weather radar data, unifying coordinate projections and data formats, before outputting to ATMAS.The pre-processing server offers the following key functions:

a) Configurable intensity level and color classification for weather radar echo intensity maps, achieved through visualized configuration.

b) Decode and process original data formats from Doppler weather radars at civil aviation airports in China. Capability to decode and process China Meteorological Administration's standard weather radar original data formats, MSG31 format, NC format data, including echo extraction from imagery products.

c) Convert diverse data format into a unified format for output to ATMAS. Supported data include: Composite Reflectivity, CAPPI (Constant Altitude Plan Position Indicator), PPI (Plan Position Indicator).

d) 3D or flat mosaicking capability for over 100 weather radars. For 3D mosaics, supports configurable output of CAPPI mosaic products at any altitude from 0-15,000 meters above ground, and output of composite reflectivity mosaics.

e) Quality control of input weather radar data, filtering out abnormal or low-quality echo data, including incomplete data, radial missing wedges, co-channel interference, random strong noise, etc.

f) Supports dual-server hot standby.

g) Logging functions, recording all statuses including normal, abnormal, filtered echoes, processing exceptions, etc., providing a visual interface for user review.

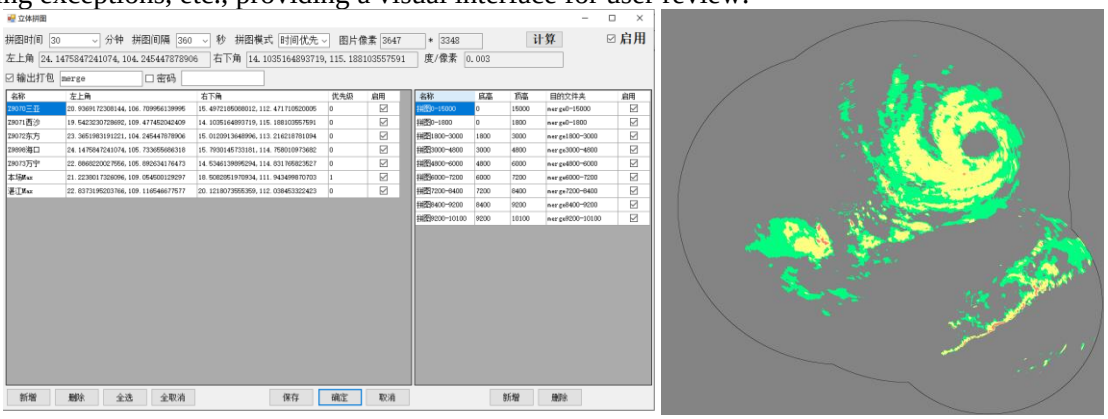

Figure 2-Weather data mosaicking

2.3.2 In addition to generating weather radar data following the ASTERIX CAT008 (Single Radar Derived Weather Info) and CAT009 (Combined Weather Report) standards set by Eurocontrol, the pre-processing server can also output data files in XML format.

These XML format data files use an equal latitude-longitude projection, where each pixel horizontally and vertically represents a fixed span of latitude and longitude values. By default, the weather radar echo intensity is divided into three levels (e.g 2,3,4), with a fixed value of 1 assigned to the edges of the radar detection range, resulting in a total of four possible data values. Areas with no echoes or beyond the radar's detection range have no data represented.

Table 1-Comparative Analysis of CAT008, CAT009, and XML Files

Data Format	CAT008/CAT009	XML File
Benefit	a) Standard data format b) No modification required on ATMAS	a) Stored in file form, can be separated to different file by weather echo range, height stratification, intensity classification as customized b) The FTP file push mechanism reduces the transmission occupation c) Only contain valued weather radar echo, significantly reduce the size of meteorological radar data and alleviate the burden on ATMAS
Cost	a) The transmission of data streams carries the possibility of transmission errors	a) Non-standard data formats

	b) The full transmission of weather data, regardless of whether echoes, imposes a burden on network links and the processing capability of automation systems.	b) Modification required on ATMAS

2.4 HMI display on ATMAS

2.4.1 Currently, ATMAS in China have the ability to display cloud imagery. However, the existing display methods and visual effects are not satisfactory, requiring upgrades and changes. The main areas that need improvement include the following:

2.4.2 Color configuration

a) The main principle is to use a single-color scheme, with two or more options for controllers to choose from and optimize. The research suggests three color scheme options: blue shades, orange shades, and grayscale tones.

b) Areas with no weather radar echoes are made see-through, while the edges of the combined weather radar coverage areas are shown using dashed lines.

c) The weather layer must not cover up or hide any map or aircraft track displays.

d) The weather layer should show different displays for controlled and non-controlled airspace areas.

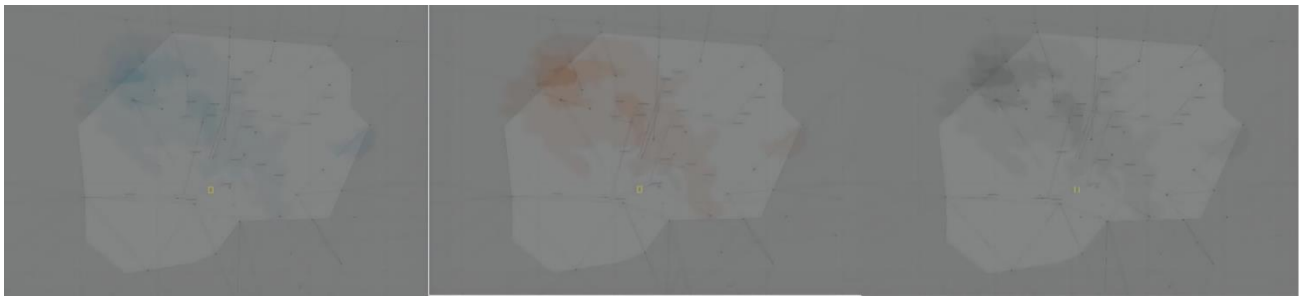

Figure 2-Three color scheme example

2.4.3 Weather Window

With the integration of weather radar echo data into ATMAS, several new functional buttons are introduced into HMI. The explanation of button layout elements is as follows:

a) Severity: Options for different weather intensity levels - Level 1, Level 2, and Level 3. The exact intensity value for each level can be set up in the pre-processing server. The three intensity levels can be chosen one at a time or multiple ones together, as needed.

(Note: From operational experience, the weather intensity that requires aircraft to go around it changes in different seasons. Being able to configure the weather intensity settings allows controllers to flexibly adjust the go-around criteria based on the actual operating conditions.)

b) Level: Represents common fly altitude layers for tower, terminal, and area control units, displaying a composite weather layer. Multiple selections are permissible.

c) Type: Corresponds to source of weather data type - "6min-" denotes weather radar data from 6 minutes ago, while "Now" represents the extrapolated current weather conditions.

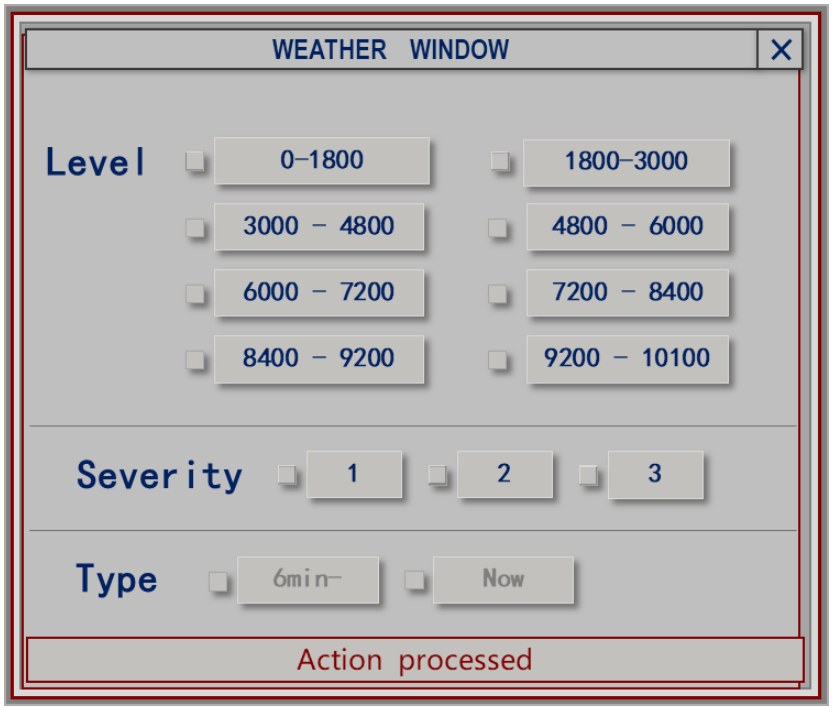

Figure 3-Weather Window

d) In the event of prolonged data source inactivity, HMI will incorporate an alert functionality to notify controllers. The alert window is dismissible through an acknowledgment operation. A weather display widget is introduced in the bottom command line of HMI:

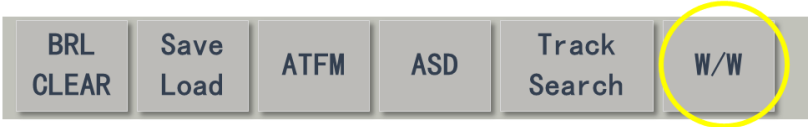

Figure 4-weather display widget

When weather data exceeds a predefined time threshold without receiving new updates, a warning alert will be triggered, causing the widget to turn yellow.

Figure 5-weather data overtime warning

2.5 Summary

Currently, the test and verification for the research have been completed on ATMAS experiment platform.in 2024, a trail operation will be launched at Mid-South regional ATMB and Hainan sub-ATMB before the coming of rainy seasons. China will share further information and experience in the future meetings.

3 ACTION BY THE MEETING

The meeting is invited to:

a) note the information contained in this paper; and
b) discuss any relevant matter as appropriate.

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