Interim Report by the Air Traffic Management System Expert Panel

April 2017

Interim Report
of the Air Traffic Management System Expert Panel

Period: 14 November 2016 – end February 2017

Contents

Glossary

Term	Definition
ADS-B	Automatic Dependent Surveillance – Broadcast
AMAN	Arrival Manager System
ATC	Air Traffic Control
ATCOs	Air Traffic Control Officers
ATM	Air Traffic Management
ATMS	Air Traffic Management System
CAD	Civil Aviation Department
DGCA	Director-General of Civil Aviation
E-ATCC	East Air Traffic Control Centre
FDP	Flight Data Processor
GPS	Global Positioning System
HKFIR	Hong Kong Flight Information Region
ICAO	International Civil Aviation Organisation
LoS	Loss of separation
NATS	National Air Traffic Services
PFI	Phased Functional Implementation
SDP	Surveillance Data Processor
SMS	Safety Management System
TEFS	Tower Electronic Flight Strip System

Term	Definition
UFS	Ultimate Fallback System
VCSS	Voice Communication Switching System

(I) Executive Summary

Summary of the Expert Panel's Views & Initial Conclusion

1.1 The Civil Aviation Department (CAD) has set up an Air Traffic Management System (ATMS) Expert Panel comprising local and overseas air traffic management (ATM) experts, academics, electronics engineers to offer independent advice to the Director-General of Civil Aviation (DGCA) and CAD on the teething issues identified since the new ATMS' full commissioning. The five-member Expert Panel comprises local representatives including Mr Warren Chim, Mr Albert Lam and Professor Man Hau-chung, and overseas representatives including the President of the National School of Civil Aviation in France, Mr Marc Houalla, and the Chairman of the International Civil Aviation Organisation (ICAO) Regional Air Traffic Management Sub-Group, Mr Kuah Kong Beng. The members are appointed for a one-year term till 30 November 2017. Brief introduction on the Expert Panel members is at **Annex A**.

1.2 The Expert Panel had held 3 meetings since its establishment in December 2016. The following is a summary of views and initial conclusion gathered from the discussions of the 3 meetings:

(i) Since its full commissioning on 14 November 2016, the new ATMS has experienced some teething issues, which were inevitable for such a large and complex system. Despite these teething issues, the ATMS has been providing safe, reliable

and generally smooth air traffic services within the Hong Kong Flight Information Region (HKFIR) and in compliant with the international safety standard.

(ii) Overall speaking, the total number of HKFIR air traffic movements handled by the new ATMS between 14 November 2016 and 28 February 2017, including the traditional busy travel periods of Christmas, New Year and Lunar New Year holidays, increased by 3.75% as compared with the same period in the previous year. The Expert Panel considered this an assuring indication of the handling capacity of the new ATMS as well as the frontline air traffic control (ATC) staff's competence in using the new system.

(iii) The new ATMS architecture had back-up contingency provision in its design and multiple levels of fallback systems to enable its continued operation during contingency situations. The Expert Panel considered such level of precautionary and back-up facilities in proportion to the complexity and essentiality of the ATMS. The Expert Panel noted the equipment of the new ATMS, its designed architecture of redundancy and resilience and the available functions and features compared very favourably against international and ICAO best practices and current requirements.

(iv) During the occurrences of the teething issues:

(a) none of the fallback systems of the ATMS (i.e. the Fallback System and the Ultimate Fallback System (UFS)), which were available at all times, had to be activated;

(b) CAD's staff had handled those occurrences professionally, per standing practices, and acted prudently to minimise potential safety risks; and

(c) there was no impact on safety and the impact on ATC operations was minimal.

The Expert Panel was of the view that CAD should continue its efforts in optimising the system to minimise future occurrences.

(v) The performance of the new ATMS has so far exceeded the applicable Eurocontrol requirements[1] on the availability of target surveillance information, which is an important safety criterion of ATC adopted by most European aviation authorities. However, given the relatively short period of time since the commissioning of the new ATMS, CAD should continue to optimise the operating procedures and system operations.

(vi) With system enhancement such as phased introduction of satellite-based Automatic Dependent Surveillance – Broadcast (ADS-B) surveillance, progressive resolution of teething issues, system adaptation updates and gradual improvement in staff's competency level in the light of operational experience, the ATMS performance has improved. This is supported by the decreasing incident rate of teething issues.

(vii) CAD has in place an effective and established mechanism for responding to different situations occurring after the full

[1] Eurocontrol Specification for ATM Surveillance System Performance Volume 1 & 2 (Edition March 2012); http://www.eurocontrol.int/publications/eurocontrol-specification-atm-surveillance-system-performance

commissioning of the new ATMS judging from and comparing against the international best practices and the ICAO's safety management system process[2].

(viii) The Expert Panel noted the Contractor (Raytheon) is one of the major suppliers of ATM and communications, navigation and surveillance related products, and is also the supplier of the old ATMS in Hong Kong, which had been in operation for more than 18 years prior to its standby mode. The Expert Panel also noted the Contractor has been providing continued support to CAD in the necessary optimisation work for the new ATMS, as would usually be required after the commissioning of any major complex ATMS projects.

1.3 The Expert Panel urged CAD to continue to fine-tune the operation and the ATMS and stay vigilant. It opined that while the ATMS has successfully coped with the challenges of peak traffic demand during the holiday seasons in end 2016 and early 2017, CAD should be prepared for the next round of challenges during the inclement weather and typhoon seasons in summer 2017. CAD should continue monitoring the performance of ADS-B closely throughout the progressive implementation of the ADS-B in 2017 with a view to further enhancing the display of aircraft positions on radar screen and gauging more views from the frontline air traffic control officers (ATCOs) for optimising operational procedures and hardware.

[2] ICAO Safety Management Manual (Doc 9859) (Third Edition- 2013) http://www.icao.int/safety/SafetyManagement/Documents/Doc.9859.3rd%20Edition.alltext.en.pdf

(II) Introduction

2.1 The new ATMS of CAD, developed by the Raytheon Company under the brand "Autotrac III", was selected in 2011 by an open tender process in accordance with established Government procurement and World Trade Organisation Government Procurement Agreement (WTO GPA) procedures.

2.2 The Audit Commission (Audit) and the Public Accounts Committee (PAC) of the Legislative Council (LegCo) made some recommendations regarding the administration of CAD's ATC and related services in October 2014 (http://www.aud.gov.hk/pdf_e/e63ch04.pdf) and June 2015 respectively (http://www.legco.gov.hk/yr14-15/english/pac/reports/63a/m_4.pdf). The Audit recommended CAD, in conjunction with the contractor of the new ATMS, to expedite action in rectifying the outstanding deficiencies/observations in the new ATMS and closely monitor the remaining contract work to minimise further project delay. The PAC urged CAD to –

(i) ensure that all the deficiencies/observations identified during the Factory Acceptance Tests and Sites Acceptance Tests must be completely and satisfactorily resolved prior to putting the new ATMS into operation;

(ii) request the contractor to take all possible effective measures to expedite the implementation of the new ATMS contract; and

(iii) closely monitor the performance of the contractor and take pro-active effective measures to ensure that the contractor settles the outstanding issues in a timely and satisfactory manner.

2.3 The Government accepted the views and recommendations made by the Audit and the PAC. CAD has accordingly taken follow-up actions as appropriate. All the acceptance test events of the new ATMS have been conducted in accordance with the requirements specified in the contract, in order to ensure that the system operation complies with the contract conditions and CAD's safety requirements. For some follow-up items of the system to be addressed, CAD, together with the contractor, have come up with a timetable to address them gradually. CAD has closely monitored the contractor to ensure that the matters are handled in compliance with CAD's requirements.

2.4 To ensure the new ATMS' compliance with the relevant requirements, CAD has engaged an independent overseas consultant in 2012 for conducting safety assessment for the new ATMS to ensure that the contractor would keep up with the international quality standards and the ICAO's safety requirements in the process of system development. Furthermore, the Secretary for Transport and Housing has appointed the UK-based National Air Traffic Services (NATS) as an independent overseas consultant to advise the Secretary directly and independently on the overall operational readiness of the new ATMS and CAD's operational staff, to ensure that both the system and the operational staff were completely ready before the new ATMS could be commissioned.

2.5 Before it was fully commissioned on 14 November 2016, the new ATMS had undergone a Phased Functional Implementation (PFI) process as recommended by NATS which commenced in June 2016. During the 5-month PFI, the use of the new ATMS managing live air traffic was progressively expanded in terms of operating time and the scope of service coverage:

(i) as the first step in a phased commissioning arrangement in June 2016, the new ATMS was used to support ATC Tower operations. Initially, the new ATMS was used for selected control positions in the Tower for two to three hours a day during non-peak periods;

(ii) in July 2016, live air traffic operations using the new ATMS were progressively extended to include all control positions in the ATC Tower and carried out at different times of the day. Reviews were conducted after each operation day to ensure smooth operations and procedural improvement in subsequent sessions; and

(iii) from August to October 2016, PFI was extended to cover other ATC functions, namely Area, Terminal and Approach at the new ATC Centre. Similar to Tower operation approach, live air traffic operations started with selected control positions to gradually cover all control positions in Approach, Terminal and Area Control functions, culminating in the use of the new ATMS for the whole new ATC Centre.

2.6 During the entire PFI period, operational functions not scheduled to be operated by the new ATMS remained with the old ATMS.

2.7 The new ATMS consists of both Main System, Fallback System and UFS. These are two separate but identical systems, which can immediately take up the role of one another for continuing the system operation in the event of failure of one of them. The new ATMS comprises two major sub-systems, namely, the Surveillance Data Processor (SDP) and Flight Data Processor (FDP), which are detailed in paragraph (III)3.1(ii)(b). Apart from the SDP and FDP, there are other sub-systems developed by different manufacturers other than Raytheon with their major functions summarised below:

(i) Ultimate Fallback System (UFS)

The UFS is a separate system with software and system architecture fully independent from those of the Main System and Fallback System to support ATC operation in case both Main System and Fallback System fail.

(ii) Tower Electronic Flight Strip System (TEFS)

The TEFS is a sub-system used at the ATC Tower to display flight information to controllers in flight strip format electronically, with automated/manual updating and posting features, replacing the conventional paper flight strips.

(iii) Arrival Manager System (AMAN)

AMAN is a tool integrated into the new ATMS to provide the aircraft arrival sequence automatically and to assist ATCOs in optimising the sequence, so as to achieve more efficient use of airspace and optimise the arrival capacity.

2.8 After the PFI and full commissioning of the ATMS, there were occurrences during the initial stage of the new ATMS operation, including the following:

(i) Occurrences involving the ATMS -

Date	Occurrence
15 November 2016	The position of an aircraft was not displayed temporarily on the radar screen of one workstation for 12 seconds.
29 November 2016	The radar screens were unable to display some of the flight information (such as flight callsigns and flight speed) for about 26 seconds. To safeguard aviation safety, ATCOs had suspended departure flights for 15 minutes during the incident.
12 December 2016	The radar screens were unable to display some of the flight information (such as flight callsigns and flight speed) for about 75 seconds. It was caused by failure of working staff to follow the

	recommended procedures promulgated by CAD earlier, which was to avoid retrieving and archiving data from the Main System.
26 December 2016	Two workstations responsible for handling flight plans in the ATC Centre which are temporarily could not process the command to change the operation configuration as the command received did not fully match with the operating configuration. The sequence of some 20 departure flights have to be rearranged to suit the air traffic situation.

(ii) Besides, a few individual systems developed by different manufacturers which were operating independently from the old ATMS were also incorporated into the new ATMS as sub-systems. Occurrences of those sub-systems included -

Date	Occurrence
	AMAN
18 November 2016	The AMAN temporarily failed to show the arrival sequence of the arrival flights for about 2 minutes due to human factor.
2 January 2017	The AMAN temporarily failed to show the arrival sequence of the arrival flights for about 2 minutes due to

	human factor.
12 February 2017	The AMAN temporarily failed to show the arrival sequence of the arrival flights
	TEFS
18 December 2016	Some functions of the TEFS System installed at the ATC Tower of the CAD were temporarily affected.

2.9 To tap into the experience, knowledge and expertise from experts with a view to appraising CAD's response/action to these occurrences and to enhancing the optimisation work of the ATMS, CAD set up an Expert Panel comprising local and overseas ATM experts, academics, electronics engineers to offer independent advice to DGCA and CAD on the teething issues identified since the new ATMS' full commissioning. The Expert Panel is also tasked to share with CAD international experiences and best practices in relation to the long-term optimisation of the new ATMS.

2.10 The Expert Panel is chaired by DGCA, Mr Simon Li. Members include local experts, Ir Warren Chim, Mr Albert Lam and Mr Man Hau-chung, and overseas experts, Mr Marc Houalla and Mr Kuah Kong Beng. The Terms of Reference and respective backgrounds of Members are at **Annex A**.

2.11 The Expert Panel members, appointed for a one-year term (from 1 December 2016 to 30 November 2017), have met three times so far to review the latest operations of the new ATMS and to provide independent professional advice to CAD. The Expert Panel also had direct dialogues with key stakeholders, including frontline ATCOs, electronics engineers, their respective association representatives and major local airlines' management pilots, to collect views and comments directly from these major users of the ATMS and providers of ATC services.

2.12 This interim report represents the Expert Panel's initial findings and conclusion of the new ATMS' operation based on the information available and deliberated at the three meetings held so far. The main focus of this interim report is to set out the Expert Panel's preliminary observations and conclusion specifically on the various teething issues upon the commissioning of the new ATMS and the optimisation work, as well as to compare CAD's ATMS performance against internationally recognised standards and best practices.

(III) Expert Panel's Activities

3.1 Since the setting up of the Expert Panel in December 2016, three meetings have been held in Hong Kong respectively on 16 December 2016, 18 January 2017 and 20 February 2017. The members attended the meetings either in person or via teleconferencing facilities.

(i) 1st Meeting on 16 December 2016

At the inauguration meeting, Members were given presentations on and discussed/observed the following:

(a) ATMS System Architecture and Multi-Level Fallback Systems

The Expert Panel noted the ATMS system architecture which comprised the ATMS Main System (a fully self-contained system that is able to deliver on its own the full ATMS system capacity, functions and capabilities), the Fallback System (a separate but identical system to the Main System, which can immediately take up the role of Main System for continuing the operations of the system in the event of failure of the Main System) and the UFS (which could run independently, though with reduced functions which will limit the handling capacity, to sustain the operations of the system in the unlikely event of total failure of both the Main System and Fallback System, thus ensuring flight safety). After reviewing the details, the two overseas Members with extensive ATC experience noted that this Multi-level Fallback arrangement in Hong Kong was in line with the practice of large-scale ATMS in other countries. The Expert Panel also noted that the contractor of the new ATMS (Raytheon) was a major supplier of ATM and communications, navigation and surveillance related products in both the civilian and the military fields with a major presence in the US ATM market. Raytheon's Autotrac III was also used in the Dubai international airport, one of the busiest airports in terms of international

passenger traffic. The Expert Panel noted that the Contractor was qualified by air navigation service providers of advanced jurisdictions when considering their own new ATM and communications, navigation and surveillance projects, and the supplier of the old ATMS in Hong Kong, which had been in operation for more than 18 years prior to its decommissioning. The Expert Panel also noted the Contractor has been providing continued support to CAD in the necessary optimisation work, as would usually be required after the commissioning of any major complex ATMS projects.

(b) Acceptance Testing Processes

The Expert Panel noted that in preparation for the implementation of the new system, CAD had conducted stringent acceptance tests on the new ATMS, including Factory Acceptance Tests, Site Acceptance Tests, Flight Check Acceptance Tests, Reliability Acceptance Tests and System Integration Tests, on par with international aviation safety management standards.

(c) Safety Management System

Expert Panel noted CAD's Safety Management System had been fully implemented since 2012 and was applicable to both the old and new ATMS. There were three layers of safety assurance implemented for the new ATMS, namely ICAO Safety Management System, an external consultant (EC Harris) engaged by CAD in 2012, and an independent external safety expert, UK's NATS engaged by the Transport and Housing Bureau (THB) in end 2015. The

conclusion in NATS' report was "*CAD is ready to proceed with Full Transition as planned, well supported by clear entry and success criteria, robust fall back contingency measures if needed, and with demonstrated operational readiness in the areas of planning, people, procedures, equipment and safety management processes, that together evidence safe implementation of the new ATMS*".

(d) Phased Transition Processes

CAD adopted the PFI approach, as recommended by NATS, which allowed staff to gradually familiarise themselves with the new operating environment, and be more focused when dealing with safety issues (such as inclement weather during the typhoon season). PFI would enhance staff confidence, allow more time for staff to adapt to the new working environment and relieve their stress with an extended period of transition. The new ATMS was launched incrementally from June 2016 onwards. The use of the new ATMS was progressively expanded in terms of operating time and the scope of service coverage over a period of about five months.

(e) "Display Degraded" Occurrence on 27 October 2016 (Prior to ATMS' Full Commissioning)

On 27 October 2016 during PFI, noting that the China International Aviation and Aerospace Exhibition would be held in Zhuhai, a flight data operator attempted to input into the new ATMS an unusual flight plan, the planned route of which did not enter the HKFIR, primarily for

information of colleagues. The unusual flight plan triggered a "display degrade" incident.

NATS' report is given in **Annex B**.

(f) Teething issues - Split tracks, False Targets and Aircraft Positions Not Displayed Temporarily

The Expert Panel noted that the occurrences were caused by, among other external factors, the limitations of radar technology. The ATMS' developer, Raytheon, would undertake optimisation work in the light of the actual operations of the system. To fundamentally overcome the limitations of ground-based radar technology, the Expert Panel noted CAD's plan to implement the ICAO-advocated ADS-B.

Refer to details in paragraph (IV)4.1.(ii).(a).

(g) Flight Plan Dis-association Occurrences on 29 November and 12 December 2016

For the incident on 29 November 2016, the radar screens were unable to display some of the flight information (such as flight callsigns and flight speed) for about 26 seconds. Nevertheless, positions and altitudes of the flight targets were still available on the radar screens. The flight information eventually reappeared automatically. To safeguard aviation safety, ATCOs had suspended departure flights for 15 minutes during the incident. According to the contractor of ATMS, the incident was primarily caused by data synchronisation process which took a higher priority over the flight plan association process, when the

offline number two Flight Data Processor commenced to synchronise data after its restart. While the data synchronisation process took priority, the flight plan association process was expected to take place shortly afterwards, resulting in the momentary flight plan dis-association. For the incident on 12 December 2016, according to investigation and analysis by Raytheon, it shared a common root cause with the occurrences of 29 November. The root cause was that, the flight plan association process took a lower priority than another system maintenance process of retrieving and archiving data, resulting in the momentary flight plan dis-association for about 75 seconds. There was no loss or corruption of flight plan data during the occurrence. All other functions of the new ATMS were functioning normally. ATCOs could obtain all the flight information through the radar system and ADS-B simultaneously at all times. For both cases, neither air traffic management nor aviation safety was affected. The Fallback system and the UFS of the new ATMS were operating normally and available for selection at all times.

(h) The Expert Panel was of the view that all these issues did not compromise the aviation safety of Hong Kong. Given the complexity of the new ATMS, the Expert Panel members noted that it was inevitable and understandable to encounter some special or unforeseen situations described under sub-paragraph (e) to (g) above in the initial stage of full commissioning. Any ATMS,

regardless of the brand, would encounter this situation and there have been similar experiences overseas. The Expert Panel was of the view that the most important point was that the CAD had established an effective mechanism to cope with different situations. Concerning this point, the Expert Panel considered that the responding mechanism of the CAD over the past month was on a par with international practice.

(ii) 2nd Meeting on 18 January 2017

(a) Prior to the 2nd meeting, Members:

(1) visited the new ATC centre and the ATC Tower to understand more about the actual operations of the new ATMS, which included the description-cum-demonstration of the features of the new ATMS, review of the system recordings of various post-transition occurrences and those known issues that had been discussed at the first meeting and reported by the media; and

(2) met with frontline staff representatives from the CAD Electronics Engineers' Branch of the Hong Kong Chinese Civil Servants' Association (EEB) and the Hong Kong Air Traffic Control Association (HKATCA) to gauge their views on the new ATMS' performance and/or experiences in operating the new

ATMS. Views of frontline staff are summarised in paragraph 4.3 below.

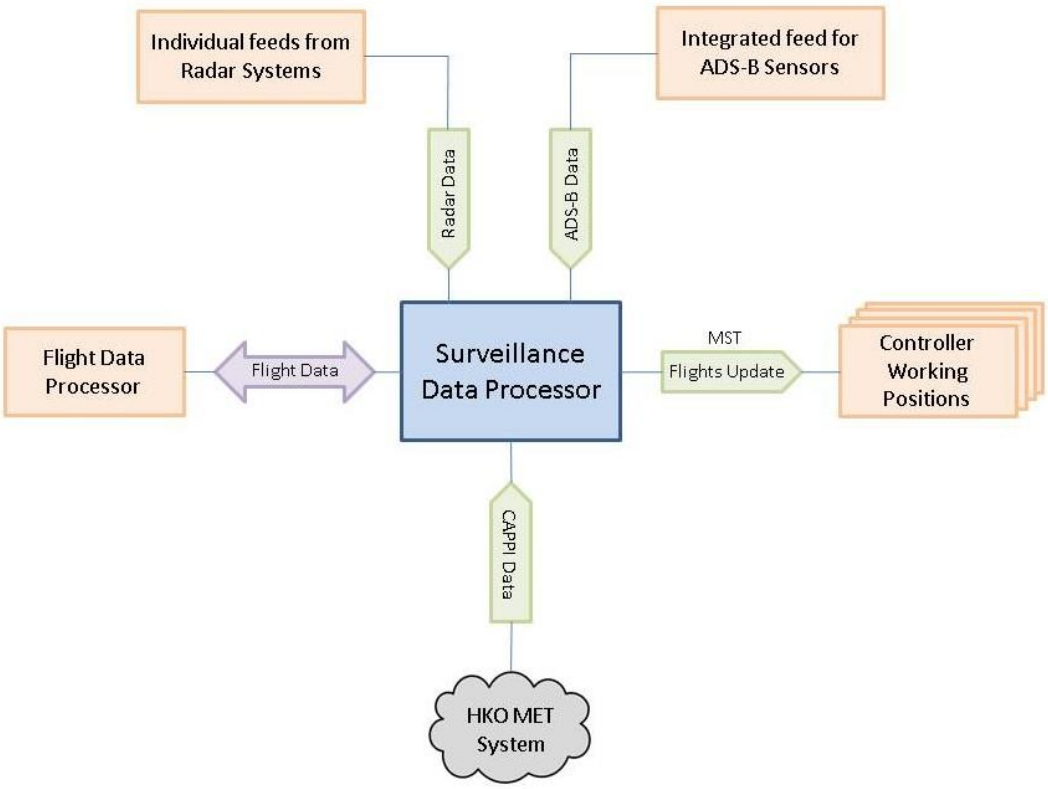
(b) At the 2nd meeting, members were given a presentation on the various functions of the Surveillance Data Processor (SDP) and Flight Data Processor (FDP) of the new ATMS:

(1) Schematic Block Diagrams and Key Functions of SDP

- Accepts and processes a maximum of 26 surveillance data inputs from the following types of surveillance sources.
  - primary surveillance radar
  - secondary surveillance radar
  - ADS-B ground stations
  - weather radar data
- Uses Multi-Surveillance Tracking algorithm
- Displays and updates the locations of flights (up to 1500 aircraft/vehicles) for regular updates to controllers' radar screens
- Processes and associates the tracks with flight plan data
- Processes and superimposes 10 layers of CAPPI[3] weather information from Hong Kong Observatory onto the radar screen

[3] CAPPI - Constant Altitude Plan Position Indicator

Fig 1. Key Functions of SDP

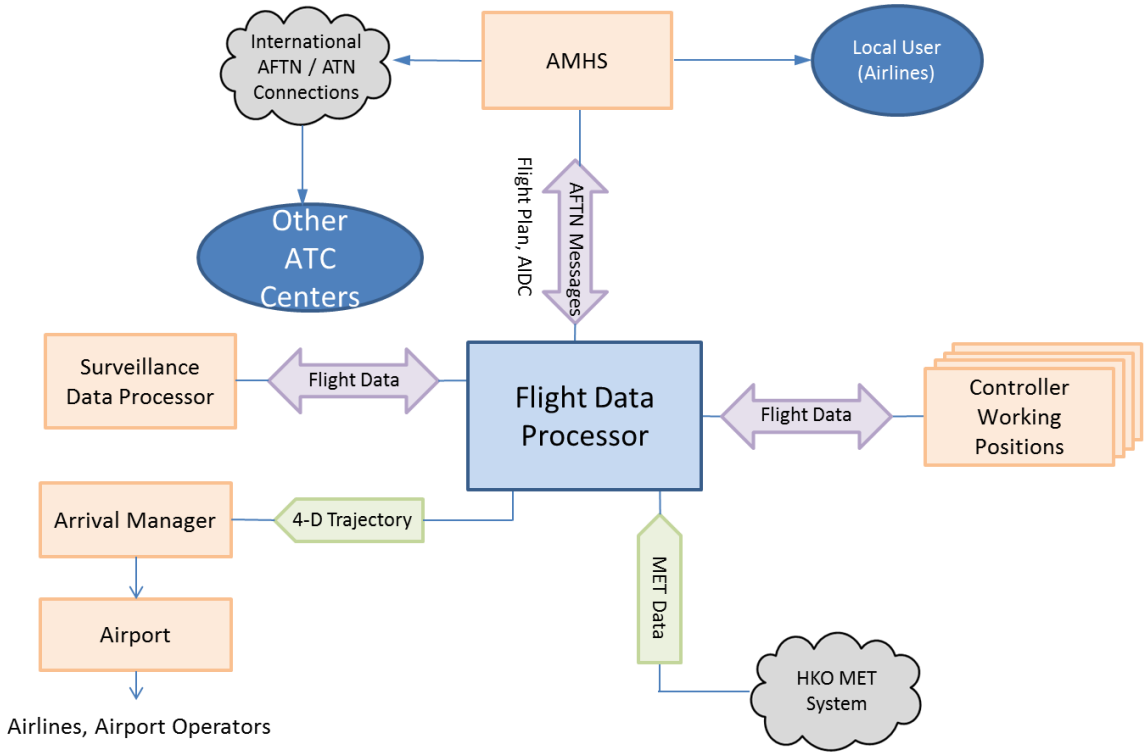


(2) Schematic block diagrams and key functions of FDP

- Processes seasonal, daily and ad hoc flight plans filed by airlines
- Displays the flight data including flight path and estimated times at way-points and at landing
- Exchanges information on aircraft parking bay stands and estimates arrival time
- Automatically transfers and accepts control of flights between Hong Kong and adjacent FIRs

- Making use of advanced 4-Dimesional trajectory prediction, provides advanced safety net alerts to potential loss of separation

Fig 2. Key Functions of FDP)



(3) Benchmarking of ATMS' Performance against Eurocontrol Requirements [4]

For benchmarking purposes and the new ATMS' performance during the 2016 Christmas and 2017 New Year holiday periods; the system availability[5] of the new ATMS had all along well exceeded 99.9%, fully achieving the international best requirements. Details of the ATMS benchmarking are given in **Annex C**.

(4) NATS' Review of Flight Plan Dis-association Occurrences of 29 November and 12 December 2016 and General View

THB invited NATS to review the two flight plan dis-association occurrences, and the Expert Panel noted NATS' assessment - "*Overall NATS confirmed that the occurrences were not unusual, and were examples of the kind of issues foreseen in previous analysis and experience from NATS. CAD's engineering and ATC responses were effective and proportionate, maintaining safety and initiating both short term measures and system changes to resolve the issue. On*

[4] The performance of ATMS is benchmarked against the international standard, namely "Eurocontrol specification for ATM Surveillance System Performance" which specifies the performance requirements for ATM systems for provision of air traffic control service. The "European Organisation for the Safety of Air Navigation", commonly known as Eurocontrol, is an international organisation working to achieve safe and seamless air traffic management across Europe. The above specification has been adopted worldwide for benchmarking performance of ATMS.

[5] According to international standard, "availability" is defined as "the probability that a system will perform its required function at the initiation of the intended operation."

29 November 2016, departure flights were temporarily held on ground for 15 minutes, while an on-site review meeting was immediately held at the East Air Traffic Control Centre (E-ATCC) between Management staff, Supervisors and Subject Matter Experts (SMEs) from both engineering and operational divisions. A total of nine departure flights were held on the ground during the temporary departure suspension. It is an international norm that implementation of safety measure should always outweigh delay. Whilst the slight impact in terms of delays and punctuality was unfortunate and to be avoided as far as possible, given the speed of response to the scenario and the need to assess the stability of the system following the resumption of normal performance of the ATMS, the temporary suspension of departure flights is considered proportionate to the scale and impact of the occurrence. NATS believes that the occurrences demonstrate that CAD has a good safety ethos whereby both occurrences were managed actively to ensure the safety of their services, and the impact on services was minimised, with normal ATC service being resumed within a short period of time. On the basis of this occurrence and the associated evidence provided by the CAD, NATS maintains its assessment that CAD's overall operational use of the ATMS is fit for purpose, with clear safety assurance to support full operations."

NATS' report is at **Annex H**.

(5) New Occurrences since the 1st Meeting relating to:

(a) Tower Electronic Flight Strip System (TEFS) Issue on 18 December 2016:

On 18 December 2016, there was an intermittent flight plan data exchange problem between the TEFS at ATC Tower and the operational ATMS at East Air Traffic Control Centre (E-ATCC) affecting departure flights. The tower workstations could not process the flight plan data of some departure flights and relevant information was provided by the ATC Centre temporarily. During the occurrence, communication among TEFS workstations could not be made and pre-departure clearance had to be delivered by the radiotelephony rather than the datalink. However, the operations of the ATMS and the E-ATCC were not affected. After investigation with the ATMS contractor, the issue was found to have been caused by a software glitch leading to the "deadlock" situation of two simultaneous tasks being processed by the TEFS server with growth of heap memory utilisation. It resumed normal operation after the server was re-booted. The Expert Panel was pleased to note that CAD has the plan to implement the fix in end March 2017, and before the change was implemented, CAD would

closely monitor the memory utilisation and carry out regular system housekeeping work, as appropriate. *[Post-meeting note: The software fix has been implemented on 20 March 2017.]*

(b) ATMS Sector De-combining on 26 December 2016

The operation configuration of some of the workstations in the ATC Centre has to be changed (ATC sector de-combining) to cope with the air traffic movements. During the process, an ATC sector split into smaller sectors to handle increase in traffic. On 26 December, the de-combining action was not successful on two controller (Planner) positions. There was no impact on safety or ATC operation except for re-sequencing of 20 outbound flights to suit prevailing traffic situation. Investigation revealed that the selected configuration did not match with any of the pre-defined configurations. The issue was considered a human factor in nature and the Expert Panel was satisfied that with briefing provided to staff and no further recurrence, the issue was closed.

(c) Arrival Manager (AMAN) Outage on 2 January 2017

An inadvertent manual initiation of runway closure by the AMAN operator led to outage of AMAN sequencing, which was resumed in 2 minutes after restoration of runway by the same personnel. The

AMAN behaved as designed. During the brief outage, controllers handled the arrival sequencing as per standing instruction. There was no impact on safety or ATC operation. The Expert Panel considered AMAN a controller decision support tool, not critical in ensuring aircraft separation and not related to the ATMS performance. The issue was considered related to human factor and the Expert Panel was satisfied that with briefing provided to staff and no further recurrence, the issue was closed.

(d) Voice Communication Switching System (VCSS) on 4 January 2017 *[Note: VCSS is unrelated to the new ATMS]*

Brief interruption (about 30 seconds) to VCSS occurred due to maintenance activity. Controllers used backup VCSS to maintain communication as had been advised prior to commencement of the activity, without any impact on safety or ATC operation. On investigation, the contractor advised that the brief interruption was due to improper conduct of the maintenance procedure. The issue was considered a human factor nature and the Expert Panel was satisfied that with briefing provided to staff and no further recurrence, the issue was closed.

(iii) 3rd Meeting on 20 February 2017

(a) Prior to the 3rd meeting, members of the Expert Panel met with five management pilots of all major local airlines and the Government Flying Service during which the management pilots shared their views on the operations of the new ATMS. In general, the pilots remarked that transitioning to the highly complicated new ATMS involved great organisational and working cultural change to CAD which posed a challenge to the Department and the frontline staff. Judging from their day-to-day experiences, the management pilots appreciated the efforts made by CAD and were of the view that transition of the new ATMS was generally seamless and their operations had been smooth since the commissioning of the new ATMS.

(b) At the 3rd meeting, Members:

(1) were briefed on the latest developments of and improvement on the ATMS performance noted since the progressive implementation of the ADS-B technology in the HKFIR. Members noted that ADS-B provided aircraft position by means of aircraft on-board Global Positioning System (GPS) and the aircraft avionics broadcast the aircraft position in a continuous manner. The ADS-B ground stations received and transmitted the aircraft position data to the ATMS for display. This ADS-B technology was different from radar. There were known limitations of radar technology, such as

reception of radar signals interfered by external factors like moving obstacles or terrain etc. ADS-B has proven to be effective in supplementing radar technology without subject to those limitations;

(2) were informed that the new software fix, which was expected to address the flight plan dis-association issue and issue with the electronic flight strip described in paragraphs (III)3.1.(i).(g) and (III)3.1. (ii).(b).(5).(a) above, had been developed and tested by the contractor, Raytheon;

(3) were briefed that CAD has closely worked with Raytheon to address various observations and the new software build delivered on 16 February 2017. The new software build was being verified according to CAD's SMS processes and was expected to address the following issues:

- Flight Plan Dis-association

  The system has been optimised for handling system backup task, server and data synchronisation task to minimise the flight plan dis-association.

- Tower Electronic Flight Strip (TEFS) Server Issue

  The system has been optimised for handling the data synchronisation between the main and standby TEFS servers for better memory management.

(4) reviewed the operations and the performance of the AMAN in the light of the three occurrences (two of which involved human factors) since the full commissioning of the new ATMS. The Expert Panel members were satisfied with CAD's quick dissemination of lessons learnt to frontline staff;

(5) were briefed on CAD's categorisation of loss of separation (LoS) incidents, their general handling as well as safety performance analysis; and

(6) deliberated on the implementation status of ATMS "multiple safety net" features. CAD has adopted an incremental approach in implementation of safety net features in the ATMS in accordance with the requirements and procedures of the ICAO's Safety Management System, in order to minimise risks while introducing any changes. The full list of safety net features available in the new ATMS is given in **Annex D**. Members were informed that safety net features implemented in the old ATMS, particularly the Short Term Conflict Alert which was a mandatory ICAO requirement, have been implemented in the new ATMS since the full transition in November 2016. Subject to prevailing ICAO requirements and operational need, the remaining safety net features would be reviewed to determine their priorities and implementation plan. The Expert Panel agreed that CAD's plan in implementing the "multiple safety net" features

progressively aligned with the best international practice.

Attendance records of the three meetings are at **Annex E**. The press releases issued after each of the above meeting are at **Annex F**.

(IV) Details of Discussion/Views Considered on Major Issues

4.1 Teething Issues

The Expert Panel members pointed out that as the new ATMS was a large-scale and complicated, comprehensive computer system, minor setbacks would occur intermittently for different reasons (including human factors), for instance, the temporary interruption of display of arrival sequence information of AMAN on 2 January 2017 due to human factors and the temporary interruption of the Voice Communication Switching System (VCSS) on 4 January 2017. These minor setbacks did not affect the operations of the ATMS, nor did they affect ATC operations or aviation safety. After evaluating the relevant occurrences, the Expert Panel considered that safety performance of the new ATMS, so far, exceeded international requirements. However, given the relatively short period of time since the commissioning of the new system, CAD was urged to continue to optimise the operating procedures and system operations in order to enable the system to perform to the highest standard possible as a safe and reliable tool for uninterrupted ATM operations. The Expert Panel members also concurred that CAD had put in place an effective and established mechanism for responding to different situations occurring after the

full commissioning of the new ATMS in accordance with international best practices and the ICAO's safety management process. The Expert Panel learnt that CAD had already explained to its staff in a timely manner the causes of the occurrences and the necessary corrections, thus pooling wisdom to improve future operations. Furthermore, the Expert Panel suggested that CAD should foster communications between the system's supplier and frontline staff continuously in order to resolve any teething problems progressively.

(i) In general, the Expert Panel was of the view that:

(a) teething issues were inevitable for a large and complex system like the new ATMS and it would be unrealistic to expect zero issues.

(b) the focus should be on the availability of multiple fallback provisions, safety nets and contingency procedures and handling. The Expert Panel noted that CAD had adequate operation and contingency procedures in place. The Expert Panel also noted that no fallback system of the ATMS had to be activated during the known occurrences, which did not impact on safety and had caused nil or minimal impact on ATC services.

(c) the Expert Panel observed a downward trend of teething issues, indicating that the new ATMS was stabilising as expected, with reference to experiences of other overseas projects.

(ii) On the teething issues, which the Expert Panel has reviewed and deliberated in detail:

(a) Split tracks, False Targets and Aircraft Positions Not Displayed Temporarily

The Expert Panel held the view that those issues could occur in any ATMS, regardless of brand. Some Expert Panel Members also shared their own experience in handling teething issues in their respective countries, which were very similar to those in Hong Kong. The Expert Panel had also engaged in a detailed technical exchange on the causes of such issues in the Hong Kong context, which were often associated with physical factors extraneous to the new ATMS. Members believed that the satellite-based ADS-B surveillance technology would have a distinct advantage over more traditional radar technologies. In fact, marked improvement (i.e. reduction in occurrences of split tracks, false targets and aircraft positions not displayed temporarily) was reported to the Expert Panel with details given in **Annex G**, coinciding with the expanded coverage of ADS-B. The Expert Panel noted that CAD has in place a plan to progressively implement the ADS-B within the HKFIR by end-2017, which should significantly reduce such occurrences; and noted CAD's efforts in fine-tuning the performance of surveillance sources and mitigating adverse external factors affecting system surveillance performance. The Expert Panel

urged CAD to continue its efforts and performance monitoring work with a view to resolving these teething issues promptly and providing a better working platform for staff.

(b) Temporary Flight Plan Dis-association on 29 November and 12 December 2016

The root cause and the circumstances leading to the momentary flight plan dis-association had been identified by CAD and its contractor. With the workaround procedures implemented, there has been no recurrence of similar issue at time of writing this Report. The Expert Panel also noted that the contractor has come up with a software fix, which would be deployed in the next software build scheduled for end-March 2017 after the necessary testing and safety assessment processes. CAD will give an update to the Expert Panel on the progress during the process. The Expert Panel noted NATS had reviewed these two occurrences and it agreed with the observations of NATS. NATS' report submitted to THB on these two occurrences is at **Annex H**. *[Post-meeting note: The software has been implemented on 20 March 2017.]*

(c) Tower Electronic Flight Strip (TEFS) Server Disruption on 18 December 2016

There was intermittent flight plan data exchange between TEFS and the new ATMS. The root cause

has been identified to be a memory management issue, commonly affecting large-scale and complex computer systems. An Expert Panel Member shared a similar experience of an overseas project and the regular flushing of system memory as a housekeeping practice, which was also being practiced by CAD. There has been no recurrence of similar issue at the time of writing this Report while a permanent fix to the issue is to be deployed in the next software build scheduled for end-March 2017. *[Post-meeting note: The software has been implemented on 20 March 2017.]*

4.2 **Views on Other Issues which had Drawn Public Attention**

(i) ATMS Sector De-combining Issue on 26 December 2016

Members noted that sector de-combining through splitting a jurisdiction into sub-jurisdictions was a common means to more effectively manage ATC sector workload and handle expected increase in traffic. During the incident, the selected ATC sector configuration did not match with any of the pre-defined configurations adapted in the system. The new ATMS had performed as designed. The glitch was basically caused by human factor issue, and briefings had been provided to ATC staff to prevent recurrence. There has been no recurrence of similar issue at the time of writing this Report. The Expert Panel considered the issue closed.

(ii) AMAN Disruptions on 18 November 2016, 2 January 2017 and 12 February 2017

The occurrence on 18 November 2016 was caused by an ad-hoc log collection on AMAN during high traffic period, inducing a brief two-minute disruption. During the interim, the controllers adopted the "in-trail spacing" so the impact to the operations was minimal. Nevertheless, lesson learnt was subsequently shared among the technical staff and formal maintenance rules were also established. The occurrence on 2 January 2017 was caused by the manual initiation of runway closure resulting in the suspension of display of arrival sequencing, which quickly resumed as soon as the runway closure action was reversed. These two occurrences were caused by human factor and briefings/lessons learned have already been provided to staff concerned and the relevant operational/maintenance procedures have been revised by CAD. There has been no recurrence of similar issue at the time of writing of this Report. The Expert Panel considered the two occurrences on 18 November 2016 and 2 January 2017 closed. Members noted that the root cause of the last occurrence on 12 February 2017 was still being investigated by CAD and the contractors concerned. While concurring that the AMAN was not a safety critical system, the Expert Panel urged CAD to follow up closely with the contractors concerned to identify the root cause and implement a fix. CAD was requested to report the finding to the Expert Panel in due course.

(iii) Issue with the Voice Communication Switching System (VCSS) on 4 January 2017

On 4 January 2017, a particular radio channel in the main VCSS was not serviceable in one controller position at North Tower while the VCSS operations at other positions were normal. A brief half-minute disruption to the main operational system was caused when the server was rebooted by maintenance staff. During the brief disruption, controllers immediately used the backup VCSS to maintain radio communication with pilots and the new ATMS was running normally throughout the process. The Expert Panel noted CAD's explanation that the VCSS was a separate system provided by another supplier (i.e. not Raytheon) and the occurrence was not related to the new ATMS. Nevertheless, it was included for the Expert Panel's review as VCSS was essential to ATC services. The Expert Panel noted that a brief interruption to the main VCSS had occurred from the carrying out of maintenance activity. The controllers turned to the readily available Backup VCSS as per standard practice, and as advised prior to commencement of the maintenance activity. CAD has been liaising with the contractor for an explanation on the cause of the brief interruption. As VCSS has been available at all times during the incident, the Expert Panel considered the issue not critical in nature. CAD was requested to report the cause of the interruption to the Expert Panel in due course.

(iv) Loss of Separation Incidents

The Expert Panel also discussed the recent media reports on the Loss of Separation (LoS) incidents, which was defined as an infringement of applicable standard horizontal and vertical distances between aircraft. The ICAO allowed individual civil aviation authority to establish different categorisation and procedures in handling LoS incidents to suit the individual circumstances. With reference to practices of international air navigation service providers, CAD established the current procedure, in which same rules were applied while using the old and new ATMS. The Expert Panel considered that the categorisation and handling procedures of LoS incidents by CAD were on par with international practice. By comparing the safety performance in terms of event rates based on the international practice of adopting a running 12-month period up to end January 2017 (**Annex I**) against the Safety Performance Indicator (based on CAD's performance data of past 10 years), the Expert Panel noted that the overall incident figures were well below the safety threshold. The Expert Panel also reviewed and commented that the LoS incidents in January 2017 reported in the media were of minor nature, without causing any threat to aviation safety. Nevertheless, the Expert Panel urged CAD to continue to closely monitor LoS incidents to arrest any increasing trend and identify any apparent cause if such a trend is noted.

4.3 **Views of Frontline Staff**

The Expert Panel had met with representatives of frontline ATCOs and electronics engineers of CAD on 18 January 2017 and noted the following feedback:

(i) Staff considered that the ATMS was safe and reliable, and that the controllers were becoming more competent and confident in using the ATMS in providing ATC services.

(ii) The controllers expressed the view that the teething issues encountered were inevitable for such a complex system and wished to see the necessary optimisation work done as soon as practicable in addressing their comments/observations.

(iii) The engineering staff considered that the contractor (Raytheon) was responsive so far in conducting prompt investigation and necessary actions when needed.

(iv) Controllers had expressed concerns about the nuisance caused by certain predictive conflict alert warnings, the setting of which would need to be fine-tuned pending the accumulation of more operational experiences and staff feedback.

(v) Some controllers also indicated that operating the new ATMS could be, at times, relatively more tiring compared with operating the old system, especially during the initial period of the commissioning of the new ATMS.

(V) Recommendations

5.1 Addressing Teething Issues

The Expert Panel is satisfied with CAD's handling of the teething issues and the progress of resolution so far. With reference to Members' local/overseas experiences and the international best practices, the Expert Panel proposes the following recommendations/advices for CAD's follow-up:

(i) Quite a few reported occurrences shared a common thread of maintenance activities at time of occurrence. Except for emergency maintenance, such work should be best carried out in a period of low traffic or when impact on ATC services could be kept to a minimum.

(ii) It is important for the maintenance team to maintain good coordination with the operation team. Timely advice on the temporary arrangement, including fallback arrangement, and any possible impact to be expected arising from maintenance activities should be provided to frontline staff as far as possible.

(iii) CAD should continue to optimise the operating procedures and system operations in order to enable the system to continue to perform to the highest standard possible as a safe and reliable tool for uninterrupted ATC operations.

(iv) Given the reduction in surveillance related issues and possibly enhancement of conflict alert performance with the progressive implementation of ADS-B, the Expert Panel recommended CAD to continue its efforts to expedite full integration of ADS-B in the new ATMS by end-2017.

(v) Upon implementing the software in end March, CAD should closely monitor the system performance and its effectiveness

to avoid recurrence of reported teething issues. *[Post-meeting note: The software has been implemented on 20 March 2017.]*

(vi) On deployment of software fixes/enhancements, CAD should prioritise the items and implement those changes prudently in order to minimise risks while introducing any changes.

5.2 Effective Communication

(i) The Expert Panel notes CAD has promptly disseminated appropriate factual information through different channels and fora, both externally and internally, in order to avoid unnecessary misunderstanding and concerns. The Expert Panel encourages CAD to continue to do so.

(ii) The Expert Panel also recommends CAD to be more proactive in sharing with staff the considerations, practicality and hence the priorities and timelines in implementing enhancement and optimisation measures. This is important in avoiding unnecessary misunderstanding. CAD should continue with its good practice of gathering views and facilitating feedbacks from both the operational and engineering teams.

(iii) The Expert Panel also recommends CAD to consider how to promote the ATC profession and knowledge to the community at large, which will understandably take time.

5.3 Addressing Staff Concerns

To address the staff's concerns and enhance staff's confidence in the new ATMS, the Expert Panel recommends CAD to:

(i) reduce conflict alert nuisance caused by false targets, and in particular, through the on-going efforts in implementing ADS-B in phases to be completed by end-2017; and

(ii) continue fine-tuning the predictive conflict alert settings in order to best suit operational needs; and

(iii) continue monitoring controllers' concerns on workload, and address through measures like reviewing the break/relief arrangements in consultation with operational staff representatives and providing additional ATC manpower during peak hours/seasons of air traffic to keep pace with growing air traffic in the longer term, etc.

(VI) Way Forward

6.1 The Expert Panel will continue to provide independent expert advice to DGCA and CAD on the teething issues as well as long-term optimisation of the new ATMS through regular meetings, among other means. The Expert Panel will also closely monitor CAD's follow-up work on its recommendations.

6.2 The Expert Panel opines that while the ATMS has successfully coped with the challenges of peak traffic demand during the holiday seasons in end 2016 and early 2017, CAD should be prepared for the next round of challenges during the inclement weather and typhoon seasons in summer 2017. CAD should continue monitoring the performance of ADS-B closely and gauging the views from the frontline ATCOs for optimising operational procedures and hardware, and be prepared for the full

integration of ADS-B in the new ATMS in a progressive manner in 2017 to further enhance the display of aircraft positions and minimise conflict alert nuisance caused by false targets.

6.3 A final report of the Expert Panel will be issued following expiry of the one-year term by 30 November 2017.

ATMS Expert Panel
April 2017

Annex A

Air Traffic Management System
Expert panel members

Terms of Reference

- To provide objective expert advice to the Director-General of Civil Aviation on the teething issues arising from the commissioning of the new Air Traffic Management System (ATMS) by the Civil Aviation Department (CAD) and the necessary optimisation work; and
- To share with the CAD international experience and best practices in relation to long-term optimisation of ATMS.

Term of appointment

- From December 1, 2016 to November 30, 2017

Background of Expert Panel Members

Ir Warren Chim is a professional aircraft engineer and Deputy Chairman of the Hong Kong Institution of Engineers' Aircraft Division. He has over 30 years of professional aviation experience at executive and operational level in Aviation Consulting, Aircraft Hangar Design, Airworthiness, Business Aviation, Business Development, Corporate Planning, Fleet Planning, Base Maintenance, Line Maintenance, Learning & Development, Technical Training, Quality Assurance & Management, Safety & Risk Management in Hong Kong, Macau and Mainland.

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Mr Marc Houalla is the President of Ecole Nationale de l'Aviation Civile (National School of Civil Aviation). He commenced as an engineer specialised in software and telecommunications applications to air transportation at the Civil Aviation Authority of Canada. In early 2000s, he was the Marseilles Airport Director. From 2004 to 2007, he was director of the French Air Navigation Service Provider in South East region. In 2007, he became CEO of service d'exploitation de la formation aéronautique (SEFA, former National School of Civil Aviation).

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Mr Kuah Kong Beng is the Chairman of International Civil Aviation Organization (ICAO) Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) Air Traffic Management Sub-Group.

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Mr Albert Lam assumed the post of Director of Civil Aviation in October 1998 and retired in April 2004. During his service, he has made significant contribution to the development of Hong Kong as an international and regional aviation centre and actively promoted Hong Kong in the international civil aviation arena. He was responsible for coordinating the relocation of the Airport from Kai Tak to Chek Lap Kok. Mr Lam was elected as the Chairman of the International Civil Aviation Organization 11th Air Navigation Conference, which was the first time that such a significant international aviation conference has been chaired by a Chinese. He was awarded the Silver Bauhinia Star in 2004.

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Professor Man Hau-chung is the Dean of the Faculty of Engineering of the Hong Kong Polytechnic University. He graduated with a BSc(Eng) in Polymer Science and Engineering from Queen Mary College, University

of London, an MSc in Plant Engineering in the Process Industries from the University of Technology, Loughborough, UK, and a PhD in Laser Materials Processing from Imperial College of Science, Engineering and Medicine, University of London.

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Incident Report on Air Traffic Management System (ATMS) Occurrence 27th October 2016

1. Introduction

1.1. Arising from a recent occurrence of the ATMS when some workstations entered into a "Display Degraded[1]" mode on the 27th October 2016[2] during a Phased Functional Implementation (PFI) session at East Air Traffic Control Centre (E-ATCC), THB have requested NATS to assess the course of actions undertaken in response to the occurrence, to advise on the safety and readiness of new ATMS, and to make relevant recommendations based on NATS' experience of similar system transitions. This report details the following aspects and consideration factors of the occurrence in turn:

a) The sequence of the event.
b) In the context of the specific event, did the associated operational and engineering reversion procedures adequately deal with the issue to maintain a safe air traffic service and minimise the operational impact?
c) In the context of the specific event, have CAD identified the root cause of the event and put in place appropriate revisions to the systems and training to ensure that this event will not re-occur?
d) In the wider context, should this event have occurred after Full Transition, would the system have been sufficiently robust to continue to provide a safe service with managed impact on service provision?
e) In the light of this event, are there recommendations that NATS would make to support CAD's full commissioning of the new ATMS?

2. Sequence of the Event

2.1 During the Full E-ATCC PFI session on 27 October 2016, a full team of frontline operational and engineering staff were manning respective positions of the new ATMS (Autotrac 3 or AT3) at E-ATCC handling all 3 ATCC functional streams, viz. approach/departure (APP/DEP), terminal (TMC) and area (AREA) with AT3's North Tower (N-TWR) in parallel operation mode. Concurrently, South Tower (S-TWR) and West Air Traffic Control Centre (W-ATCC), served by the existing ATMS, were respectively providing operational aerodrome control and parallel ATC operations to support the PFI session with capability of instant reversion to W-ATCC according to the pre-defined PFI reversion process and criteria for all planned and unplanned completion of PFI[3] to ensure seamless ATC operations.

[1] Workstation "Display Degraded" indicates a data mismatch has been detected and contained by disabling the associated software processing thread in the workstation only. Other threads running simultaneously in the workstation remain unaffected. "Display Degraded" mode is not a system crash, but is an automated system strategy in AT3 as per system design to contain potential system issues at affected workstation whilst preserving data integrity and continuing a safe ATC service.

[2] All times in Hong Kong local time.

[3] A previous unplanned reversion was called during the PFI on 27 September 2016 when an inbound flight declared emergency due to engine failure. Reversion to W-ATCC operation was initiated per pre-defined PFI reversion process and criteria and completed without impact on safety or ATC operations.

2.2 Noting that the bi-annual China International Aviation and Aerospace Exhibition would be held in Zhuhai, a Flight Data Operator (FDO) concerned attempted to input some "non-routine" command / scenario data into the new ATMS primarily for information of frontline colleagues.

2.3 At 10:23, a flight plan (FPL) for an airshow practice flight (not entering HK Flight Information Region - HKFIR) in association with the Zhuhai Airshow was received and rejected by AT3 and as per system design, channelled into its Problem Message Queue (PMQ)[4]. The PFI commenced at 10:33. At 11:29, the FDO retrieved a rejected FPL from the PMQ for review and noted that the FPL had departure aerodrome, route, destination aerodrome fields all indicating Zhuhai airport, which was unusual. In an attempt to recover the FPL, the FDO first deleted the route field entry but the change was rejected by AT3. In a second attempt, the FDO revised the FPL route to go directly to a navigation route fix called ROMEO ("direct to ROMEO"). It should be noted that ROMEO is not a route fix within HKFIR. The change was applied and the FPL was processed by the system.

2.4 This unusual FPL, though processed, did not indicate entry into HKFIR, and was followed subsequently by 3 controller positions[5] in Terminal Stream assigned to process the FPL for flight planning purpose entering into "Display Degraded" mode automatically. These positions were not involved in providing active control of aircraft. This is an automatic protection mechanism by system design to contain the data mismatch at these positions, whereby all executive control positions with radar display used for direct communication with flights were operating normally as usual at all times.

2.5 In recognition of multiple workstations entering into "Display Degraded" mode and in consideration of on-going parallel operation at W-ATCC with full operations/engineering team and instant reversion capability, the PFI managers (one each from operations and engineering), in accordance with pre-defined PFI reversion process and criteria[6], initiated the reversion procedure at 11:35 notwithstanding the availability of Fallback System as well as the Ultimate Fallback System (UFS) running in parallel in the background in addition to the normal operation of the Main System. The reversion was completed safely and successfully at 11:41. While AT3 was under shadowing operations, spare positions in the AT3 were logged on, per standing instruction, in an attempt to recover from the degraded workstations and a similar issue was observed.

2.6 With the presence of a full operations/engineering team, as part of the testing, shadowing operations commenced at E-ATCC at 12:08 using ATMS Fallback System and "Display Degraded" at the workstations concerned was observed as expected. At 12:30, the UFS was used to continue with shadowing operations and to further confirm all of the workstations were functioning normally without workstation "Display Degraded" as expected. The shadowing operations completed at 13:00.

[4] "Problem Message Queue" (PMQ) is AT3's repository of problematic FPLs detected with syntactic or semantic errors for manual processing.

[5] Currently, there are about 50 controller working positions in E-ATCC and N-TWR.

[6] The PFI reversion process with entry/exit criteria was reviewed by NATS in its Phase 2 study.

NATS Observation 1 – NATS noted a good engineering practice of new ATMS architecture design and contingency provision in its Main System, Fallback System and UFS. There is no provision of UFS in the existing ATMS. NATS also noted that provisions are available for the Main System itself to handle multiple scenarios of failure, which are not available in the existing ATMS.

Moreover, the Main System and Fallback System are exactly the same in terms of hardware and software design. Thus, the Fallback System, by offering contingency provisions, can cater for multiple hardware problems, e.g. overheating and failure of circuit boards and the design was such that it responded in the same manner as the Main System to the "non-routine" command/scenario data, as expected.

On the other hand, the UFS is different from the Main System and Fallback System in terms of software and hardware design and therefore did not encounter the same problem. The testing conducted in E-ATCC, after reversion of operations to W-ATCC, is a good demonstration and confirmation to ascertain the response of the new ATMS Fallback System and the UFS with expected results tallied with the design of the system in ensuring the continued provision of ATC service.

Moreover, the Main System, Fallback System and UFS were stable. No system crash was observed at all times.

2.7 In parallel, CAD and the on-site engineer of the new ATMS Contractor (the Contractor) investigated the issue by collecting data logs while leaving the system in its then present state to facilitate testing/investigation. The concerned FPL causing the issue was positively identified (see Section 4).

2.8 At 14:15, a de-briefing session was held to inform CAD staff who had participated in the PFI in that morning about what had happened, cause of the occurrence, decision for reversion to existing ATMS, system designed protection mechanism available, immediate workaround, follow-up fix, and a Question & Answer (Q&A) session to provide as much information to the CAD staff as available on hand.

NATS Observation 2 – CAD had undertaken significant and stringent system testing. However the specific scenario that occurred during the PFI had not been identified as part of testing and procedure design. NATS has experienced similar issues with flight planning data causing system inconsistencies during both system transitions and normal operations in UK. Even with all reasonable efforts and endeavours, there could still be possibilities to have set-backs of this type during introduction of a new system. This underlines the importance of contingency, transition and fallback provisions, procedures, and associated training that were duly covered in Phase 2 Study. Moreover, new ATMS design to have “Display Degraded” mode to contain a data mismatch at the workstation level, without causing system or workstations crash, is obviously an improvement over the existing ATMS to preserve data integrity and ensure a safe ATC service.

3. Effectiveness of System Reversion from PFI

3.1 As detailed within the NATS' PFI Stage 2 and Full Transition Assessment (Phase 2 Study – see Reference 1), in preparation for PFI and Full Transition, CAD has established a framework of evidence that the people, procedures, equipment, and safety management processes for each stage of the PFI and Full Transition are operationally ready. This scope includes the following specific PFI criteria that are related to the occurrence:

a) Operational entry and exit criteria were established for both planned and unplanned occurrences (CAE Ref 1.1)
b) Both engineering and operational ATC Staff are adequately briefed (CAE Ref 1.3, 2.1, 2.2, 2.3)
c) ATC Procedures are in place for staff participating in live and parallel operations (including temporary instructions) (CAE Ref 3.1)
d) Engineering Procedures (including temporary instructions) are in place to cover steady state and fallbacks (CAE Ref 3.2 & 3.3))
e) System entry and exit criteria (planned and unplanned) are in place (CAE Ref 4.1)
f) System Test Evidence for ATMS build is in place (CAE Ref 4.3)
g) There is evidence of the PFI configuration to enable parallel operations, entry and exit from the session is understood, including any limitations/shortcomings (CAE Ref 4.4)

3.2 Phase 2 Study details the evidence provided against these areas by CAD in its overall finding, NATS confirms that CAD has achieved a robust evidence based approach and is satisfied that "CAD is ready to proceed with Full Transition as planned, well supported by clear entry and success criteria, robust fallback contingency measures if needed, and with demonstrated operational readiness in the areas of planning, people, procedures, equipment and safety management processes, that together evidence safe implementation of the new ATMS."

NATS Observation 3 – CAD's exit criteria, fallback procedures and transition out of PFI to normal operations, as reviewed and agreed by NATS in the Phase 2 study, worked as intended and allowed CAD to smoothly and safely transition out of PFI and assume continuous operations without any safety or operational impacts. The de-briefing session with the staff involved is a good practice as part of overall communications and staff engagement.

4. Fault Identification and Resolution

4.1 Following the occurrence, CAD immediately forwarded relevant system records and system logs plus relevant observation documents to the Contractor for urgent investigation and rectification. The following are findings and proposed remedial actions by the Contractor:

a) The immediate cause – that it was the route data deemed invalid by the system in the unusual FPL as determined by CAD was confirmed.

b) The root cause –the occurrence was confirmed to be in the FPL posting logic for flight planning function. An explanation of the mechanism leading to the occurrence is given in Appendix 1.

4.2 With the root cause positively identified, the Contractor has already worked out a software fix and successfully tested at their factory confirming that the same issue will not recur. The fix has also been verified in Hong Kong for all such unusual FPL scenarios with satisfactory results.

4.3 The implementation of the fix is to handle the data mismatch for HKFIR entry time before applying the posting logic. In case of no HKFIR entry time, posting logic based on HKFIR entry time would not be applied. The FPL concerned will be displayed at the auxiliary screen of the ATMS (which is next to the radar screen) for reference by the air traffic controller(s) and flight planner(s) concerned, i.e. the FPL data checking has been improved to handle such situations.

NATS Observation 4 – CAD together with the Contractor have been able to quickly identify the root cause and recreate the occurrence. NATS is satisfied that enhancement measures including the software fix and procedural changes have been implemented and verified to both solve and avoid the recurrence.

5. Potential Impact if the Issue of "Display Degraded" Had Occurred After Full Transition

5.1 If the same FPL issue causing display degrade had occurred after Full Transition without the new fix, based on established procedures, the concerned FDO would immediately retrieve the problematic FPL, of which the route field content had been modified and applied just before the workstation had entered into "Display Degraded" mode. The FDO could quickly remove the problematic FPL using his own workstation. After the FPL is deleted, affected workstation(s) with "Display Degraded" would be rebooted to resume normal operations.

5.2 NATS' assessment is that the impact of the issue should it occur after Full Transition would be minor with no safety concern because:

a) There was neither system "outage" nor system "crash". The Main System, Fallback System and UFS[7] of the new ATMS kept operating normally.
b) Only 3 out of some 50 controller positions showed "Display Degraded" and these positions are used for flight planning rather than controlling flights. All other positions in E-ATCC and N-TWR remained fully operational without affecting safety.
c) Each of the concerned positions could resume normal operation after deletion of the concerned FPL and the workstations were re-booted afterwards. The recovery process can be completed within 15 minutes with minimal operational

[7] There are multiple backup hardware and software modules with the Main System, and the same for Fallback System. The UFS would be used for operation only when the hardware and software of both Main System and Fallback System fail simultaneously. It is noted that the backup ATMS system for existing ATMS system has not been used for operation since its commissioning.

impacts and without the need to switch to Fallback System or UFS. This has been verified by a drill based on established procedures on 30 October 2016.

6. *Review Framework*

6.1 The framework applied for the NATS review of this occurrence has been based on key elements of existing NATS processes, in accordance with safety management system, and experiences of investigating similar incidents (including those for Flight Data Processing systems). These include:

a) System Fallback and Recovery;
b) Incident Management;
c) Problem Tracking / Investigation; and
d) Problem Fix delivery and testing.

6.2 With the objective of satisfactory resolution of the issue, minimisation of risks and the viability of Full Transition, the following areas and the relevant procedures / documents / records have been the focus of NATS' review:

a) Technical details (Equipment) – the problem system data, mechanism leading to the issue and system behaviour;
b) The circumstances leading to the issue (Environment);
c) Operation details (People and Procedure) – the sequence of events, the decision and execution of reversion, potential operational impacts, contingency and fallback readiness;
d) The relevant processes and adequacy followed up by CAD in the investigation of the incident (Procedure);
e) Effectiveness of the fix, workarounds and further enhancement to prevent recurrence of same or similar issues from a system, operational and procedural perspective (Equipment, People and Procedure); and
f) Management and handling of the incident and its potential impact on the continuation of PFI and Full Transition.

NATS Observation 5 – The actions and activities undertaken by CAD, both during and subsequent to the occurrence to manage and resolve the situation are considered satisfactory, effective and on par with those of NATS.

7. Communication

7.1 NATS places importance on open and accurate reporting, and for this reason asks all external communication to be directed through official channels. NATS notes CAD has undertaken substantial efforts in communicating with staff at all levels with an aim to conveying clear and accurate factual information on the occurrence in a timely and effective manner. With the cause leading to the issue positively identified and demonstrated to operational colleagues (the FDOs in particular), CAD had immediately provided a briefing on details of what had happened and cause of the occurrence on 27 October 2016, reversion decision, built-in system protection mechanism, and upcoming fix to colleagues who had participated in the PFI on 27 October 2016.

7.2 A separate briefing session was provided to engineering and system maintenance staff on 28 October 2016. An e-mail was also sent to all operational staff on 29 October 2016. Besides, operational staff participating in subsequent live traffic handling was also briefed on the related details.

7.3 CAD has issued a Press Release on 28 October 2016 to promulgate a correct and accurate message on the course of action, cause of the occurrence, and forthcoming actions. NATS is satisfied with the effective communication by CAD to appraise its staff and media/public on details pertinent to the occurrence.

8. NATS Summary and Recommendations

8.1 In the course of the assessment work, NATS has reviewed the evidence and the information provided by CAD and come up with five observations as shown in the previous sections. Given the complexity of an ATMS, even with all reasonable efforts and endeavours, there could still be possibilities for an issue as experienced by CAD on 27 October 2016, as NATS' own experience could attest. NATS has observed good practice by CAD in system fallback provisions, incident management, containment of data mismatch, and recovery arrangements in the areas of people, procedures, and equipment. The five observations by NATS were summarised as follows:

a) NATS noted a good engineering practice of new ATMS architecture design and contingency provisions in its Main System, Fallback System and UFS to cater for multiple failure scenarios, which are more advanced than the existing ATMS. The Main System, Fallback System and UFS were stable. No system crash was observed throughout the occurrence;
b) NATS underlined the importance of contingency, transition and fallback provisions, procedures, and associated training by CAD that were previously assessed by NATS as effective and satisfactory. NATS noted the enhancement feature for new ATMS to contain the data mismatch which preserves data integrity and ensures a safe ATC service;
c) NATS noted that the occurrence was well-managed by CAD professionals in accordance with pre-defined PFI reversion procedures ensuring safe, smooth and effective ATC service;
d) NATS considered the investigation on the root cause and implementation of enhancement measures, including effective software fix and procedural changes

by CAD and the Contractor were efficient and effective. NATS is satisfied that the occurrence reported was satisfactorily resolved; and

e) NATS is satisfied with and impressed by CAD's overall management of the occurrence, including in particular the dissemination of information to internal and external parties, which is on par with NATS.

8.2 NATS has had direct experience of flight planning issues impacting both NATS' system transitions and live operations, arising from issues related to FPL format / data as well as issues within the core processing. On the occasions these have occurred during live operations, NATS has experienced high levels of traffic delay. To avoid disclosing piecemeal or isolated information to external parties that may cause unnecessary confusion, NATS has experience in treating information collected from occurrence of similar nature and in preserving its confidentiality until completion of investigation.

8.3 Noting the adverse impact of inaccurate information reaching the media/public through unofficial channels, despite all endeavours by CAD including issuing of circulars / reminder emails, it is suggested that CAD might consider to further reduce that risk by reiterating staff responsibility with regards to external communications, including information provided to social media, as appropriate.

8.4 On the basis of the evidence provided to NATS, CAD's handling on the occurrence was considered effective and the reversion procedure was conducted and completed as designed (as reviewed and agreed by NATS in its Phase 2 Study) resulting in no impact to safety and ATC operations. This is largely due to the clarity of the entry and exit criteria for PFI, and the level of staff training to support an instant reversion.

8.5 Considering that software fix and workarounds are already in place, the risk of recurrence of the same occurrence is assessed as low. Based on NATS experience, NATS would recommend CAD to take the following further steps before Full Transition:-

Minimising the likelihood of further FPL issues

a) Undertake testing to build confidence of the fix for this specific issue.

b) For non-conventional FPLs[8] that normally enter into the PMQ requiring manual processing, carry out testing to verify if manual amendment on those FPLs would cause no issues to AT3.

Minimising the impact of any future FPL issues

c) Enhance procedures and practice for FDOs to remove the problematic FPL once it is detected.

d) Review and refine the reversion and backup plan to cater for different scenarios/faults.

[8] Non-conventional flight plans involving:

- re-entrant flight – a flight that takes off and lands at same airport
- multiple-point flight – a flight passes through multiple navigation route fixes
- slow aircraft – a helicopter or small propeller-driven aircraft that flies by visual flying rules
- flights with duplicated identifiers – each flight with FPL under process by the system should have a unique identifier
- incomplete flight plan – a flight plan with missing information in its data field(s)

8.6 The CAD responses including actions to each of the recommendations are detailed at Appendix 2.

9. Conclusion

9.1 In conclusion, upon review of the occurrence, and CAD's responses to each of the NATS' recommendations, NATS is satisfied that CAD has implemented all actions arising from the recommendations, some of which bear the benefit of a wider and general coverage to other potential issues. NATS also find that CAD's actions are also supported by documentary evidence. Considering the nature of the occurrence, that corresponding effective mitigating measures have been in place and the event-tested reversion, NATS is confident that the issue as reported has been satisfactorily resolved, and NATS' assessment on CAD's readiness for Full Transition as previously concluded in Phase 2 Study remains unchanged.

References

1. Phased Transition Approach for Air Traffic Management System and Overall Transition Readiness for ATC Replacement System - PFI Stage 2 and Full Transition Assessment (Issue 1.5, October 2016)

Appendix I – Mechanism of flight strip posting logic leading to the occurrence

(a) A posting logic based on FIR entry time had been activated through system adaptation. Therefore, to determine when and where to post a FPL to controllers, AT3 required the FIR entry time to make the decision.

(b) The concerned FPL did not indicate any entry to HKFIR, which caused the FPL to be placed into the PMQ by the system. Subsequent manual amendment of the FPL also did not rectify the issue. Therefore, no FIR entry time could be determined by the system. The FPL posting logic at the workstation detected a data mismatch. As a result, when the concerned FPL was posted to the respective flight planning workstations, the protection mechanism was immediately triggered to protect the workstation from crashing with a "Display Degraded" shown onto the screen.

(c) All Executive Control positions, directly communicating with flights, were operating normally at all times, and with no safety and operational impacts due to the occurrence.

(d) As the amended FPL passed the format checking at the time and so no warning/error popup was displayed at the time of executing the FPL amendment. It is confirmed that the Main System, Fallback System, and UFS were working normally and stable as per system design with the issue occurred at flight planning workstation level only.

(e) As the concerned FPL was only required to be processed by the affected workstations, other positions not required to process the FPL were not affected by the occurrence.

Appendix 2 – NATS Recommendations & CAD Responses

ID	NATS Recommendation	CAD Comment/Response	Status
REC 1	• Undertake testing to build confidence of the fix for this specific issue.	• As an established practice, the fix developed by Contractor has undergone various tests including the factory testing at their factory at Marlborough, functional tests, on-site verification tests in Hong Kong and normal ATC operations (NATCO) so as to build confidence that the fix could successfully address the identified issue.	Closed
REC 2	• For non-conventional FPLs that normally enter into the PMQ requiring manual processing, carry out testing to verify if manual amendment on those FPLs would cause no issues to AT3.	• A thorough and structure review were conducted to trace the problematic FPLs from the PMQ of new ATMS. These problematic FPLs were fed into the AT3 for manual amendments at PMQ and it was confirmed that such actions did not cause any problem to AT3. The above-mentioned review was made during the subsequent PFI sessions with satisfactory results.	Closed
REC 3	• Enhance procedures and practice for FDOs to remove the problematic FPL once it is detected.	• Procedures have been enhanced and practice/briefing was conducted for FDOs to remove the problematic FPL once it is detected.	Closed
REC 4	• Review and refine the reversion and backup plan to cater for different scenarios/faults.	• The reversion and backup plan were reviewed and refined to cater for different scenarios/faults. Such review was conducted with documents updated.	Closed

Annex C

ATMS Benchmarking

1. Introduction

The performance of Air Traffic Management System (ATMS) is benchmarked against the international standard, namely "Eurocontrol specification for ATM Surveillance System Performance" (referred herein as "Specification"), which specifies the performance requirements for air traffic management systems to meet for provision of air traffic control (ATC) service.

The Specification specifies performance requirements for display of aircraft targets on radar screen, namely:

(a) flight data
(b) known issues of aircraft positions not displayed temporarily, false targets and split tracks

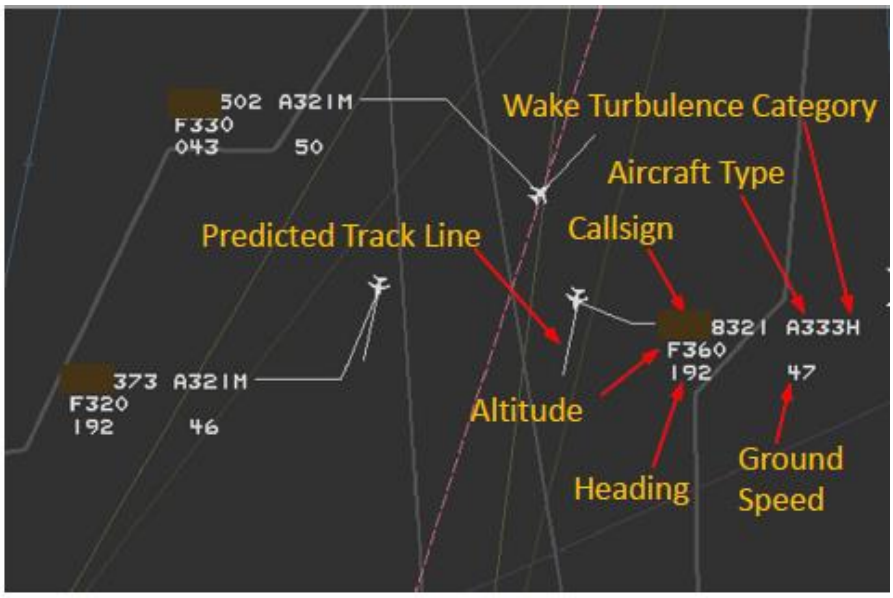
2. Flight data

Regarding the issue of some flight data temporarily not displayed on radar screen, the Specification requires:

(a) 3 types of essential data, including "aircraft position", "altitude" and "Mode A code" (i.e. radar identification code of aircraft), to be displayed on radar screen with no less than **99.999%** availability, and;

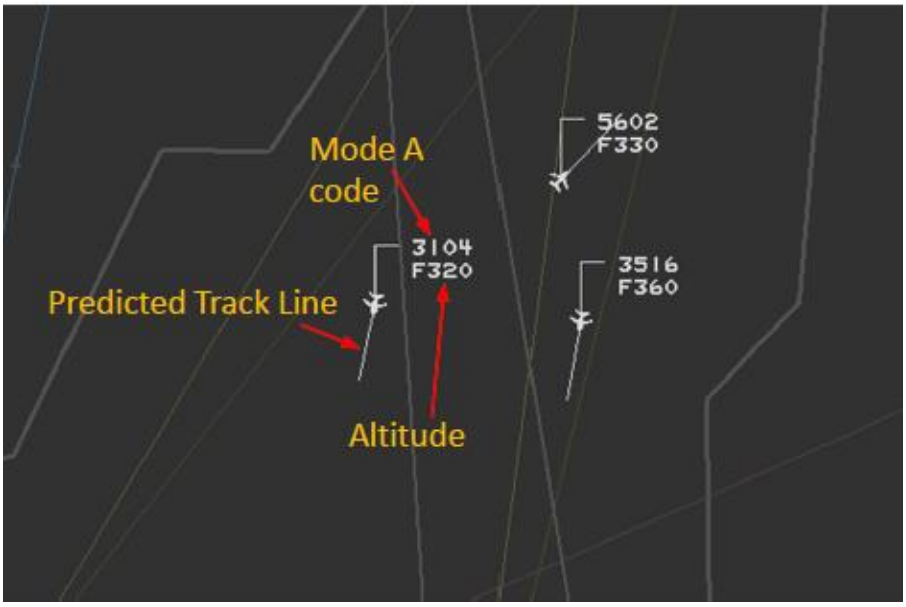
(b) supplementary flight data, such as ground speed or aircraft identification (i.e. aircraft callsign) etc. to be displayed on radar screen with no less than **99.5%** availability.

For the new ATMS, all essential flight data have always been available for display on radar screen since its full commissioning, hence the requirement (a) is fully met. Taking into account the incidents on 29 November 2016 and 12 December 2016, in which supplementary flight data such as ground speed and aircraft callsign etc. were not displayed for 26 seconds and 75 seconds respectively, the availability of such data measured from 14 November 2016 on which the new ATMS was fully commissioned has well exceeded the requirement (b).



Essential and supplementary flight data are displayed on radar screen

[Note: the callsign of the aircraft is purposely covered]



Essential flight data are displayed on radar screen

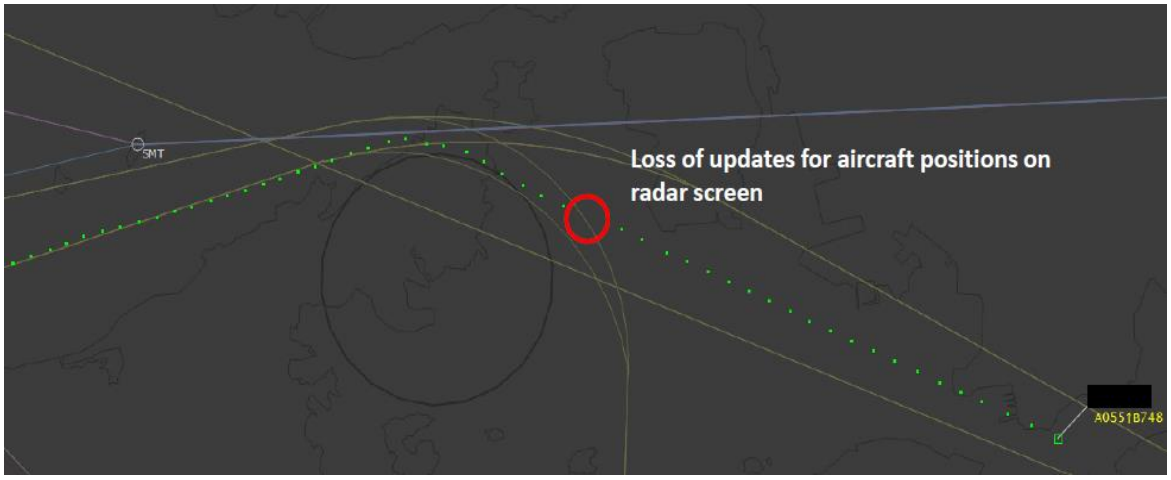
3. Known issues related to aircraft targets

There are several known issues related to the display of aircraft targets on radar screen, namely aircraft positions not displayed temporarily, false targets and split tracks. These issues were caused by the limitations of radar technology and can be observed in the air traffic management systems of various manufacturers. Specifically, the limitations of radar technology refer to radar signal interference by external factors and/or moving obstacles or terrain, occasional problems of aircraft transponders, etc, affecting the display of aircraft positions on radar screen. These issues are not unique to the new ATMS and have also been seen in air traffic management systems elsewhere as well as in the old ATMS in Hong Kong. The International Civil Aviation Organisation (ICAO) has issued guidelines on the limitations of radar technology and the contributing factors, and has organised international meetings on such issues from time to time to exchange views

on the latest strategies for tackling them and feasible solutions by implementing new technology.

(i) Aircraft Positions Not Displayed Temporarily

The provision of ATC service relies on the regular provisions of the horizontal position of aircraft. A requirement is defined in the Specification for the Probability of Update (PU) of horizontal position of each aircraft to be no less than **97%.** Starting from 14 November 2016, all the cases reported on aircraft positions not displayed temporarily were analyzed. It was found that except one case on 15 November 2016, the other cases were caused by simultaneous reception issues of all radars, which was unrelated to the performance of new ATMS. For the case on 15 November 2016, there was temporary loss of updates on the aircraft positions of one aircraft on radar screen. The actual PU for that aircraft was 99.5%, which exceeded the requirement in the Specification.



(ii) False Targets

A false target is a target report that does not correspond to the actual position of the aircraft. Two requirements are specified by the Specification to limit density of false target reports within an area measured over a time interval, so as to minimise disturbance to the ATC controllers:

(I) For terminal/enroute control, there should be less than 10 false target reports per area of 900 NM^2 and over a duration of 30 minutes; and

(II) For approach control, there should be less than 2 false target reports per area of 100 NM^2 and over a duration of 48 minutes.

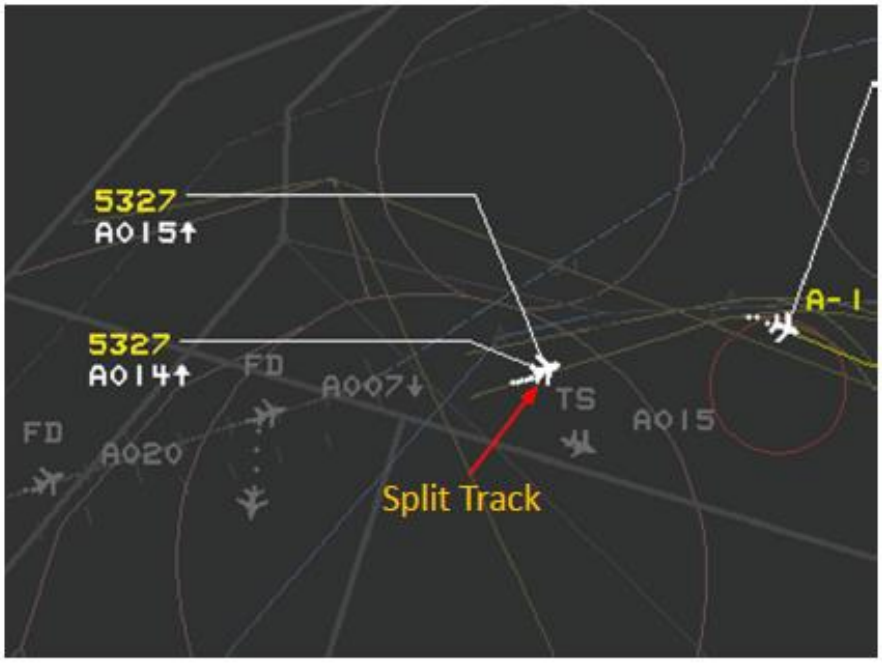
All the false target cases reported since 14 November 2016 were analysed. Upon analysis, it was found that the frequency of false target reports commensurate with the area and time interval specified in item (I) and (II) above was less than the figures as specified in the above Specification.

(iii) Split Tracks

A split track is also known as a falsely confirmed track, which is formed by at least 3 correlated false target reports. The presence of unexpected track in the vicinity of aircraft will generate additional workload to ATC controllers to determine whether the displayed track correspond to a true aircraft or not. Two requirements are specified by the Specification to limit the number of falsely confirmed track that are located close to true tracks:

(I) For terminal/enroute control, there should be less than or equal to 2 non-coincident falsely confirmed tracks per hour that are closer than 13,000 m (7 NM) from true tracks; and

(II) For approach control, there should be less than or equal to 1 falsely confirmed track per hour that are closer than 16,700 m (9 NM) from true tracks.



All the falsely confirmed track cases reported since 14 November 2016 were analysed. It was found that the frequency of falsely confirmed track cases

per hour was less than the respective number of falsely confirmed tracks as specified in the above Specification.

4. Conclusion

The new ATMS is benchmarked against the requirements in the Specification and its performance is confirmed to have met the requirements specified in the Specification. The ATMS Expert Panel members considered that the safety performance of the new ATMS had so far exceeded international requirements. However, given the relatively short period of time since the commissioning of the new system, the CAD was urged to continue optimising the operating procedures and system in order to enable the system to continuously outperform international requirements.

* * * * * *

Annex D

List of Safety Features in New ATMS

Safety Net Feature	Description
Special Use Airspace Intrusion Warning (SUAIW)	The SUAIW is to indicate any infringement of an aircraft flying into a special airspace defined by the user.
Short Term Conflict Alert (STCA)	The STCA generates alerts on the infringement and potential infringement of user-adaptable separation standards (area of conflict) between 2 or more aircraft at any time.
Cleared Level Adherence Monitoring (CLAM)	The CLAM generates visual alert when the level of an associated track exceeds the defined tolerances of its cleared level
Similar Callsign Advisory (SCA)	The SCA provides visual alerts in a list display on detection of similar aircraft identification operating under a controller.
Route Adherence Monitoring (RAM)	The RAM generates visual alert when an associated track leaves the defined track keeping tolerances of its cleared route.
Minimum Safe Altitude Warning (MSAW)	The MSAW provides alerts controllers on aircraft proximity to terrain with reference to the minimum safe altitude for each MSAW Defined Area.
Departure Path Monitoring (DPM)	The DPM monitors the flight trajectory of departing aircraft from each runway and generates visual and audio warning when a departing associated track leaves the required track keeping tolerances.
Position Report Monitoring (PMON)	The PMON alerts the controller when the ATO and/or ETO next point stated in the position report differ from that calculated by the flight trajectory by more than a user-adaptable time interval.
Approach Path Monitoring (APM)	The APM monitors the defined 3-dimensional approach paths for each approach of the North and South runways at HKIA.
Medium Term Conflict Detection (MTCD)	The MTCD allows the user to adapt the separation standards required between aircraft in each of the MTCD defined volume of airspace.

Annex E

Attendance to the First Meeting of the Expert Panel

Chairman:	Mr Simon LI	Director-General of Civil Aviation
Members present:	Ir Warren CHIM	Deputy Chairman of the Aircraft Division of the Hong Kong Institution of Engineers
	Mr Marc HOUALLA	President of École Nationale de l'Aviation Civile
	Mr KUAH Kong Beng	Chairman of the International Civil Aviation Organization Asia Pacific Air Navigation Planning and Implementation Regional Group Air Traffic Management Sub-Group
	Mr Albert LAM	Former Director-General of Civil Aviation
	Professor MAN Hau-chung	Dean of the Faculty of Engineering, Hong Kong Polytechnic University
Secretary:	Mr Vincent WONG	Senior Electronic Engineer (Projects)1
In attendance:	Capt Victor LIU	Deputy Director-General of Civil Aviation (1)
	Mr Raymond LI	Assistant Director-General of Civil Aviation (ATM)
	Mr Richard WU	Assistant Director-General of Civil Aviation (AES)
	Ms Mona CHEUNG	Chief (Technical and Development)
	Mr Thomas FOK	Chief Electronic Engineer (Projects)
	Mr Samuel NG	Senior Evaluation Officer (1)

Attendance to the Second Meeting of the Expert Panel

Chairman:	Mr Simon LI	Director-General of Civil Aviation
Members present:	Ir Warren CHIM	Deputy Chairman of the Aircraft Division of the Hong Kong Institution of Engineers
	Mr Marc HOUALLA	President of École Nationale de l'Aviation Civile
	Mr KUAH Kong Beng	Chairman of the International Civil Aviation Organization Asia Pacific Air Navigation Planning and Implementation Regional Group Air Traffic Management Sub-Group
	Mr Albert LAM	Former Director-General of Civil Aviation
Member absent:	Professor MAN Hau-chung	Dean of the Faculty of Engineering, Hong Kong Polytechnic University
Secretary:	Mr Vincent WONG	Senior Electronic Engineer (Projects)1
In attendance:	Capt Victor LIU	Deputy Director-General of Civil Aviation (1)
	Mr Kevin CHOI	Deputy Director-General of Civil Aviation (2)
	Mr Raymond LI	Assistant Director-General of Civil Aviation (ATM)
	Mr Richard WU	Assistant Director-General of Civil Aviation (AES)
	Ms Mona CHEUNG	Chief (Technical and Development)
	Mr Thomas FOK	Chief Electronic Engineer (Projects)
	Mr Samuel NG	Senior Evaluation Officer (1)

Attendance to the Third Meeting of the Expert Panel

Chairman:	Mr Simon LI	Director-General of Civil Aviation
Members present:	Ir Warren CHIM	Deputy Chairman of the Aircraft Division of the Hong Kong Institution of Engineers
	Mr Marc HOUALLA	President of École Nationale de l'Aviation Civile
	Mr KUAH Kong Beng	Chairman of the International Civil Aviation Organization Asia Pacific Air Navigation Planning and Implementation Regional Group Air Traffic Management Sub-Group
	Mr Albert LAM	Former Director-General of Civil Aviation
	Professor MAN Hau-chung	Dean of the Faculty of Engineering, Hong Kong Polytechnic University
Secretary:	Mr Vincent WONG	Senior Electronic Engineer (Projects)1
In attendance:	Capt Victor LIU	Deputy Director-General of Civil Aviation (1)
	Mr Kevin CHOI	Deputy Director-General of Civil Aviation (2)
	Mr Raymond LI	Assistant Director-General of Civil Aviation (ATM)
	Mr Richard WU	Assistant Director-General of Civil Aviation (AES)
	Ms Mona CHEUNG	Chief (Technical and Development)
	Mr Thomas FOK	Chief Electronic Engineer (Projects)
	Mr Samuel NG	Senior Evaluation Officer (1)

Annex F

Air Traffic Management System Expert Panel holds first meeting
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The Air Traffic Management System (ATMS) Expert Panel held its first meeting today (December 16).

"I would like to thank the local and overseas expert panel members for sparing the time to join the meeting today. The Civil Aviation Department (CAD) briefed members on the design and functionality of the new ATMS, preparation for the transition of the system, operations since its commissioning, issues encountered and the solutions," said the Chairman of the Expert Panel and Director-General of Civil Aviation (DGCA), Mr Simon Li.

"Given the complexity of the new ATMS, expert panel members noted that it is inevitable and understandable to encounter some special or unforeseen situations in the initial stage of full commissioning. Any ATMS, regardless of the brand, would encounter this situation and there have been similar experiences overseas. The most important point is that the CAD has established an effective mechanism to cope with different situations. Concerning this point, the expert panel considered that the responding mechanism of the CAD over the past month was on a par with international practice," he added.

Apart from drawing on overseas experience, the most important thing is that all ATMSs must go through stringent tests. They can only be launched after meeting the international standards set out by the International Civil Aviation Organization and being adapted to local operational needs, as has been the case in Hong Kong.

The CAD also informed the expert panel members of the standby arrangement of the old ATMS. The two overseas experts possessing extensive Air Traffic Control (ATC) experience noted that the standby arrangement in Hong Kong is in line with the practice of large-scale ATMS transition in other countries.

Mr Li said, "It was the first meeting of the expert panel. Expert panel members got a preliminary understanding of the new ATMS. There are a number of follow-up tasks ahead to further explore ways to speed up the optimisation process of the system. The expert panel has set out the work plan in the coming year. Tentatively, it was agreed that the second meeting would be held at the end of next month. Other stakeholders, including the CAD's frontline staff, for example ATC staff and electronics engineers, will be invited to join the meeting and to share their views on the optimisation process. The CAD will make public the views and work progress of the expert panel from time to time. It is expected that the expert panel will make a preliminary report in March or April, 2017."

The five-member expert panel comprises local representatives including Mr Warren Chim, Mr Albert Lam and Professor Man Hau-chung, while overseas representatives include the President of the National School of Civil Aviation in France, Mr Marc Houalla, and the Chairman of the International Civil Aviation Organization Regional Air Traffic Management Sub-Group, Mr Kuah Kong Beng. Mr Lam and Mr Kuah, who are currently not in Hong Kong, joined the meeting via tele-conference.

The expert panel's terms of reference are to provide objective expert advice to the DGCA on teething issues arising from the commissioning of the new ATMS and the

necessary optimisation work; and to share with the CAD international experience and best practices in relation to the long-term optimisation of new ATMS. The members are appointed for a one-year term till November 30, 2017.

Please refer to the gist of remarks (Chinese only) made by the DGCA at a media session after the first meeting of the expert panel.

Ends/Friday, December 16, 2016
Issued at HKT 20:53

Air Traffic Management System Expert Panel holds second meeting
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The Air Traffic Management System (ATMS) Expert Panel held its second meeting today (January 18). Prior to the meeting, expert panel members visited the Air Traffic Control (ATC) Centre and ATC Tower to appreciate more about the operations of the new ATMS. They also met with frontline air traffic control officers (ATCOs) and electronics engineers to solicit their comments on operating the new ATMS.

Expert panel members at the meeting today included local representatives Ir Warren Chim, Mr Albert Lam and overseas representative the Chairman of the International Civil Aviation Organization (ICAO) Asia Pacific Regions Air Traffic Management Sub-Group, Mr Kuah Kong Beng. Another overseas representative, the President of the National School of Civil Aviation in France, Mr Marc Houalla, joined the meeting via tele-conference. Professor Man Hau-chung was not able to attend the meeting today.

During the meeting, officers of the Civil Aviation Department (CAD) reported to the expert panel members on the operations of the new ATMS since the first meeting on December 16, 2016, including the incident in which some functions of the Electronic Flight Strips System installed at the ATC Tower were temporarily and intermittenly affected, and the occurrence when two planner positions temporarily could not adjust the operation configuration. Both occurrences were made known to the public by the CAD earlier. Expert panel members agreed that the two occurrences did not undermine aviation safety nor affect the operations of the new ATMS. The expert panel suggested the CAD continue urging the ATMS contractor, Raytheon Company, to optimise the operations of the new ATMS.

The expert panel also met with the chairman/president and representatives of the CAD Electronics Engineers' Branch of Hong Kong Chinese Civil Servants' Association and the Hong Kong Air Traffic Control Association. The expert panel invited them to provide comments and experiences in operating the new ATMS. The electronics engineers' representatives informed the expert panel that the teething issues arising from the initial commissioning period of the new ATMS is unavoidable in the transition of any large-scale and complicated ATMS. The ATCOs' representatives said that they have gradually adapted to different functionalities of the new system, and have become more competent and confident in operating the new ATMS by now. The representatives provided constructive feedbacks to the expert panel and made suggestions to optimise the ATMS from the perspective of actual operation. The expert panel agreed to consider in collaboration with the CAD management.

Summing up the meeting today, the expert panel considered that safety performance of the new ATMS, so far, exceeded international requirements. However, given the relatively short period of time since the commissioning of the new system, the CAD was urged to continue to optimise the operating procedures and system operations in order to enable the system to outperform international requirements. The expert panel members also pointed out that as the new ATMS is a large-scale and complicated comprehensive computer system, minor setbacks would occur intermittently for different reasons (including human factors) such as, for instance, the recent temporary interruption of display of arriving aircraft sequencing information of the Arrival Manager System (AMAN) due to human factors and the temporary interruption of the Voice Communication Switching System (VCSS). Raytheon Company does not supply either the VCSS or the AMAN. These minor setbacks did not affect the operations of the ATMS, and neither did they affect ATC operations or aviation safety. After evaluating the relevant occurrences, the expert panel members concurred that the CAD had put in place an effective and established mechanism

for responding to different situations occurring after the full commissioning of the new ATMS in accordance with international best practices and the ICAO's safety management process. The expert panel learnt that the CAD had already explained to its staff in a timely manner the causes of the occurrences and the necessary corrections, thus pooling wisdom to improve future operations. Furthermore, the expert panel members suggested that the CAD should foster communications between the system's supplier and frontline staff continuously in order to resolve any teething problems progressively.

The expert panel members will hold another meeting next month. After collating and summing up all the information, an interim report is expected to be made in March or April this year.

The expert panel's terms of reference are to provide objective and expert advice to the Director-General of Civil Aviation on teething issues arising from the commissioning of the new ATMS and the necessary optimisation work; and to share with the CAD international experience and best practices in relation to the long-term optimisation of new ATMS. The members are appointed for a one-year term till November 30, 2017.

Ends/Wednesday, January 18, 2017
Issued at HKT 21:25

Air Traffic Management System Expert Panel holds third meeting
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The Air Traffic Management System (ATMS) Expert Panel set up by the Civil Aviation Department (CAD) held its third meeting today (February 20). The expert panel members considered that safety performance of the new ATMS continued to exceed international requirements and urged the CAD to continue to optimise the system as well as the operating procedures, with a view to enabling the system to achieve and exceed the international requirements in a consistent manner.

During the meeting, the CAD updated the expert panel members on the latest developments of implementing satellite-based Automatic Dependent Surveillance – Broadcast (ADS-B) technology in the Hong Kong Flight Information Region (HKFIR). With the progressive introduction of ADS-B in Hong Kong, the expert panel members noted that improvements have been seen in the display issues of aircraft positions on the radar screens (in regard to occurrences such as the phenomena of split tracks and aircraft positions not being displayed temporarily on the radar screens). The expert panel members were satisfied with the progress of and improvement brought about by the implementation of ADS-B. At present, the Air Traffic Control Officers (ATCOs) can obtain both radar and ADS-B information on flights within the HKFIR at the same working position. The expert panel members advised the CAD to continue monitoring the performance of ADS-B closely and gauging more views from the frontline ATCOs for a full implementation of ADS-B progressively in 2017 to further enhance the display of aircraft positions.

With regard to the issue that the radar screens were unable to display some of the flight information, the expert panel members agreed that the aviation safety was not undermined as the ATCOs could keep direct communications with the pilots at all times during those occurences to ascertain the aircraft position and altitude. They were informed that the contractor of the new ATMS delivered a new software fix to the CAD last Thursday (February 16) for site acceptance testing, which would help address the issue. The new software fix is expected to be launched by the end of March after relevant tests and assessment are completed. The CAD will give an update to the expert panel on the progress during the process.

The expert panel was also invited to review the operations and the performance of the Arrival Manager System (AMAN). The AMAN used to be independent of the old ATMS, but the new ATMS enhanced the AMAN's functions and incorporated it as a sub-system. The expert panel members agreed that the AMAN was a tool to provide an arrival sequence of arrival flights to ATCOs automatically and not intended as a tool for ensuring standard separation between aircraft. The ATCOs had handled the landing sequence according to the default in-trail spacing during the recent temporary hiccups of the AMAN and the technical staff had helped restore the services of the AMAN within a short period of time. Having reviewed the information above, the expert panel members were of the view that the CAD had put in place an effective and established mechanism for responding to different situations occurring after the full commissioning of the new ATMS in accordance with international best practices and the International Civil Aviation Organization (ICAO)'s safety management process. The expert panel members were satisfied with the actions taken by the CAD in view of the hiccups of the AMAN to ensure overall smooth operation of the ATMS and they urged the CAD to continue working closely with the contractors concerned to identify the root cause of the occurrences and formulate a long-term plan so as to further optimise the performance of the AMAN. The expert panel will be briefed on the progress in future.

In addition, the CAD also discussed the recent media reports on the loss of standard separation incidents with the expert panel members. The expert panel members noted that the CAD, in accordance with international practice, has established procedures to conduct investigation on all loss of standard separation incidents, follow up on the cases in a timely manner and make necessary improvement measures. The incidents and investigation results are regularly reviewed by the Air Traffic Safety Assessment Committee, as well as the flight and aviation safety experts from the airlines. The expert panel members were of the view that the categorisation and handling procedures on the loss of standard separation incidents of the CAD are on par with international practice. Based on relevant safety performance statistics in the past two years presented by the CAD, the expert panel members were of the view that all the incidents had no impact on aviation safety. Relevant statistics also surpassed international indicators. Nevertheless, the expert panel members suggested the CAD continue closely monitoring safety performance of the new ATMS.

Before the meeting, the CAD arranged the expert panel members to meet with the management pilots of the major local airlines and the Government Flying Service. Upon the request of the expert panel members to share their views on the operations of the new ATMS, the management pilots noted that the transition of the ATMS was a huge challenge on organisational and cultural changes. They considered the CAD had overcome the challenge effectively with professional expertise and experience.

While concluding the meeting today, the expert panel members considered that safety performance of the new ATMS, so far, continued to exceed international requirements. The CAD was urged to continue to optimise the system as well as the operating procedures, with a view to enabling the system to achieve and exceed the international requirements in a consistent manner.

All the expert panel members attended the meeting today, including local representatives Mr Warren Chim, Mr Albert Lam and Professor Man Hau-chung, as well the President of the National School of Civil Aviation in France, Mr Marc Houalla, and the Chairman of the ICAO Asia Pacific Regions Air Traffic Management Sub-Group, Mr Kuah Kong Beng, as overseas representatives.

The expert panel's terms of reference are to provide objective and expert advice to the Director-General of Civil Aviation on teething issues arising from the commissioning of the new ATMS and the necessary optimisation work, and to share with the CAD international experience and best practices in relation to the long-term optimisation of new ATMS. The members have been appointed for a one-year term till November 30, 2017. The expert panel members will submit an interim report in March or April after collating and summing up all the information from the first three meetings.

Ends/Monday, February 20, 2017
Issued at HKT 22:15

Annex G

Statistics of Reported Cases on Aircraft Positions Not Displayed Temporarily, Split Track and False Target

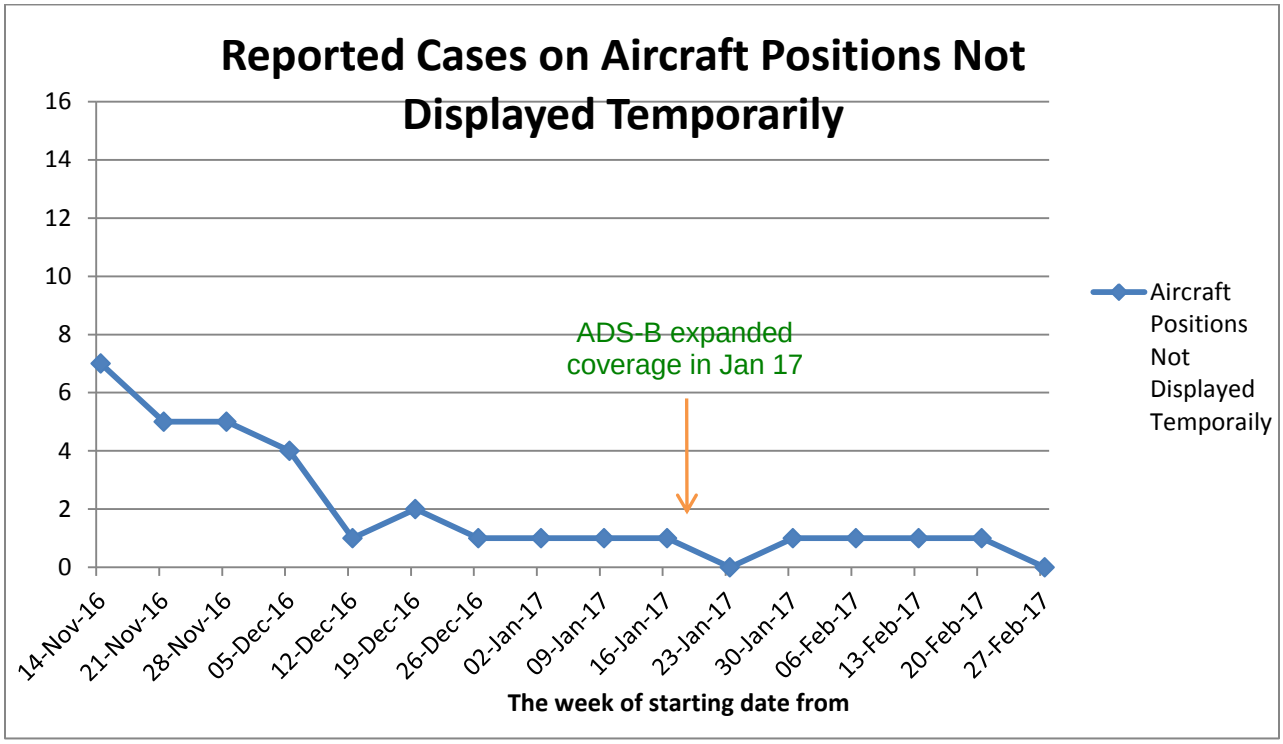


Chart 1: A decreasing trend in aircraft positions not displayed temporarily was observed with expanded ADS-B coverage in January 2017

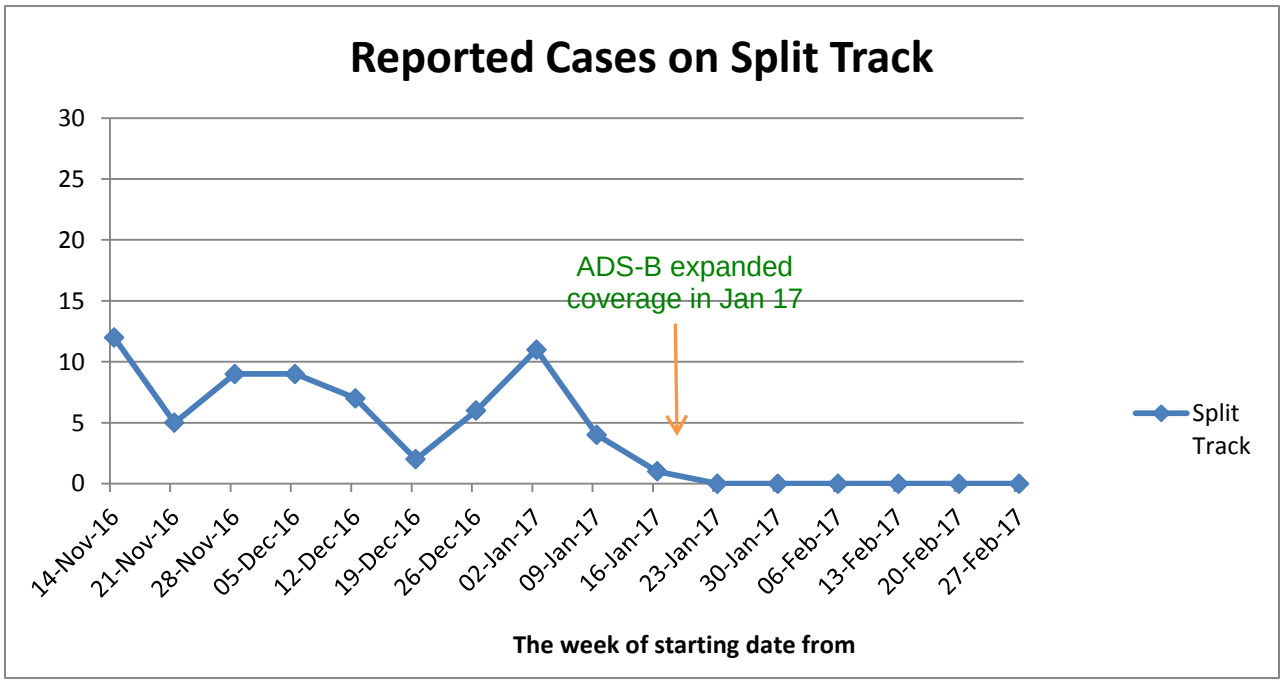


Chart 2 : A decreasing trend in split track was observed with expanded ADS-B coverage in January 2017

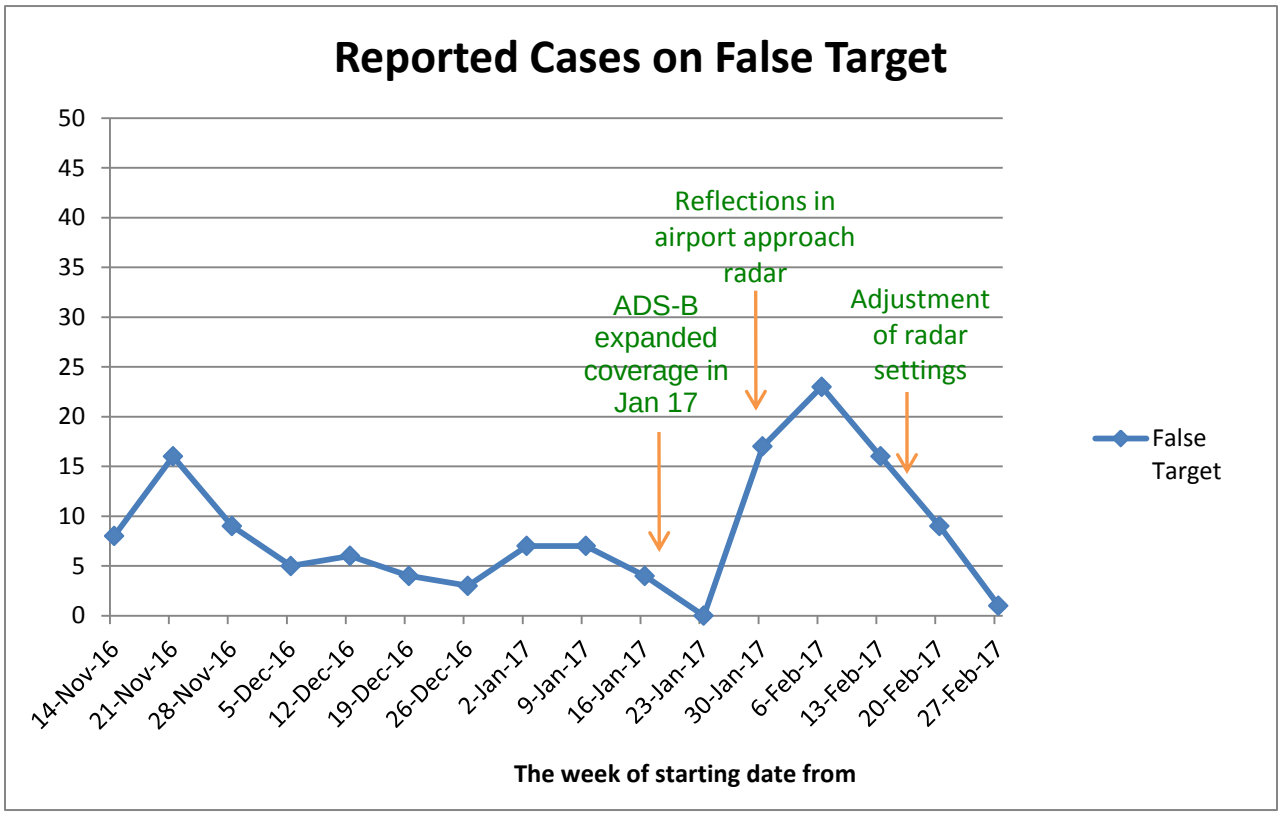


Chart 3: A decreasing trend in false target was observed in January 2017 with expanded ADS-B coverage. There was an increasing trend in early February 2017 due to vessels maneuvering and development activities around the airport causing reflections in the airport approach radar. With the adjustment of the airport approach radar settings carried out in February 2017, the number of reported false target has significantly dropped.

Report on Air Traffic Management System Occurrences on 29 November & 12 December 2016

1. Introduction

1.1 On 29 November and 12 December 2016, the Civil Aviation Department (CAD) experienced two similar occurrences as detailed below.

29 November 2016 - During full operation of the Air Traffic Management System (ATMS) at 13:15 (HK time), the primary server of the Flight Data Processor (FDP#1) of the Main System experienced a file access anomaly induced by an interactive playback session initiated on FDP#1, triggering automatic switchover to its hot-standby server (i.e. the secondary server – FDP#2), while putting FDP#1 offline. As per the system design, the process was automatically initiated and completed. External links with interfacing systems were not affected during the switchover. At 13:20, per standing procedures, the offline FDP#1 server was manually restarted to restore full hot-standby dual operations of the FDP. During the restoration process, at 13:25, the screen refreshed with momentary flight plan dis-association affecting those targets that were already associated with flight plans at the time at all logged-on workstations. Display of information was affected for about 26 seconds. The root cause of flight plan dis-association was that the FDP#2 had to handle the flight information synchronisation to FDP#1 required for the restoration of FDP#1 in parallel with the on-going flight plan association process, with the former being set to take a higher priority, thus the occurrence of temporary flight plan dis-association.

12 December 2016 - At 11:47, retrieval and archiving of data from the FDP of the Main System was initiated. Shortly after the process was initiated, radar screens refreshed with flight plan dis-association for currently associated targets at all logged-on workstations momentarily. The flight information reappeared automatically after about 75 seconds - a similar observed phenomenon and the same root cause as that of the 29 November 2016 occurrence described above.

1.2 The Transport and Housing Bureau has requested NATS to assess the course of actions taken in response to these two occurrences, to advise the impact to the safety and readiness of new ATMS, and to make relevant recommendations based on NATS' experience in similar system transitions.

1.3 The framework applied for the NATS' review has been based on the key elements of existing NATS process, experiences of investigating and subsequently resolving similar occurrences. This report details the following aspects of the occurrences in turn to assess how the events and associated corrective actions were handled, and whether appropriate steps are in place to minimise the risk of recurrence. Accordingly, NATS' review is focused on three areas, as follows:

a) Incident Management and System Fallback / Recovery;

b) Incident Investigation / Tracking / Rectification / Testing; and
c) Impact on staff training and procedures.

1.4 To facilitate its review, CAD has provided relevant documents and supporting evidence including system logs and records, system health checks, operational and engineering instructions and contingency procedures, briefing materials, internal and external communication materials to support NATS' assessment and to address NATS' recommendations in ensuing paragraphs.

2. Incident Management and System Fallback / Recovery

Expectation of display occurrences within normal Air Traffic Control (ATC) operations

2.1 Teething problems are not unexpected particularly for a large and highly complex system such as an ATMS during the initial period following the full system commissioning. From NATS' experience, some outages such as a radar station loss have little impact on our service due to resilience of multi-radar tracking, providing a mosaic of overlapping coverage such that loss of any single radar rarely leads to a service impact. Noting the high potential impact to operations of inadvertent system outage NATS further minimises risks of service outage by undertaking 'higher potential impact' activities overnight when traffic levels are relatively low to allow more time to manage / overcome any transition issues and to make decisions.

NATS Observation 1 – While safety is of utmost priority, it is not practical to achieve zero risks or have a system with no issues reported. According to the ICAO requirements, risks need to be assessed and mitigated to an acceptably low extent. In NATS' experience, it is not unusual for new systems or new functionality introduced that were stable during trial to cause issues when transitioned into service. The occurrences on 29 November and 12 December are not unusual given these facts and factors.

Safety assurance and handling of event during and following the occurrences

2.2 Both occurrences (on 29 November and 12 December) resulted in the temporary flight plan dis-association (for 26 and 75 seconds respectively). During these periods controllers were still able to see from their radar displays the essential flight information including the aircraft position and altitude, and identification of the aircraft from their assigned Secondary Surveillance Radar Code (SSR Code), which is a 4-digit identifier code uniquely assigned to each individual flight prior to departure. Additionally, for the case on 12 December, air traffic control officers could elect to obtain references to additional flight information through the then recently-implemented ASM (ADS-B Surveillance Monitor) at the Executive positions. Direct controller-pilot radio communications were

maintained and fully functional at all times. In both occurrences there was no report of safety related occurrences by ATC.

2.3 On 29 November, as a usual precaution, departure flights were temporarily held on ground for 15 minutes while an on-site review meeting was immediately held at the East Air Traffic Control Centre (E-ATCC) between Management staff, Supervisors and Subject Matter Experts (SMEs) from both engineering and operational divisions. Given the momentary loss of flight association and quick and automatic resumption of normal system operation, the meeting concluded to resume normal ATC service given the availability of other contingency measures (including the Fallback System and Ultimate Fallback System (UFS)) at all times. Accordingly the temporary stoppage of departure flights, which lasted for 15 minutes, was lifted.

2.4 On 12 December, as a usual precautionary measure, departure flights were temporarily held on ground for 4 minutes while an on-site review by engineering and operational staff was conducted. Given the momentary loss of flight plan association and automatic recovery, the continued availability of the Fallback System and UFS, it was decided to resume normal ATC service. There was minimal impact on departure flights resulting from the temporary suspension of departure flights.

NATS Observation 2 – Whilst the temporary loss of certain flight information could affect the normal working practices of ATC, the alternate identification methods available that had been covered in the basic training for every controller still enabled the controllers to provide a safe ATC service. It was a prudent and safety measure for ATC to temporarily withhold outbound aircraft under the circumstance allowing the situation to be assessed by multidisciplinary professionals prior to resuming normal service. This is on par with that adopted by NATS and international best practice. The two levels of fallback provisions (i.e. Fallback System and UFS) were unaffected and available at all times during the occurrences.

Curtailed service delivery during the 29 November occurrence

2.5 On 29 November a total of nine departure flights were held on the ground during the temporary departure suspension. Neither flight cancellations nor knock on delays were reported as a result of the occurrence. On 12 December no flights were significantly delayed as a result of the temporary suspension of service to departing aircraft.

NATS Observation 3 - It is an international norm that implementation of safety measure should always outweigh delay. Whilst the slight impact in terms of delays and punctuality was unfortunate and to be avoided as far as possible, given the speed of response to the scenario and the need to assess the stability of the system following the resumption of normal performance of the ATMS, the temporary suspension of departure flights is considered proportionate to the scale and impact of the occurrence.

3. Incident Investigation / Tracking and Rectification

Fault diagnosis

3.1 **Occurrence on 29 November** - CAD requested the Contractor to promptly investigate into the occurrence with system logs and relevant data immediately provided to the Contractor. Following prompt investigation and analysis of the occurrence, the Contractor provided an investigation report (Reference 1, Appendix 1) with root cause and workarounds identified within 48 hours of the occurrence.

3.2 **Occurrence on 12 December** – upon investigation, the Contractor had promptly confirmed that the occurrence of December bearing the same root cause with a common fix for both occurrences.

3.3 On both occurrences, the temporary loss of flight plan information from the ATC display was caused by the Flight Data Processor having to respond to a manually triggered maintenance processes. For both occurrences there was no loss or corruption of flight plan data. The Surveillance Data Processor (SDP), which tracks and displays essential positional data and flight identification of aircraft (SSR code), and all other functions were also functioning normally. Moreover, the Fallback System and the UFS were operating normally and available for selection at all times.

NATS Observation 4 – The Contractor has promptly analysed the system log and diagnosed the issues with explanation consistent with the occurrences and confirmed no loss or corruption of flight plan data. The two levels of fallback provisions were unaffected and available at all times during the occurrence.

Strategies to minimise risk of recurrence until a permanent fix of the root cause is established

3.4 Given the quick identification of the cause of flight plan dis-association and the causal circumstances, the proposed mechanism for a fix should be available shortly and the interim workarounds should avoid the causal factor associated with engineering procedures i.e.

- Interactive Playback sessions should only be carried out in the Fallback System at all times without inducing any risk on the operational system or impacting Main System operation; and
- CAD should manage synchronisation of flight information by scheduling to bring up the offline FDP during periods of low traffic, while not retrieving or archiving data from the Main system under normal circumstances.

3.5 NATS is satisfied that these measures are both effective and readily available. Beyond the two instances included in the report, there have been no further instances up to the time of publication of this report (5 March).

> **NATS Observation 5** – CAD has clearly identified both ATC and engineering operating instructions to adopt workarounds above to minimise the risk of recurrence through revised procedures which have been promulgated to staff concerned, while a permanent software change is being developed and tested.

Testing the Change

3.6 The change was planned to be available in December 2016, with CAD reporting that their review with the Contractor on 6 December 2016 had confirmed availability was on course. CAD has requested the Contractor to conduct thorough testing at factory before delivering the change to Hong Kong for subsequent on-site testing / regression testing / system reliability performance / safety assessment prior to launch. CAD's established Safety Management System (SMS) procedures, in compliance with the International Civil Aviation Organisation (ICAO) Doc 9859 requirements, would mean that the timing of the launch of the change is currently estimated to be within the first quarter of 2017. The detailed on-site test and launching plan is being developed jointly with the Contractor.

> **NATS Observation 6** – The availability of a fix notwithstanding, CAD's request for thorough factory and off-site testing /evaluation in accordance with ICAO standards prior to launch of the change is prudent, a view which is bolstered by workarounds already put in practice.

4. The Impact on Staff Training and Procedures

Effectiveness of standing ATC and Engineering procedures

4.1 CAD has assessed that no ATC additional training will be involved since colleagues have been trained on the use of the Main System, Fallback System and the UFS (i.e. the two levels of fallback) and the standing contingency procedures.

4.2 From the engineering perspective, the manual resumption of offline FDP server to online state would initiate necessary flight information synchronisation from the operational FDP server. The recommended practice in the Contractor's report to avoid such a restoration process at a time of high traffic was a sensible recommendation to prevent data synchronisation from potentially pre-empting the flight plan association process. Likewise, the recommendation to conduct interactive playback on the Fallback System rather than the operational system was a logical recommendation, which could have avoided the causal circumstances that led to flight plan dis-association in the first place. Since both procedures are standing procedures and the recommended

workarounds involved the timing or the system onto which such procedures were to be carried out, there was no impact on staff training, ATC or engineering procedures.

Internal and external communication

4.3 NATS places importance on open and accurate reporting, and for this reason asks all external communication to be directed through official channels. NATS notes CAD has taken a consistent manner, similar to the occurrence on 27 October 2016, communicating with their staff through various means to convey clear and accurate factual information on the occurrence in a timely manner.

4.4 Various briefing sessions have been conducted to frontline staff explaining the cause leading to the occurrence on 29 November 2016, precautionary measures taken, fallback options available, immediate workaround measures and upcoming changes. A press briefing and a press release (with subsequent updates) were provided on the day of occurrence to explain the preliminary findings to provide accurate information to the public (Reference 2 and Reference 3).

4.5 For the 12 December 2016 occurrence CAD has provided briefing for engineering staff. CAD also released a press statement to the public via CAD's website on the same day of the 12 December 2016 occurrence.

NATS Observation 7 – NATS is satisfied with the effective and speedy communication by CAD to apprise its staff and media/public of details pertinent to the occurrences and expects CAD to maintain its good practice of maintaining clear communications through official channels only.

5. NATS Summary and Recommendations

5.1 NATS has reviewed the two specific occurrences. Overall NATS confirms that the occurrences are not unusual, and are examples of the kind of issues foreseen in previous analysis and experience from NATS. CAD's engineering and ATC responses were effective and proportionate, maintaining safety and initiating both short term measures and system changes to resolve the issue.

5.2 In the course of the assessment work, NATS has reviewed the evidence and the information provided by CAD and identified seven observations as shown in the previous sections. Given the complexity of an ATMS, even with all reasonable efforts and endeavours, there could still be possibilities for further issues, as NATS' own experience could attest. NATS has observed good practice by CAD in incident management and system fallback / recovery provisions, prompt incident investigation / tracking / rectification, availability of immediate and effective measures, leading to minimal changes to training arrangements associated with procedures and equipment. On the basis of the

evidence provided to NATS, CAD's handling on the occurrence is considered effective resulting in no impact to safety and minimal interruption to ATC operations.

5.3 NATS' observations are summarised as:

- The expectation of zero issues for such a large and highly complex ATMS is impractical;
- There was no safety impact caused by both occurrences. The impact on ATC operation was minimal and brief. Essential flight information was available at all times at the radar screens, the Fallback System and UFS were unaffected and available at all times;
- The decision to temporarily suspend outbound traffic, as a usual precautionary measure, was prudent before the situation was assessed and prior to the decision taken to resume normal ATC service. The resulting delays were proportionate. The contingency handling by CAD was on par with international best practice;
- The investigation and analysis by the contractor had resulted in prompt identification of the cause of the problem and assurance that both issues represented momentary flight plan data display issues rather than loss of flight data. There was further assurance from the investigation that the Fallback System and UFS were available and operating normally;
- Given the identification of the cause of the issue, effective workarounds were readily available. CAD had promptly implemented the workarounds with adequate communication including briefing materials to the staff. NATS is satisfied that these measures are effective and readily available, and that beyond the two instances included in the report, there have been no further instances up to the time of publication of this report (5 March);
- CAD is following its SMS process and test / evaluation procedures to ensure the fix is well tested at factory and at site prior to its launch; and
- Noting the importance of accurate information reaching staff, stakeholders and the media / public, NATS is satisfied with the effective and speedy communication by CAD to apprise its staff and media/public of details pertinent to the occurrences and expects CAD to maintain its good practice of maintaining clear communications through official channels only.

5.4 These are general recommendations from NATS, as good practice, to provide greater and wider assurance of a lower likelihood of occurrence of similar events in future. The recommendations together with CAD's responses are summarised in Appendix 2. All the recommendations have been adequately addressed and therefore closed.

6. Conclusion

6.1 While safety is of utmost priority, it is neither possible to eliminate all risks nor have a system with no issues reported, as reflected in the ICAO requirements, "risks need to be assessed and mitigated to an acceptably low extent". NATS believes that the occurrences demonstrate that CAD has a good safety ethos whereby both occurrences were managed

actively to ensure the safety of their services, and the impact on services was minimised, with normal ATC service being resumed within a short period of time.

6.2 In NATS' experience, it is not unusual for new systems or new functionality, such as the new ATMS, introduced on a previously stable system to cause issues when transitioned into service. NATS finds CAD's overall handling of and resolution to the occurrence thorough and proportionate. CAD's decision to temporarily withhold outbound aircraft, as a precautionary measure allowing the situation to be assessed prior to resuming normal service, is on par with that adopted by NATS and international best practice.

6.3 In addition to the existing actions undertaken by CAD, NATS has made some recommendations as good practice to further reduce the risk of future occurrences, including regular reviews of system and ATC performance to seek further improvements and to demonstrate that the system is effectively maintained in a 'stable state' over the system life-cycle.

6.4 On the basis of this occurrence and the associated evidence provided, NATS maintains its assessment that CAD's overall operational use of the ATMS is fit for purpose, with clear safety assurance to support full operations.

Appendix 1 - References

References	Description
1	Contractor's Investigation Report for the occurrence on 29 November 2016
2	CAD press release on 29 November 2016
3	CAD press release on 12 December 2016

Appendix 2 – NATS' Recommendations and CAD's Response

ID	Category	NATS Recommendation	CAD Response	Status
REC 1	Minimising likelihood of recurrence	CAD to review decoupling the "Replay" task from the Operational Main System to minimise risks to system performance.	CAD agreed with and has implemented NATS' recommendation with the task of "Replay" to be conducted on the Fallback System rather than the Operational Main System.	Closed
REC 2	Minimising the likelihood of recurrence	CAD to consider tracking the number and severity of similar ATC and engineering observations and issues to evidence that the system is bedding in, and identify any trends of similar system behaviour.	CAD has been tracking ATC and engineering observations and conducting regular reviews in accordance with standing practice under the established SMS process in CAD in compliance with the ICAO requirements.	Closed
REC 3	Monitoring of system performance	CAD to consider conducting system health analysis to watch out for any leading indicators following a transition of any system abnormal / concerning behaviours, e.g. increase in processor utilisation, increasing backlog of messages in queue through, for example, monitoring of computer processing utilisation (CPU), with suitable alert to engineering staff upon detection of abnormal trends for proactive actions.	Under a long established SMS regime, CAD has operational and engineering Subject Matter Experts (SMEs) to collect/analyse/categorise the observations, and conduct regular reviews. CAD has also been conducting proactive regular system health checks since system commissioning and has further enhanced system CPU monitoring mechanism for proactive actions.	Closed
REC 4	Effectiveness of change	CAD to review the system logic and heuristics that are initiated at start-up and changeover to ensure the integrity of the displayed data.	NATS' views have already been embedded in the software change to be implemented as per technical discussion with the Contractor. The Contractor has also confirmed that with the software change, the FDP will include specific logic to ensure the continuity of flight information display while responding to manually triggered maintenance processes. The effectiveness of the change will be verified through the	Closed

			CAD's stringent testing process in accordance with established SMS in compliance with the ICAO requirements.	
REC 5	Enhancement of response time, communication and fault handling	CAD to consider having a lead engineer in the Ops room at all times to discuss issues and options with ATC colleagues (the engineering team are normally located in a separate office and only enter the ops room when there is a fault). Working in this way has helped NATS resolve minor issues before they escalate.	Apart from a 24-x7 Watch Keeping Control Centre for the new ATC system next door to E-ATCC, CAD had established a 24x7 on-site Duty Engineer (DE) with its permanent position residing inside E-ATCC to directly liaise with the Operational Supervisors and to oversee the Operations and Maintenance (O&M) support of E-ATCC since its full commissioning. Moreover, a Resident Engineer / SME from the CAD's engineering team is also stationed next to the DE position at E-ATCC to enhance O&M support and effect prompt escalation, as appropriate.	Closed

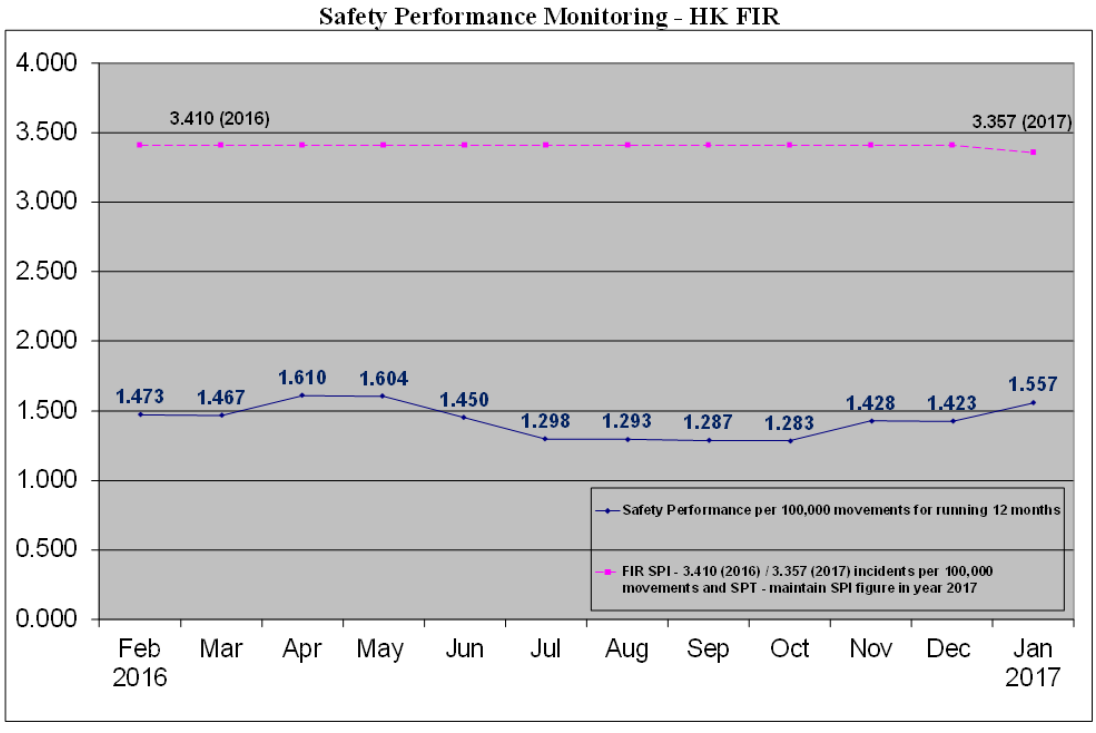
Annex I

Safety Performance

Safety Performance of January 2017 is 1.557, defined as the number of LoS incidents (total 11) in running 12-month period up to end January 2017 per 100,000 flight movements (total 706,340).

Safety Performance Indicators

Safety Performance Indicators is a data-based safety parameter used as a safety threshold for monitoring and assessing safety performance. The indicator is computed based on mean event rate of past 10 years. The 2017 Safety Performance Indicator is 3.357.



Safety Performance Target (SPT) & Safety Performance Indicator (SPI) Vs Safety Performance at Febraury 2016 - January 2017