



Final Report by the Air Traffic Management System Expert Panel

November 2017

Final Report
of the Air Traffic Management System Expert Panel

Period: November 2016 – November 2017

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Glossary

Term	Definition
ADS-B	Automatic Dependent Surveillance – Broadcast
AMAN	Arrival Manager System
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCOs	Air Traffic Control Officers
ATM	Air Traffic Management
ATMS	Air Traffic Management System
AUG	AutoTrac III Users Group
CAD	Hong Kong Civil Aviation Department
CANSO	Civil Air Navigation Services Organisation
FDP	Flight Data Processor
HKFIR	Hong Kong Flight Information Region
HKIA	Hong Kong International Airport
ICAO	International Civil Aviation Organization
LoS	Loss of separation
NATS	National Air Traffic Services
PFI	Phased Functional Implementation
SDP	Surveillance Data Processor

Term	Definition
SMS	Safety Management System
STS	Static Transfer Switch
3RS	Three-runway System
TEFS	Tower Electronic Flight Strip System
UFS	Ultimate Fallback System
VCSS	Voice Communication Switching System

(I) Executive Summary

Background

1. The Civil Aviation Department (CAD) had set up an Expert Panel comprising local and overseas experts and academia in the fields of air traffic management, engineering and aviation safety management to offer independent advice to CAD on the teething issues identified since the full commissioning of the new Air Traffic Management System (ATMS). Chaired by the Director-General of Civil Aviation, membership of the Expert Panel includes, in alphabetical order of last names, Ir Warren CHIM, Mr Marc HOUALLA, Mr KUAH Kong Beng, Mr Albert LAM and Professor MAN Hau-chung for a one-year term from December 2016 to November 2017. A brief introduction of the Members and Terms of Reference of the Expert Panel are at **Annex A**.

2. Since its establishment in December 2016, the Expert Panel had held seven meetings and had direct dialogue with frontline Air Traffic Control Officers (ATCO), electronics engineers, their respective associations and management pilots of major local airlines to collect views of key stakeholders of air traffic control (ATC) services. The Expert Panel also visited the operational East Air Traffic Control Centre and North Aerodrome Control Tower served by the new ATMS. In addition, the Expert Panel witnessed system demonstrations and reviewed playbacks of reported issues. To provide views and initial conclusion covering the period of 14 November 2016 to February 2017, the Expert Panel published an

Interim Report in April 2017. The full version of the report is available at the following CAD website link:

<http://www.cad.gov.hk/reports/Interim%20Report%20by%20the%20Air%20Traffic%20Management%20System%20Expert%20Panel.pdf>

3. Since the publication of the Interim Report, the Expert Panel continued its work in reviewing the performance of the ATMS and the continuous efforts by CAD to address the teething issues, as well as providing necessary advice and recommendations to CAD. This Final Report sets out the findings and conclusions of the Expert Panel, the summary of which is outlined in the following paragraphs.

An Appraisal of the ATMS' Operation and Performance

4. Since the full commissioning on 14 November 2016, the new ATMS had been providing safe, reliable and smooth round-the-clock ATC services for more than one year and had run the gamut of all weather, traffic peaks and contingency situations registering record traffic figures. The Expert Panel was satisfied with the overall good performance of the ATMS. The Expert Panel also noted that air traffic movements handled by the new ATMS after the transition had continuously increased and the system had successfully coped with the peak air traffic flow including the challenges posed by adverse weather. For more than one year of operation, the Fallback ATMS was activated on one single occasion to sustain continuous ATC operations as per design whereas the Ultimate Fallback System (UFS) had never been activated. That said, the UFS had been available at all time serving as the ultimate safety net should the Fallback ATMS fail.

5. The performance of the new ATMS had been exceeding the important safety criteria adopted by most European aviation authorities, i.e. the system availability of 99.9% as well as availability of surveillance information of 99.999% for essential flight data since the system commissioning.

6. It was pleasing to learn that the last non-surveillance related teething issue reported to the Expert Panel was in June 2017. As for the surveillance related ones, namely, split track, false target, aircraft position temporarily not displayed (i.e. dropped target), as a result of on-going fine-tuning and optimising and progressive deployment of Automatic Dependent Surveillance – Broadcast (ADS-B) technology within the Hong Kong Flight Information Region (HKFIR), the figures for split track, false and dropped target had decreased from 3.4, 8.6 and 1.9 to 0.0, 1.3 and 0.3 per week respectively from system commissioning to mid November 2017. With the on-going efforts, the Expert Panel is confident that such figures would continue to decrease and well exceed applicable international requirements.

7. It is worth noting that safety was never compromised during any of the occurrences. On a few occasions, departure flights were suspended briefly, which the Expert Panel believed was an appropriate and prudent measure taken under the circumstances as per normal international practice. The teething issues were handled properly as CAD staff had responded to the issues professionally and in a timely and prudent manner.

8. The Expert Panel concluded that the overall performance of the new ATMS was satisfactory and smooth after a run-in period and the front-line staff had become more conversant with the operation and maintenance of the system, with the staff association (namely the Hong Kong Air Traffic Control Association and the Civil Aviation Department Electronics Engineers Branch of Hong Kong Chinese Civil Servants' Association) (See **Annex F**) expressing confidence in and appreciation of the system through open letters. The Expert Panel further noted that in November 2017, CAD was announced the recipient of the annual Global Safety Achievement Award 2017 by the Civil Air Navigation Services Organisation (CANSO¹) for the successful implementation of the new ATMS in recognition of CAD's contribution to the improved safety level and increased efficiency in the provision of air navigation services in the HKFIR,² which certainly has a positive impact on the long term development of the aviation industry in the Asia Pacific Region. Overall, the Expert Panel has affirmed the handling capacity of the ATMS and the frontline ATC staff's competence in using the new system.

¹ CANSO is a leading organisation of and represents the interests of Air Navigation Service Providers around the world. As a full member since October 2016, CAD alongside other members account for the great majority of global air traffic. The mission of CANSO is “to be the global voice of air traffic management in the transformation of the aviation system; creating value for Members and our stakeholders.”

² The CANSO Global Safety Achievement Award is an annual award to commend and recognise “a company or team that has made a significant safety contribution which has reduced aviation risk in the previous 12 months. This may be a local, regional or global contribution and may encompass a process, procedure, technology or training improvement.” In November 2017, the Safety Standing Committee of the CANSO selected CAD, among five nominations (including the Federal Aviation Administration of U.S.A and the National Air Traffic Services (NATS) of U.K. etc.), as the recipient of the Global Safety Achievement Award in recognition of CAD's significant contribution and prestigious achievements in the area of improvement of safety in air traffic management.

Source: <https://www.canso.org/canso-global-safety-achievement-award>

9. Since the full commissioning of the new ATMS, the old ATMS had been maintained on standby mode for ready assumption of operation in the unlikely event of such a need. In view of the proven stability and reliability of the new ATMS, the old ATMS was never reactivated and was subsequently decommissioned on 14 July 2017.

Key Areas Reviewed and Recommendations

10. Based on their experience in implementation of similar projects overseas, the Expert Panel reiterated the views that as the new ATMS was a large-scale, complex and comprehensive computer system, minor occurrences would occur intermittently for different reasons (including human factors) especially during the initial stage of its operations. The Expert Panel stressed the importance of a pragmatic approach on resilience and multi-layers of fallback in system design, well-trained professionals with standing procedures for contingency handling and an effective Safety Management System (SMS) to anticipate and manage risks. These were all in place as evidenced by the effective management of teething issues, including prompt communication to internal and external parties for disseminating factual and accurate information and, where necessary, for clarification to dispel any misunderstanding.

11. The Expert Panel had reviewed all reported teething issues including two non-ATMS issues, which had resulted from a faulty power switch unit serving two workstations and from maintenance of the Voice Communication Switching System (VCSS) respectively. The Expert Panel was satisfied that there was no associated safety impact and all

issues had been closed. There was also a clear continuous downward trend in teething issues, which was well within expectation and in line with the experiences of Air Navigation Service Providers (ANSPs) overseas.

12. The Expert Panel also made a number of recommendations in addressing the teething issues, including specifying procedures to minimise incidents attributable to human factors, enhancing co-ordination between engineering staff and ATCOs, continuous monitoring of the overall ADS-B performance with regular reviews on the operational, technical and system aspects, and continuous optimisation of operating procedures and system operations of the ATMS. CAD had taken measures to implement all the recommendations, including establishing a mechanism to closely monitor the performance of ADS-B avionics of aircraft flying within the HKFIR and following up with relevant airlines/civil aviation authorities for aircraft with suspected degraded ADS-B avionics performance in accordance with the guidance document promulgated by the International Civil Aviation Organization.

13. The Expert Panel also made recommendations on enhancing communication with both staff and external stakeholders, which CAD had promptly followed up. It also suggested that CAD should continue to uphold its long established and effective SMS and safety culture to safeguard the smooth and safe provision of ATC services.

14. The Expert Panel noted that CAD had taken the initiative to form an international users group of AutoTrac III (model name of ATMS manufactured by Raytheon Company) (AUG) with its inaugural

meeting held from 19 to 20 September 2017 in Hong Kong with full participation by all AUG members and the management of Raytheon Company to share technical and operational experiences of their ATMS implementation, and Communications, Navigation and Surveillance systems. The Expert Panel was appreciative of CAD's efforts in championing the AUG, and opined that CAD could further optimise the new ATMS in Hong Kong through experience sharing with international users. The AUG recommended to continue holding AUG meetings in future and sharing experience at both local and international arena as opportune. With the AUG members being supportive of sharing issues, lessons learnt, findings, solutions, know-hows, workarounds and recommendations on a regular basis among themselves, CAD has followed up with other AUG members on hosting future AUG meetings.

Future Challenges and Conclusion

15. The ATMS had been operating smoothly for more than one year and had successfully coped with increasing air traffic with record-breaking air traffic figures. During the period, ATC had been able to provide safe and efficient air navigation services even during bad weather periods, including the passage of five severe storms to severe/super typhoons, as well as aircraft experiencing emergency situations. Nevertheless, against the challenges brought by fast growing air traffic, particularly with the planned expansion of the Hong Kong International Airport (HKIA), the Expert Panel considered that on-going effort was needed to sustain the long term development of the ATMS. This in turn would help maintain Hong Kong's status as an

international aviation hub. The Expert Panel considered that CAD should take actions as set out in the following paragraphs.

16. CAD should adhere to the on-going enhancement and deployment plan for introducing new features, commonly practised for ATC systems, throughout the service life of the ATMS arising from operational necessity. CAD should continue to keep the operating and maintenance procedures of the ATMS updated. In response, CAD has established regular meetings with the frontline maintenance staff to review and upkeep the maintenance procedures. CAD has also established regular communication with the frontline ATC and engineering staff, including representatives from the Hong Kong ATC Association and the Electronics Engineer Branch of the Hong Kong Chinese Civil Servant Association, in order to solicit frontline views in formulating both short term and long term plans in enhancing the ATMS for meeting the new ICAO initiatives and addressing on-going operational needs.

17. CAD should continue to upkeep its internal and external communication with relevant parties in a timely manner, collect feedbacks from staff, and thus pool wisdom to continuously improve ATMS operations. The CAD-initiated AUG serves as an excellent forum for sharing of knowledge and operational experiences, system enhancements, future development plans and roadmaps with other AutoTrac III users.

18. CAD should continue to review and formulate a long term ATC manpower plan to provide adequate competent staff for the

foreseeable expanded operation of the ATMS, especially that arising from the operational requirements of the HKIA Three-runway System (3RS).

19. The Expert Panel noted the latest developments of ICAO in the area of air traffic management contingency. The Expert Panel believed it prudent for CAD to closely monitor developments and fine-tune and/or upgrade the ATMS on an on-going basis in maintaining the capability and resilience of the ATMS on a sustained basis, especially during contingency.

20. In conclusion, given the demonstrated capabilities of the new ATMS after one full year of safe, reliable and smooth operation, the effective management and mitigation of teething issues, a well-established SMS, resilience and redundancy in the ATMS design, the Expert Panel is confident that with the continuing concerted efforts, the ATMS would continue to provide safe, reliable and smooth ATC services to support Hong Kong's position as an international aviation hub.

(II) Introduction

21. The new ATMS of CAD, developed by Raytheon under the brand “Autotrac III”, was selected in 2011 through an open tender exercise in accordance with established Government procurement process and World Trade Organisation Government Procurement Agreement procedures.

22. CAD had conducted a series of robust acceptance tests on the new ATMS in accordance with the requirements specified in the contract to ensure that the system operation complies with the contractual conditions and CAD’s safety requirements.

23. To ensure the new ATMS’ compliance with the relevant requirements, CAD also engaged UK-based EC Harris as 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 ICAO’s safety requirements in the process of system development. Furthermore, the Secretary for Transport and Housing had 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 ready before the new ATMS could be commissioned.

24. Before it was fully commissioned on 14 November 2016, the new ATMS had undergone a Phased Functional Implementation (PFI) process as recommended by NATS. During the 5-month PFI, which

commenced in June 2016, the use of the new ATMS to manage live air traffic was progressively expanded in terms of operating time and service coverage. During the entire PFI period, various operational functions were scheduled to be operated by the new ATMS in phases.

25. The new ATMS consists of Main System, Fallback System and UFS. The Main and Fallback Systems 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). The SDP processes surveillance data from different surveillance sources, while the FDP processes flight plans data and displays them on radar screen in association with the targets. Apart from the SDP and FDP, there are other systems or sub-systems developed by manufacturers other than Raytheon. Major functions of these system/sub-systems are 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 the event of failure of both the Main System and Fallback System (though with reduced functions which will limit the traffic handling capacity).

(ii) Tower Electronic Flight Strip System (TEFS)

The TEFS is a sub-system integrated into the new ATMS and used at the ATC Tower to display flight information to

controllers in flight strip format electronically, with automated/manual updating and posting features between work positions within the Tower or between work positions at the Tower and at the ATC Centre, replacing the conventional paper flight strips.

(iii) Arrival Manager System (AMAN)

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

26. After the full commissioning of the ATMS, there were occurrences during the initial stage of the new ATMS operation. 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, and electronics engineers to offer independent advice to the Director-General of Civil Aviation and CAD on the teething issues identified since the new ATMS' full commissioning. The Expert Panel was also tasked to share with CAD international experiences and best practices in relation to the long term optimisation of the new ATMS.

27. The Expert Panel was chaired by the Director-General of Civil Aviation, Mr Simon LI. Members included local experts, Ir Warren CHIM, Mr Albert LAM and Professor MAN Hau-chung, and overseas experts, Mr Marc HOUALLA and Mr KUAH Kong Beng. A brief

introduction of the Members and Terms of Reference of the Expert Panel are at **Annex A**.

28. Since its establishment in December 2016, the Expert Panel had held seven panel meetings. It also had direct dialogue with frontline controllers, electronics engineers, their respective associations/representatives and major local airlines management pilots to collect views and key comments direct from these major users of ATMS and providers of ATC services. In addition, the Expert Panel visited the operational Air Traffic Control Centre and Tower, witnessed system demonstrations and reviewed playbacks of reported issues.

29. This Final Report represents the Expert Panel's findings and conclusions of the new ATMS' operation based on the information available and deliberations at the meetings held. It sets out the Expert Panel's observations and recommendations, based on the knowledge, experience, judgement and areas of expertise of its Members on the various teething issues and the optimisation work. Where relevant, this Final Report also compares CAD's ATMS performance against internationally recognised standards and best practices. This Report ends with the Expert Panel's observations of the future challenges in relation to the safe, reliable and smooth operation of the ATMS in the longer term and the associated recommendations to meet these challenges.

30. Attendance records of all Expert Panel meetings are at **Annex B**. The press releases issued after each of the meetings are at **Annex C**.

(III) Appraisal of the ATMS' Operation and Performance

31. Since the full commissioning on 14 November 2016, the Expert Panel noted that the ATMS had been providing safe, reliable and smooth air traffic services for more than one year and ran the gamut of practically all local weather conditions, fair, foul and seasonal, traffic peaks during holiday periods and contingency situations (e.g. extraneous situations such as aircraft emergencies) and achieving new records of traffic figures.

32. Overall speaking, the ATMS had successfully coped with the increased traffic during the traditional busy travel periods of Christmas, New Year, Lunar New Year, Easter, and summer holidays. The total number of movements handled by the new ATMS between November 2016 and October 2017 increased by 6.7% as compared with the same period in the previous year.

33. Weather wise, there had been an unusually high number of occurrences of significant weather in the past year (see **Annex D**). A record high figure of 2,341 total movements was recorded over a 24-hour period on 24 August 2017 recovering from the impact of Typhoon HATO. The ATMS had successfully coped with the peak air traffic flow and overcome the challenges brought by adverse weather.

34. In the past year, the ATMS had experienced some teething issues particularly at the initial stage of operation, which were considered inevitable for such a large and complex system. Upon review of the reported teething issues, the Expert Panel was satisfied that they were

effectively handled by staff professionally as per standing practice and in a prudent manner to minimise potential risk. The UFS of the ATMS was never called into use. Indeed, even the Fallback System was only switched over as the full Main operational ATMS on one occasion during the 8 April 2017 occurrence³. Despite the brief disruptions brought by a few occurrences, essential surveillance data as well as radio communication (a non-ATMS system), and all other essential information was available at all times during the occurrences. Safety was thus never compromised by the occurrences.

35. The Expert Panel noted that the performance of the ATMS had exceeded the applicable EUROCONTROL⁴ requirements on the system availability of 99.9% as well as the availability of surveillance information of 99.999% for essential flight data which are important safety criteria adopted by most European authorities. Moreover, there are applicable EUROCONTROL requirements⁵ governing ATM surveillance system performance in the aspects of surveillance-related issues (such as aircraft positions not displayed temporarily, false targets and split tracks). Performance of the ATMS since its commissioning had been benchmarked against those requirements. Details of the benchmarking results are provided at **Annex E**, concluding that the performance of the ATMS had always exceeded the required performance levels in all of the applicable aspects.

³ The 8 April 2017 occurrence was caused by an accumulation of users' preferences settings exceeding the preset system limit, i.e. 5 500. As a result, the FDP could not function properly. ATMS operation was resumed through the activation of the Fallback ATMS and there was no safety impact.

⁴ "EUROCONTROL" stands for European Organisation for the Safety of Air Navigation which is an intergovernmental organisation with 41 Member States working to achieve safe and seamless air traffic management across Europe.

⁵ EUROCONTROL Specification for ATM Surveillance System Performance Volumes 1 & 2 (Edition March 2012); <http://www.eurocontrol.int/publications/eurocontrol-specification-atm-surveillance-system-performance>.

36. With the new ATMS up and running, the old ATMS was decommissioned on 14 July 2017 after the end of the Cold Standby period⁶. The space was then vacated for extension of the new ATMS to be developed as a backup to the operational facilities under the Phase 2 programme. The decommissioning work of the old ATMS was completed in September 2017. Upon installation of equipment and system acceptance testing, the West Air Traffic Control Centre would serve as the backup ATC Centre whereas the South Aerodrome Control Tower would resume the role of operational tower with the North Aerodrome Control Tower reverting to the backup role.

37. The Expert Panel concluded that the overall performance of the new ATMS was satisfactory and smooth after a run-in period and that the front-line staff had become more conversant with the operation and maintenance of the system. The staff associations (namely the Hong Kong Air Traffic Control Association and the Civil Aviation Department Electronics Engineers Branch of Hong Kong Chinese Civil Servants' Association) have expressed confidence in and appreciation of the system through open letters. It had no doubt that the foregoing had validated the performance and handling capacity of

⁶ The old ATMS was initially planned to be maintained for a period of 6 months ending on 14 May 2017 in a state to readily take over the operations of the new ATMS if necessary. Following the FDP occurrence on 8 April 2017, for prudence's sake CAD had taken the initiative to extend the Cold Standby Period until the next Expert Panel meeting in June 2017. At the June 2017 meeting, the Expert Panel cautioned about the potential risk arising from the additional extension of the Cold Standby Period in relation to recency and competency of ATC personnel in operating the old ATMS, and opined that the original duration of 6 months was adequate and longer than those practiced by other ANSPs. The Expert Panel maintained its views that technical justifications for ending the Cold Standby as originally planned remained. That said, the Expert Panel was satisfied with CAD's measures such as refresher training, cue cards, etc. to address the recency and competency issues. The Expert Panel subsequently agreed to the proposal to extend the Cold Standby Period until July 2017.

both human and machine, with the underlying system redundancy and resilience, training, contingency handling experience and standing operational procedures all culminating in support of reliable and safe ATC services provision. On the other hand, the above achievement was the result of relentless improvement efforts upon close monitoring and review.

(IV) Key Areas Reviewed and Recommendations

Addressing Teething Issues

General

38. The Expert Panel pointed out that as the new ATMS is a large-scale and complex system, minor occurrences, particularly in the initial stage, were not unexpected for different reasons, including human factors related ones such as the temporary interruption of display of AMAN arrival sequencing information on 2 January 2017 and the temporary interruption of the Voice Communication Switching System on 4 January 2017.

39. However, with the multi-layer redundancy in system design, those minor occurrences did not affect aviation safety and posed insignificant impact on ATC operations. After evaluating the relevant occurrences, the Expert Panel considered that, with more than one full year of smooth and continuous operation, safety performance of the new ATMS had exceeded international requirements as specified in paragraph 35.

40. The Expert Panel also noted that there was a clear and noticeable downward trend of teething issues over time, indicating that the ATMS had entered into a more mature stage and that frontline staff had become increasingly conversant with operation of the ATMS. This outcome was within expectation and in line with experiences of similar projects overseas. This was also consistent with the views of

the external consultant, NATS, hired by the Transport and Housing Bureau.

41. The Expert Panel was of the view that new issues arising from system, operations, human factors or unforeseen external circumstances might occur despite continuous efforts to enhance the system. Therefore, the Expert Panel believed that efforts should focus on the availability of multiple fallback redundancy, safety nets and robust contingency handling procedures. The Expert Panel noted that CAD had already put in place adequate operational and contingency procedures. The Expert Panel noted that the occurrence on 8 April 2017 had necessitated the activation of the Fallback System, which had performed as designed. The Expert Panel believed that CAD should focus on strengthening the scrutiny of the deployment of software fixes/enhancement and system monitoring through the SMS regime to ensure that there were no unacceptable risks.

Review of Teething Issues

42. The Expert Panel had reviewed the teething issues, which fall into five categories, namely:

- (i) surveillance information;
- (ii) flight data processing;
- (iii) standalone systems subsumed to ATMS;
- (iv) human factors; and
- (v) non-ATMS issues.

All the teething issues reviewed were considered closed. A full list of the issues with causes and rectifications elaborated is provided at **Annex G**.

43. The Expert Panel was satisfied with CAD's handling of the teething issues and the progress of resolutions. With reference to Members' local/overseas experiences and international best practices, the Expert Panel made a number of observations and recommendations and CAD had taken actions to implement all these recommendations.

Key areas addressed

44. First, a few reported occurrences shared a common thread of human factor element of the frontline staff at the time of occurrences such as maintenance activities not conducted at time of low traffic, and inputting command to initiate an unregistered system configuration. With briefings provided to staff and updates of relevant procedures against such inadvertent activities, during the latter part of the term of the Expert Panel there had been no further reported occurrences attributable to human factor issues in the conduct of maintenance activities. Nevertheless, the Expert Panel advocated continuous vigilance against similar inadvertent activities through the standardisation of and adherence to the relevant procedures, where applicable.

45. The Expert Panel also noted that it was important for the engineering staff to maintain good communication with operational controllers. It recommended that timely advice on the temporary arrangement, including fallback arrangement, and any possible impact from conduct

of maintenance activities should be provided to frontline controllers to minimise risk and disruption to operation and improve response and recovery time should issues occur. With experience gained from these teething issues and increasing familiarity with the system, CAD had implemented various measures, in the form of Operational Instructions, team briefings, handover notes, lessons learnt and maintenance instructions, to promulgate relevant information to frontline operational and maintenance staff in a timely manner.

46. On surveillance optimisation and enhancement, the Expert Panel noted that the progressive implementation of ADS-B technology had resulted in significant decrease in reports of split tracks, false targets and aircraft positions not displayed momentarily (i.e. dropped target). The weekly averages of split track, false target and dropped target had decreased from around 3.4, 8.6 and 1.9 cases respectively in the period between November 2016 and March 2017 to around 0.0, 1.3 and 0.3 cases respectively in the period between August and mid November 2017. For more details, please refer to **Annex H**. Given the reduction in surveillance related issues and enhancement of conflict alert performance with the planned progressive implementation of ADS-B coverage integrated into the new ATMS to strengthen surveillance within the HKFIR, the Expert Panel recommended CAD continuing its efforts to closely monitor the overall ADS-B performance with regular reviews on the operational, technical and system aspects to assess the need for further fine-tuning. Nevertheless, the Expert Panel cautioned against expectation of complete elimination of such occurrences given a number of external factors that could affect the integrity of surveillance data being fed into the ATMS. In response, CAD had established a mechanism to closely monitor the performance

of ADS-B avionics of aircraft flying within the HKFIR and follow up with relevant airlines/civil aviation authorities for aircraft with suspected degraded ADS-B avionics performance in accordance with the ICAO guidance document.

47. The Expert Panel also recommended that 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. Relevant operating and maintenance procedures of the new ATMS had therefore been optimised and would be reviewed by CAD on a regular basis to ensure its highest performance standard. From maintenance and operational perspectives, necessary updates to reflect lessons learnt and day-to-day operational experience and knowledge tidbits have been incorporated into the respective maintenance procedures and operational instructions/practices, thereby contributing to overall improvement to system performance and stability. For example, maintenance procedures have been enhanced to avoid maintenance activities being carried out during high air traffic periods, and Operational Instruction has been issued to frontline staff to avoid inadvertent manual initiation of system configuration not relevant to the prevailing operating environment.

48. On deployment of software fixes/enhancements, the Expert Panel suggested that CAD should prioritise the items and implement those changes prudently in order to minimise risks when introducing any changes. Accordingly, CAD had established a mechanism to assess and review the priority of enhancement items among ATC and engineering staff. For instance, uploading of new software builds to

rectify the ATMS sub-systems related issues in June and September 2017 was prioritised and implemented under the established SMS with risks adequately mitigated. The software builds had been successfully deployed to the new ATMS for operational use without any issues.

Safety Management System

49. As mentioned previously, the Expert Panel affirmed that teething issues for any large and complex systems such as the ATMS are inevitable. It is neither possible to eliminate all risks nor to have a system with nil issues. As stated in Annex 19 to the Convention on International Civil Aviation, “Safety” is defined as the state in which risks associated with aviation activities, related to, or in direct support of the operation of aircraft, are reduced and controlled to an acceptable level. It is therefore incumbent upon the ANSP concerned to manage and mitigate such operational risks to an acceptable level.

50. The key is therefore to put in place a proper SMS to ensure that there are no unacceptable risks, which does not mean that there would not be any chance of incidents at all. The Expert Panel was satisfied that all teething issues encountered were thoroughly reviewed on their respective safety risks, analysed for any trend and correlation among them, as well as the readiness of proper training and operational procedures, etc. in accordance with the SMS regime established under the relevant ICAO annexes.

51. CAD’s SMS had incorporated the necessary and effective elements stipulated the ICAO Annex 19 and the ICAO Safety Management Manual, such as fact finding, analysis of root causes to the issues, risk

identification, mitigation and control implementation and review of their effectiveness to reduce probability and severity of the risks arising from the issues. These SMS elements were robustly applied in CAD's review of all the issues and their handling.

52. In particular, the detailed safety review conducted by CAD under its SMS had concluded that those issues had been fully addressed given the following factors: (i) the issues are isolated cases; (ii) the effectiveness of the controls and mitigating measures implemented; (iii) the effectiveness of the fixes and follow-up actions such as close monitoring of system performance, enhanced training and briefings provided to ATCOs, procedural enhancements; and (iv) no recurrence of similar issues. Further, the SMS review concluded that with preventive and remedial measures having been put in place to address the root causes of occurrences, the risk of recurrence had been mitigated to an acceptable level.

53. The Expert Panel believed that the controls and mitigation measures, contingency plan and the associated procedures, resilience in system design, along with a team of experienced and professional staff, were instrumental in managing the risks induced by the teething issues to an acceptable level. These were the result of a robust SMS that CAD had put in place. The Expert Panel appreciated and recommended CAD to uphold its long established and effective SMS and safety culture in safeguarding the smooth and safe provision of ATC services.

Effective Communication

54. Performance aside, communication with staff and other stakeholders was instrumental to the successful operation of ATMS. The Expert Panel met with representatives of frontline ATCOs and electronics engineers of CAD on 18 January 2017. Generally speaking, staff considered that the new ATMS was safe and reliable, and that the controllers were becoming more competent and confident in using the ATMS in providing ATC services. The controllers expressed the views 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. The engineering staff considered that the contractor (Raytheon) was responsive so far in conducting investigation and in taking prompt follow-up actions as necessary. Controllers had expressed concerns about the nuisance caused by certain predictive conflict alert warnings, the setting of which would need to be further fine-tuned pending the accumulation of more operational experiences and staff feedback. Some staff also expressed concern on the occasional sluggishness of workstations and keyboards/mice not responsive to commands. 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.

55. In the light of the above, the Expert Panel recommended that CAD should address the staff's concerns and enhance staff's confidence in the ATMS through a series of measures including further reducing nuisance conflict alert caused by false targets, and in particular,

through the on-going efforts with monitoring of ADS-B performance; fine-tuning the predictive conflict alert settings in order to best suit operational needs; and continuing to monitor and address controllers' concerns on workload through measures such as reviewing the break/relief arrangements to keep pace with growing air traffic in the longer term. To address the recommendation, CAD had successfully fully integrated ADS-B technology over a large portion of HKFIR; optimised the predictive conflict alert settings; and progressively strengthened the ATC operational manpower to better support the air traffic growth.

56. On occasional sluggishness and/or keyboards/mice not responsive to commands for individual workstation, the Expert Panel opined that the issue was not unique to the ATMS at CAD but also other brands of ATMS in other ANSPs. Proactive measures such as workstation restarts, memory allocation fine-tuning at the Operating System level, together with monitoring of system resources such as memory and CPU loading were part of the regular housekeeping procedures commonly carried out in accordance with international best practices regardless of brands of ATMS and is not unique to CAD. The Expert Panel noted that with the proactive measures, the number of reports of individual workstation sluggishness had been kept to a relatively low level considering CAD's sizeable ATC operation. During each of the reported cases, all flight targets and information continued to be displayed on the screens, and controllers could still communicate with and gave ATC instructions to pilots, ensuring that there was no impact on aviation safety. From a management point of view, the Expert Panel recommended CAD strengthening the communication with the frontline staff in this particular aspect. The Expert Panel noted that

regardless of the processing power of the hardware in use, it could not cater to all possible circumstances. It was therefore important to ensure that there were established procedures to handle such situations. The Expert Panel recommended CAD following up with the Contractor to strive for continuous improvement in this aspect through system enhancement in view of growing air traffic.

57. The Expert Panel also recommended CAD to be proactive in sharing information with staff on management's considerations in the implementation of enhancement and optimisation measures, including practicality, priorities and timelines of implementation. CAD should continue with its good practice of gathering views and facilitating feedbacks from both the operational and engineering teams. Communication with staff is an iterative process and the Expert Panel noted CAD Management's continuous efforts in improving the ATMS and the working environment of ATC frontline staff. CAD senior management also had regular informal gatherings with the frontline controllers and engineering staff and posted lessons learnt as a result of occurrence investigations on notice boards, conducted briefing sessions on system behaviours and disseminated information via intranet to enhance mutual communications and address staff's concerns.

58. In respect of other stakeholders, the Expert Panel also recommended CAD exploring ways to promote the ATC profession and knowledge to the community at large, which would understandably take time. As a matter of fact, the Expert Panel noted that with the establishment of the Hong Kong International Aviation Academy and delivery of training programmes since May 2017, introductory courses on ATC

had been available to the public as an initial step in promoting the ATC profession and knowledge to the community at large. CAD was also working with the Academy in incorporating ATC engineering training into its curriculum.

Sharing of ATMS Implementation and Transition Experience

59. The Expert Panel noted that CAD had spearheaded the forming of AUG, comprising all current AutoTrac III users, namely, CAD, Dubai Air Navigation Services, Airports Authority of India, and US Federal Aviation Administration as a user of a variant of the AutoTrac system. With its inaugural meeting held from 19 to 20 September 2017 and attended by all group members and management of Raytheon, the AUG had served as a forum to share technical and operational experience on one another's ATMS implementation, thereby benefitting all parties in their respective operations and system enhancements. The international users discussed their operational and technical experience over the years, international best practice and future development. They also exchanged information related to system enhancement works completed or being carried out in order to meet the ICAO's latest requirements and their respective operational requirements, with a view to enhancing operational efficiency to cope with the expected growth in air traffic.

60. AUG members were impressed by the overall system architecture of the new ATMS in Hong Kong. The AUG meeting concluded that the AutoTrac III users were in general satisfied with the overall performance of the ATMS and agreed that closer co-operation and

information sharing among the users would help improve the system performance effectively. Members considered that the teething issues at the initial period of ATMS operation were not uncommon and had occurred during the introduction of new ATMS in their own domains.

61. The Expert Panel considered that the Users' Group platform was very constructive and opined that CAD could further optimise the new ATMS in Hong Kong through experience sharing with international users. The Expert Panel was appreciative of CAD's efforts in championing the AUG, and was satisfied with the constructive outcomes of the AUG meeting. Subsequent to the successful implementation of the ATMS and the outcome of the AUG, CAD took the initiative to share its experience with other non-AutoTrac III system users at regional forums for the benefit of the civil aviation community.

62. During the term of the Expert Panel, the ATMS, the operational East Air Traffic Control Centre and North Aerodrome Control Tower had been showcased to stakeholders and participants of local and international conferences/meetings held in Hong Kong. Working papers on transition of the new ATMS were also presented at various ICAO's meetings to share CAD's experience. CAD had also played host to ANSPs, who had shown a keen interest in CAD's transition plan, post-transition operational experiences, designed-in redundancy and resilience of ATMS, and the supporting infrastructure for the new ATC systems. The success of the transition could serve as a very good reference for those planning for or engaging in ATMS transition projects, as relayed by an ICAO delegation led by the Deputy Regional Director of ICAO Asia Pacific following his visit to CAD in

June 2017. Fact finding visits, experience sharing and referencing each other's ATC system implementation are more than commonplace among ANSPs in a service industry where safety comes first.

63. The Expert Panel encouraged CAD to continue to share its positive ATC transition experience, handling of teething issues, established SMS process along with the challenges it had faced at local and overseas settings. Likewise, some members of the Expert Panel would take opportunities to share the positive CAD experience with fellow members of the industry for the benefit of the aviation community. In this connection, the AUG recommended to continue holding AUG meetings in future and share experience at both local and international forums as opportune. With the AUG members being supportive of sharing information and experience on a regular basis among AT3 users, CAD has followed up with other AUG members on hosting future AUG meetings.

Loss of Separation Incidents

64. Given media and public interest, though not related to the ATMS, the Expert Panel was also updated on Loss of Separation (LoS) incidents, which were defined as infringement of the applicable standard horizontal or vertical separation between aircraft. The Expert Panel discussed and deliberated on such incidents and noted that the ICAO allowed individual civil aviation authorities to establish procedures in handling LoS incidents to suit their respective circumstances. With reference to practices of international ANSPs, CAD established proper procedure which was applied to both the old and new ATMS. The

Expert Panel considered that the handling procedures of LoS incidents by CAD were on par with international practice. The Expert Panel also agreed that the LoS incidents reported were not related to the ATMS. As in other regions of the world, the LoS incidents were attributable to a diverse range of factors including inclement weather, operating procedures and human factors. Those incidents were of minor nature and safety was never compromised. Nevertheless, the Expert Panel urged CAD to continue to closely monitor LoS incidents and to be vigilant of any adverse trend and to identify any apparent/latent cause if such a trend was noted.

(V) **Future Challenges**

65. The ATMS had been operating smoothly for one year and had successfully coped with increasing air traffic with record breaking air traffic figures. During the period, ATC has been able to provide safe and efficient air navigation services even during bad weather periods, including the passage of a number of typhoons, as well as to aircraft experiencing emergency situations. Nevertheless, against the backdrop of fast growing air traffic as a challenge facing most ANSPs and airports around the globe, the Expert Panel considers that on-going effort is required to sustain the long term development of the ATMS to meet the challenges of future traffic demand, particularly with the on-going 3RS Project at the HKIA. CAD's 3RS Project Team, consisting of professional ATC staff and engineers, has been considering the long term development needs of the ATMS in order to meet all these challenges.

66. Following more than one year of continuous operation, the ATMS is in a consolidation stage where a review on the implementation plan for phasing in additional functional features is ongoing. In addition, a detailed study of system enhancements to comply with future ICAO initiatives and requirements, to automate and streamline ATMS/controller work flow and to adapt to the 3RS is also in the pipeline. Such enhancements need to be implemented gradually and prudently. ATMS and ANSPs by nature need to stay connected with external systems and ANSP counterparts to keep up with the latest data exchange protocols, to implement new functions and features, to adopt new but proven technologies and new operational configurations. The Expert Panel considers that continuous enhancement and

refinement of any ATMS is necessary and should be an on-going process. In addition, CAD should continue to keep the operating and maintenance procedures of the ATMS as living documents that need to be reviewed and updated on a regular basis.

67. In this respect, CAD has established regular meetings with the frontline maintenance staff to review and upkeep the maintenance procedures. CAD has also established regular communication with the frontline ATC and engineering staff, including representatives from the Hong Kong ATC Association and the Electronics Engineer Branch of the Hong Kong Chinese Civil Servant Association, in order to solicit frontline views in formulating both short term and long term plans in enhancing the ATMS for meeting the new ICAO initiatives and addressing on-going operational needs. As far as ICAO initiatives were concerned, CAD would put focus on enhancements for meeting the latest applicable ICAO requirements, which aimed to enhance capacity, increase efficiency and ensure interoperability with other ANSPs, in the light of the aviation technological advancement.

68. CAD should continue to upkeep its internal and external communication with relevant parties in a timely manner, collect feedbacks from staff, and thus pool wisdom to improve ATMS operations in future. In this connection, the AUG forum initiated by CAD is an excellent forum for sharing of knowledge and operational experiences with other AutoTrac III users.

69. CAD should continue to upkeep its relevant mechanisms, channels and practices to regularly monitor the performance of ATMS and its enhancement needs through:

- (i) collecting comments from frontline staff via formal and informal channels;
- (ii) enhancing communication between engineering and operation subject matter experts via formal and informal channels;
- (iii) reviewing with ATMS supplier and maintenance staff via standing senior management level meetings/teleconferences and system performance review meetings; and
- (iv) conducting safety performance assessments under the established SMS framework such as the review of safety performance targets, review of the effectiveness of risk mitigating measures, safety audits and inspections, refresher training and fallback drills to ensure competency and continuous improvement in system maintenance and procedures.

70. Despite the state-of-the-art ATMS, provision of round-the-clock ATC services is still very much dependent on availability of sufficient ATC manpower. A long term ATC manpower plan should be formulated to provide adequate level of competent staff to cope with the foreseeable expanded operation of the ATMS.

71. Lastly, the Expert Panel noted the latest developments of ICAO in the area of air traffic management contingency. The Expert Panel believed it prudent for CAD to closely monitor developments and fine-tune and/or upgrade the ATMS on an on-going basis in maintaining the capability and resilience of the ATMS on a sustained basis, especially during contingency.

(VI) Conclusion

72. For a large and complex system such as the ATMS, teething problems are inevitable and it is unrealistic to expect zero issues. The important point to note was that those teething issues did not affect aviation safety and had posed insignificant impact on ATC operations. CAD frontline staff has also been performing professionally and effectively and is able to master the ATMS in a relatively short time. Credit goes to CAD staff for their perseverance and professionalism as well as other stakeholders of the aviation sector which had provided full support to the system transition.

73. Nevertheless, in view of the future challenges brought by increasing air traffic particularly with the planned expansion of the HKIA, CAD should get prepared and continue its on-going effort in upgrading the ATMS and refining the related operations and procedures. With the concerted effort of all parties concerned including staff and other aviation stakeholders, it is envisaged that the ATMS would continue to provide safe, reliable and smooth ATC services to support the growth of Hong Kong as an international aviation hub.

ATMS Expert Panel

November 2017

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 1 December 2016 to 30 November 2017

Background of Expert Panel Members (in alphabetical order of last names)

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, Macao and Mainland.

Before taking up the post of the Managing Director of Paris-Orly Airport in early October 2017, Mr Marc Houalla had been the President of Ecole Nationale de l'Aviation Civile (National School of Civil Aviation) since

2008. 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).

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.

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 ICAO 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.

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.

Attendance to the First Meeting of the Expert Panel
Held on 16 December 2016

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 (via teleconference)
	Mr Albert LAM	Former Director-General of Civil Aviation (via teleconference)
	Professor MAN Hau-chung	Dean of the Faculty of Engineering, Hong Kong Polytechnic University
Secretary:	Mr Vincent WONG	Senior Electronics Engineer (Projects)1
In attendance:	Capt. Victor LIU	Deputy Director-General of Civil Aviation (1)
	Mr Raymond LI	Assistant Director-General of Civil Aviation (Air Traffic Management)
	Mr Richard WU	Assistant Director-General of Civil Aviation (Air Traffic Engineering Services)
	Ms Mona CHEUNG	Chief (Procedures and Evaluation)
	Mr Thomas FOK	Chief Electronics Engineer (Projects)
	Mr Samuel NG	Senior Evaluation Officer (1)

Attendance to the Second Meeting of the Expert Panel
Held on 18 January 2017

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 (via teleconference)
	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 Electronics 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 (Air Traffic Management)
	Mr Richard WU	Assistant Director-General of Civil Aviation (Air Traffic Engineering Services)
	Ms Mona CHEUNG	Chief (Technical and Development)
	Mr Thomas FOK	Chief Electronics Engineer (Projects)
	Mr Samuel NG	Senior Evaluation Officer (1)

Attendance to the Third Meeting of the Expert Panel
Held on 20 February 2017

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 Electronics 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 (Air Traffic Management)
	Mr Richard WU	Assistant Director-General of Civil Aviation (Air Traffic Engineering Services)
	Ms Mona CHEUNG	Chief (Technical and Development)
	Mr Thomas FOK	Chief Electronics Engineer (Technical Support)
	Mr Samuel NG	Senior Evaluation Officer (1)

Attendance to the Fourth Meeting of the Expert Panel
Held on 3 April 2017

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 Electronics Engineer (Projects)1
In attendance:	Capt. Victor LIU	Deputy Director-General of Civil Aviation (1)
	Mr Raymond LI	Assistant Director-General of Civil Aviation (Air Traffic Management)
	Mr Richard WU	Assistant Director-General of Civil Aviation (Air Traffic Engineering Services)
	Ms Mona CHEUNG	Chief (Technical and Development)
	Mr Thomas FOK	Chief Electronics Engineer (Technical Support)
	Mr Samuel NG	Senior Evaluation Officer (1)

Attendance to the Fifth Meeting of the Expert Panel
Held on 6 June 2017

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 Electronics Engineer (Projects)1
In attendance:	Mr Kevin CHOI	Deputy Director-General of Civil Aviation (2)
	Ms Mona CHEUNG	Acting/Assistant Director-General of Civil Aviation (Air Traffic Management)
	Mr Richard WU	Assistant Director-General of Civil Aviation (Air Traffic Engineering Services)
	Mr Thomas FOK	Chief Electronics Engineer (Technical Support)
	Mr Samuel NG	Senior Evaluation Officer (1)

Attendance to the Sixth Meeting of the Expert Panel
Held on 27 September 2017

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 Electronics Engineer (Projects) ¹
In attendance:	Ms Linda SO	Deputy Director-General of Civil Aviation (2)
	Mr Raymond LI	Assistant Director-General of Civil Aviation (Air Traffic Management)
	Mr Richard WU	Assistant Director-General of Civil Aviation (Air Traffic Engineering Services)
	Mr Alex HONIG	Acting Chief (Technical and Development)
	Mr Thomas FOK	Chief Electronics Engineer (Technical Support)
	Mr Samuel NG	Senior Evaluation Officer (1)

Attendance to the Seventh Meeting of the Expert Panel
Held on 21 November 2017

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 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
Member absent:	Mr Marc HOUALLA	Managing Director of Paris Orly Airport
Secretary:	Mr Vincent WONG	Senior Electronics Engineer (Projects)1
In attendance:	Capt. Victor LIU	Deputy Director-General of Civil Aviation (1)
	Ms Linda SO	Deputy Director-General of Civil Aviation (2)
	Mr Raymond LI	Assistant Director-General of Civil Aviation (Air Traffic Management)
	Mr Alan SHUM	Assistant Director-General of Civil Aviation (Air Services and Safety Management)
	Mr MH HUI	Acting Assistant Director-General of Civil Aviation (Air Traffic Engineering Services)
	Ms Mona CHEUNG	Chief (Technical and Development)
	Mr Thomas FOK	Chief Electronics Engineer (Technical Support)

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Air Traffic Management System Expert Panel holds first meeting

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

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 intermittently 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

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 occurrences 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

ATMS Expert Panel holds fourth meeting and publishes interim report

The Air Traffic Management System (ATMS) Expert Panel set up by the Civil Aviation Department (CAD) held its fourth meeting today (April 3) and published an interim report on teething issues arising from the commissioning of the new ATMS, and the optimisation and fine-tuning work carried out by the CAD.

During the meeting, the expert panel confirmed the content of the interim report, which covered the results of the discussions of the first three meetings and confirmed that, up till the end of February, the new ATMS had been providing safe, reliable and generally smooth air traffic services within the Hong Kong Flight Information Region (HKFIR) and had been compliant with the international safety standard since its full commissioning on November 14, 2016. Although the new ATMS experienced some operational hindrances, the interim report stated that the CAD's staff had handled those occurrences professionally, as per standing practice, and minimised potential safety risks. The interim report, making comparisons to international best practices and the International Civil Aviation Organization (ICAO)'s safety management system process, pointed out that the CAD has in place an effective and established mechanism for responding to different situations occurring after the full commissioning of the new ATMS.

According to the interim report, the ATMS has successfully coped with the challenges of peak traffic demand during the holiday seasons in the end of 2016 and early 2017. The average number of daily air traffic movements handled by the new ATMS increased by 3.75 per cent when compared with the same period a year earlier. It was an assuring indication of the performance of new ATMS as well as the front-line Air Traffic Control (ATC) staff, the report said. Nevertheless, it noted that the CAD should get prepared for the next round of challenges during the inclement weather and typhoon seasons in the summer of 2017, continue monitoring the performance of the satellite-based Automatic Dependent Surveillance – Broadcast (ADS-B), and further enhance the display of aircraft positions and minimise conflict alert nuisance caused by false targets. Views from the front-line Air Traffic Control Officers (ATCOs) for optimising operational procedures and hardware should be gauged. The interim report also urged the CAD to continue monitoring ATCOs' workload, and to adopt different measures, such as reviewing the break/relief arrangements and providing additional ATC manpower during peak hours/seasons of air traffic, to keep pace with growing air traffic in the longer term.

The interim report is available on the CAD's website: www.cad.gov.hk/english/reports.html.

During the fourth meeting today, the CAD updated the expert panel members on the implementation of the software fix, which was provided by the contractor to address the flight plan dis-association issue and the temporary issue with the electronic flight strip. The CAD has carried out thorough tests and safety assessments on the software fix according to the established procedures laid down by the Safety Management System, which is also in accordance with the ICAO's requirements. Upon successfully passing through relevant tests and assessments, the software fix was implemented in the new ATMS on March 20. Since then, the operation of the new ATMS has remained stable and smooth. The expert panel members reminded the CAD to continue to closely monitor the performance of the new ATMS and the effectiveness of the new software fix in fully addressing relevant teething issues.

With regard to the implementation of ADS-B technology, 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) following the progressive introduction of ADS-B in the HKFIR. The expert panel members urged the CAD to work towards the full integration of ADS-B in the new ATMS progressively in 2017 to further enhance the display of aircraft positions.

Lastly, the CAD consulted the expert panel members on ending the cold standby mode of the old ATMS. As pointed out in the interim report, the operations of the new ATMS had been smooth since the full commissioning and none of its fallback systems had to be activated. The system availability of the new ATMS had all along exceeded 99.9 per cent, fully achieving the international best requirements. In view of the above, the expert panel members agreed to the CAD's assessment that it was not necessary to use the old ATMS again. Provided that everything is smooth in the coming few weeks, the expert panel members concurred that the CAD can put an end to the cold standby mode of the old ATMS on May 14 as initially planned, i.e. six months after the commissioning of the new ATMS. The new ATMS has multiple fallback systems, including the Main System, the Fallback System and the Ultimate Fallback System, which are located at different parts of the CAD Headquarters to ensure a sustainable and reliable ATC operation. As a next step, the new ATMS will be extended to the old ATC Centre for backup purpose.

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 the new ATMS. The members have been appointed for a one-year term till November 30, 2017. The expert panel members will continue to meet from time to time to offer advice on the necessary optimisation work of the new ATMS.

Ends/Monday, April 3, 2017
Issued at HKT 14:30

Air Traffic Management System Expert Panel holds fifth meeting

The Air Traffic Management System (ATMS) Expert Panel set up by the Civil Aviation Department (CAD) held its fifth meeting today (June 6). During the meeting, the expert panel was briefed on the latest developments of the new ATMS, and was content with the way the CAD handled the occurrences which took place after the last meeting in April (see Annex for details). The CAD was reminded to follow up on individual items.

With regard to the momentary hitch experienced with the Flight Data Processors of the new ATMS' main system on April 8 due to the accumulation of users' preferences settings, the expert panel noted that a software fix has been implemented successfully in the new ATMS on May 15 and urged the CAD to continue to closely monitor the performance of the new ATMS and the effectiveness of the new software fix in fully addressing the issue. Furthermore, following careful evaluation, the expert panel confirmed that the data parameters with a preset limit in the new ATMS, other than the users' preferences setting, are far greater than the actual usage. The preset limits will not be reached and cause an issue under normal operation. In addition, there is an established protection mechanism in place. The new ATMS will either not accept additional inputs, reject further inputs or overwrite old inputs once the corresponding data parameters reach the preset limit.

The expert panel noted that there were some occasional occurrences of temporary setbacks of some sub-systems (such as the Arrival Manager System and the Tower Electronic Flight Strips System), which were independent from the old ATMS and have been enhanced by the new ATMS and incorporated into the new system. The expert panel acknowledged that aviation safety has not been undermined by the occurrences and urged the CAD to follow up with the contractor and the suppliers of the sub-systems to take necessary follow-up actions to address the issues. The expert panel also concurred that the CAD should continue to carry out regular housekeeping procedures for the system itself and all of its sub-systems as per the requirements of safety management.

During the meeting, the CAD also consulted the expert panel members on ending the cold standby mode of the old ATMS. According to the initial plan, the CAD would put an end to the cold standby mode of the old ATMS six months after the commissioning of the new ATMS, i.e. on May 14. According to the CAD's assessment, it will introduce additional and unnecessary operational risks as the Air Traffic Control Officers (ATCOs) have to adapt themselves to different mode of operation of the old ATMS. Furthermore, the new Air Traffic Control (ATC) equipment needs to be extended to the old ATC centre as a backup of the new ATC system. This can only be done when the old ATC centre is vacated when the cold standby mode comes to an end.

The expert panel noted that the new ATMS has performed well during the peak air traffic flow of the festive periods at the end of 2016 and in early 2017 as well as under severe weather conditions since its commissioning. The average daily flight movements handled by the new ATMS since its full commissioning were 1 984, increased by 5.2 per cent when compared with the corresponding period a year earlier. This affirms the performance of the new ATMS and front-line ATCOs. After balancing all the considerations and noting the Safety Management System implemented by the CAD in accordance with requirements of the International Civil Aviation Organization (ICAO), the expert panel agreed that the CAD should put an end to the cold standby mode of the old ATMS after an extension of two months, i.e. on July 14.

With regard to the long-term optimisation of the new ATMS, the expert panel noted that

the CAD had spearheaded the forming of an international user group for the AutoTrac III users (Users' Group). The ATC experts from Dubai and India and representatives of the Federal Aviation Administration of the United States have agreed to join the Users' Group to share operational and technical experience, and to enhance users' operations and map out the future system development roadmap. The expert panel supported the initiative, as it is a common international practice, and believed that it would help expedite the completion of optimisation work of the new ATMS system in Hong Kong.

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 the new ATMS.

Separately, the Deputy Regional Director of the ICAO Asia and Pacific Office, Mr Manjit Singh, accompanied by two senior officers responsible for air traffic management and communication, navigation and surveillance visited the CAD Headquarters today as invited by the CAD. The visitors were briefed on the operation of the new ATMS and they commended the CAD highly for the safe, efficient and quality air traffic management services, irrespective of whether the new or old ATMS was in use. They also relayed favourable comments on the air navigation services of Hong Kong from local and overseas airlines' management. They were of the view that the implementation of the highly advanced new ATMS in Hong Kong would create a positive and pioneering effect, which would stimulate air traffic volume and promote modern ATC management in the Asia-Pacific region.

Ends/Tuesday, June 6, 2017

Issued at HKT 20:17

Air Traffic Management System Expert Panel holds sixth meeting

The Air Traffic Management System (ATMS) Expert Panel set up by the Civil Aviation Department (CAD) held its sixth meeting today (September 27). After being briefed on the recent operation of the ATMS, the expert panel members were satisfied with the good overall performance of the ATMS. The expert panel appreciated that the CAD will continue to review the ATMS and its sub-systems in accordance with the requirements of international aviation safety management.

With regard to the occurrences experienced by the new ATMS during the initial stage of operation as discussed in the last meeting, including momentary hitches experienced with the Flight Data Processors, the Arrival Manager System and the Tower Electronic Flight Strips System, the CAD provided detailed updates to the expert panel on the progress of various forms of optimisation and follow-up work in today's meeting. Over the past three months, the new ATMS has been operating stably without hitches. It proved that the CAD, together with the system contractor and the suppliers of the sub-systems, had taken effective follow-up measures to address the issues. The expert panel members were of the view that the overall performance of the new ATMS was satisfactory after the running-in period and the front-line staff had become more conversant with the operation and maintenance of the system.

The expert panel noted that the air traffic movements handled by the new ATMS after the transition have continuously increased. The system has successfully coped with the peak air traffic flow since the end of 2016 and has overcome the challenges posed by adverse weather. The overall performance of the system continued to be safe, reliable and stable.

The expert panel noted that the CAD has taken an extra effort to set up an international users group for the ATMS (Users' Group) and the first meeting was held last week at the CAD Headquarters. Participants of the meeting included the international users of the ATMS supplied by Raytheon Company, namely the civil aviation authorities in Dubai and India; experts from the Federal Aviation Administration of the United States; and the management of the ATMS supplier. The international users discussed their operational and technical experience over the years, international best practice and future development. They also exchanged information related to the system enhancement works completed or being carried out in order to meet the International Civil Aviation Organization (ICAO)'s latest requirements and their respective operational requirements, with a view to enhancing operational efficiency for coping with the expected growth in air traffic. The meeting concluded that the AutoTrac III users were in general satisfied with the overall performance of the ATMS and concurred that closer co-operation among the users would help improve the system performance effectively and continually. The expert panel members considered that the Users' Group platform was very constructive and expressed the belief that through the sharing of experience of international users, the CAD could further optimise the new ATMS system in Hong Kong.

The expert panel was pleased to note that the cold standby phase of the old ATMS smoothly ended on July 14. The old Air Traffic Control (ATC) Centre and south ATC Tower have been vacated to accommodate the upcoming expansion of the new ATC equipment to the old ATC Complex for backup purposes.

Subsequent to the discussion on loss of standard separation incidents during the third Expert Panel Meeting, the CAD invited the expert panel to review the loss of standard

separation incidents since then. The expert panel members noted that the new ATMS issued the predictive conflict alert and/or conflict alert in each incident in a timely manner as per the system design. The expert panel members noted that, as in other regions of the world, the loss of standard separation incidents were attributable to a diverse range of factors, including inclement weather, operating procedures and human factors. After considering the relevant safety performance statistics presented by the CAD, they were of the view that the relevant statistics continued to compare favourably to those recording the performance in other international locations.

All of the expert panel members attended the meeting today, including local representatives Mr Warren Chim, Mr Albert Lam and Professor Man Hau-chung, as well as 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 the new ATMS.

Ends/Wednesday, September 27, 2017

Issued at HKT 19:30

Tallies of Severe Weather in Hong Kong
(Since Full Transition on 14 Nov 2016)

A. Weather Warning

1. Thunderstorm warnings – 143 counts
2. Black/Red/Amber Rainstorm warnings – 29 counts

B. Tropical Cyclones

Date	Tropical Cyclone - Highest Typhoon Warning Signal Raised¹
11-13 Jun 2017	Severe Storm MERBOK – Typhoon Signal No. 8
22-23 Jul 2017	Storm ROKE - Typhoon Signal No. 8
22-23 Aug 2017	Severe Typhoon HATO - Typhoon Signal No. 10
26-27 Aug 2017	Severe Storm PAKHAR - Typhoon Signal No. 8
2-4 Sep 2017	Severe Storm MAWAR - Typhoon Signal No. 3
23-24 Sep 2017	Tropical Depression - Signal No. 1
14-16 Oct 2017	Severe Typhoon KHANUN - Typhoon Signal No. 8

¹ The various typhoon warning signals are, in increasing severity:

- (a) Standby Signal No. 1
- (b) Strong Wind Signal No. 3
- (c) Southeast Gale or Storm Signal No. 8
- (d) Southwest Gale or Storm Signal No. 8
- (e) Northeast Gale or Storm Signal No. 8
- (f) Northwest Gale or Storm Signal No. 8
- (g) Increasing Gale or Storm Signal No. 9
- (h) Hurricane Signal No. 10

ATMS Benchmarking

1. Introduction

The performance of Air Traffic Management System (ATMS) is benchmarked against the international requirement, namely “EUROCONTROL specification for ATM Surveillance System Performance, Edition 1.1” (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

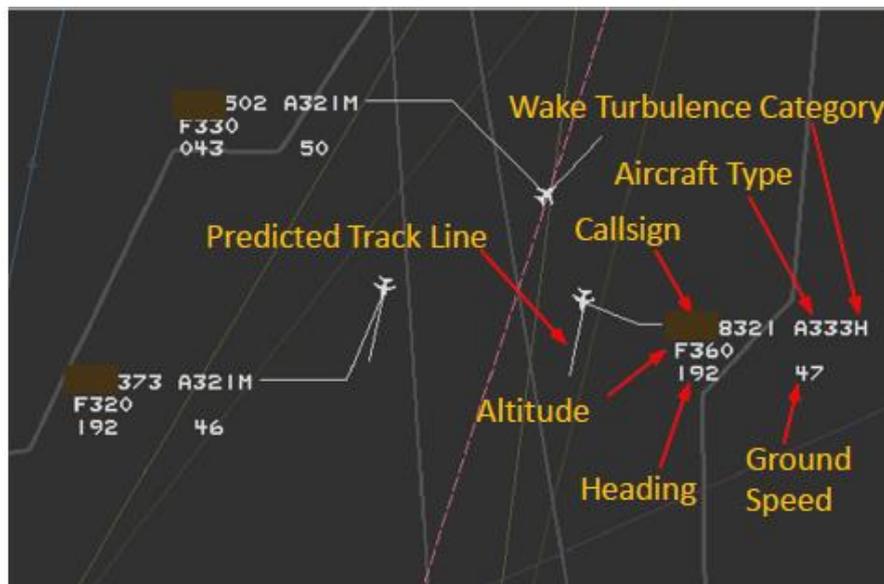
2. Flight data

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.

Annex E

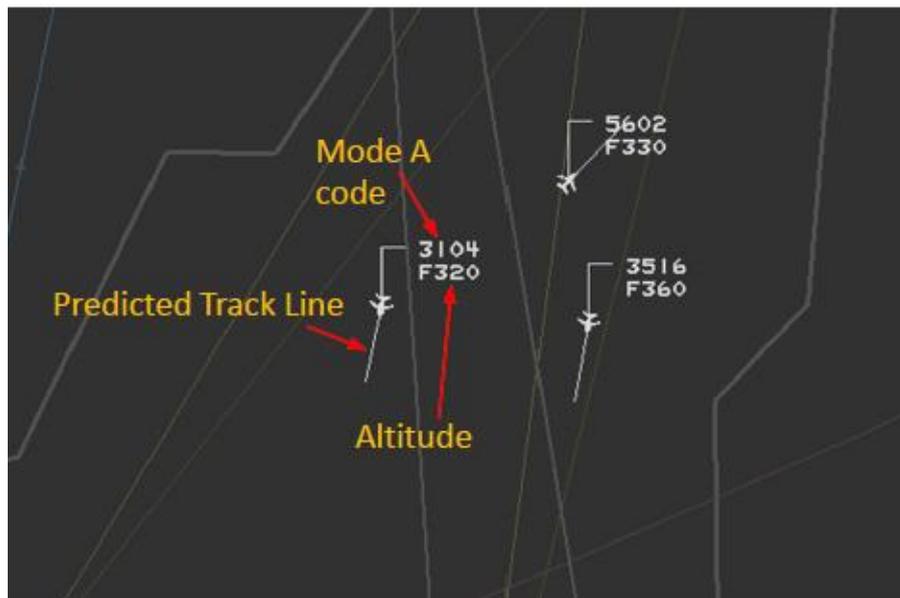
For the new ATMS, the availability of essential flight data for display on radar screen since its full commissioning has been at 99.9998% or better, hence the EUROCONTROL Requirement (a) is fully met. Unavailability of supplementary data arising from occurrences on 29 November, 12 December 2016 and 8 April 2017¹ were counted in determining fulfillment of Requirement (b) with average counting from system commissioning on 14 November 2016 shown in the chart at Attachment 1(a) as monthly averages. The availability of supplementary flight data since system commissioning has exceeded Requirement (b) at all times.



Essential and supplementary flight data are displayed on radar screen

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

¹ Please refer to the section under “Flight Data Processing” of Annex G for detailed description of the three occurrences



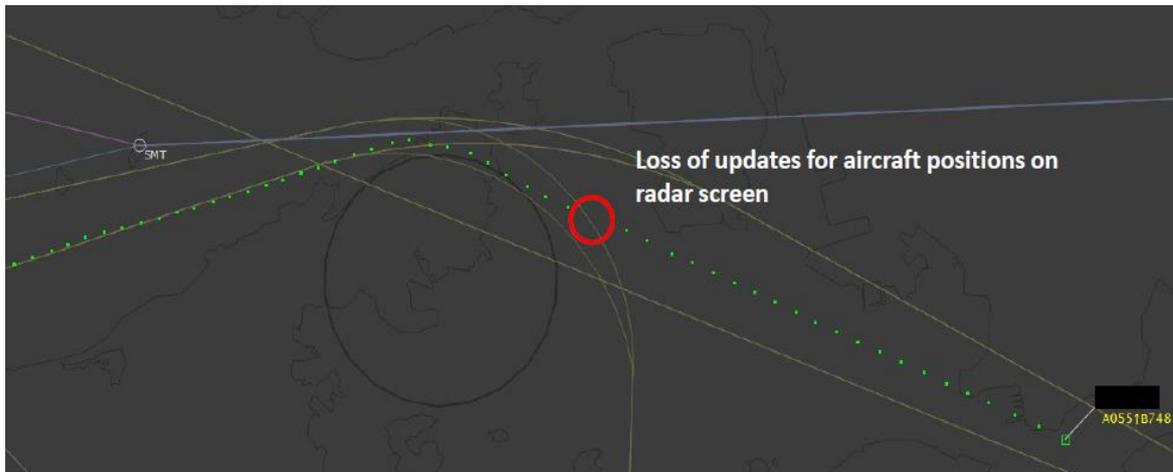
Essential flight data are displayed on radar screen

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 analysed. 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 or equal to 10 false target reports per area of 900 NM² and over a duration of 30 minutes²; and
- (II) For approach control, there should be less than or equal to 2 false target reports per area of 100 NM² and over a duration of 48 minutes³.

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 / did not exceed the figures as specified in the above Specification. Two charts, one for terminal/enroute control and another for approach control, showing the frequency of false target reports matching the area and time intervals specified in item (I) and (II) respectively, are given at Attachment 2(a) and 2(b) respectively.

² In the interim report, this requirement was specified as “For terminal/enroute control, there should be less than 10 false target reports per area of 900 NM² and over a duration of 30 minutes”. According to the EUROCONTROL Specification, the “less than 10 false target reports” should read as “less than or equal to 10 false target reports”. The typographical error is rectified in this final report.

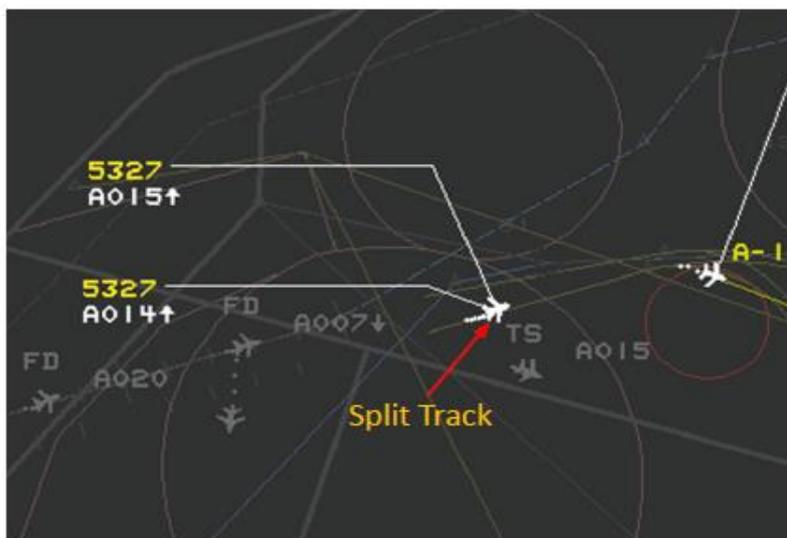
³ In the interim report, this requirement was specified as “For approach control, there should be less than 2 false target reports per area of 100 NM² and over a duration of 48 minutes”. According to the EUROCONTROL Specification, the “less than 2 false target reports” should read as “less than or equal to 2 false target reports”. The typographical error is rectified in this final report.



(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.



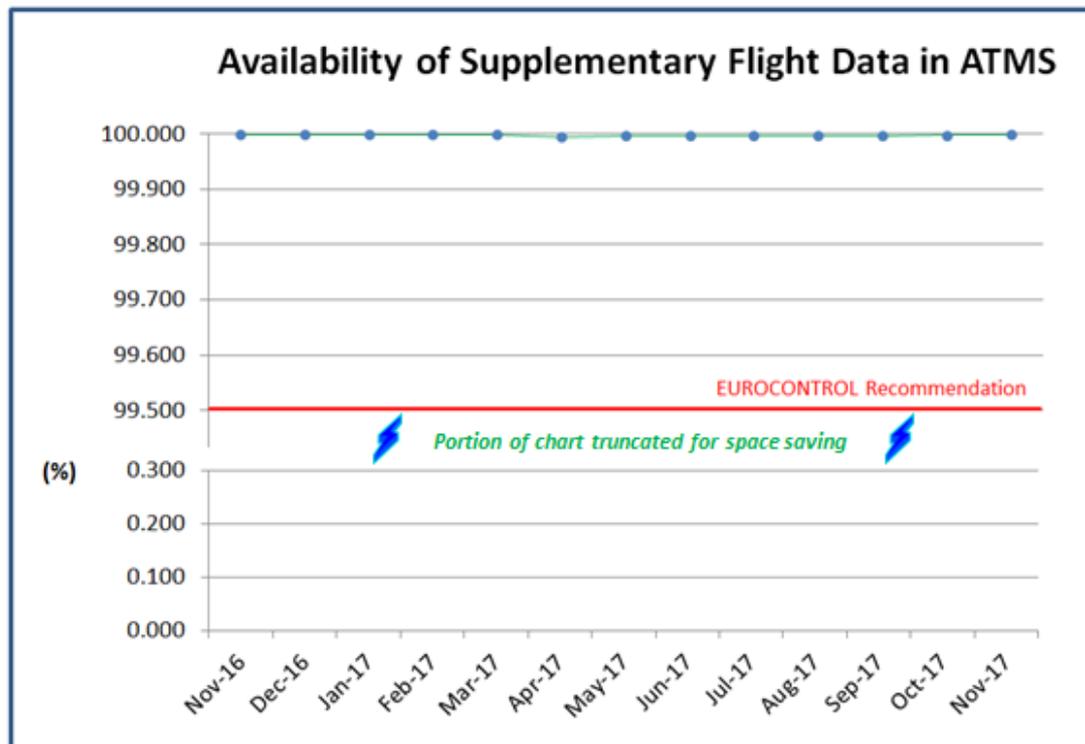
All the falsely confirmed track cases reported since 14 November 2016 were analysed. It was found that the frequency of falsely confirmed track cases per hour was less than the respective number of falsely confirmed tracks as specified in the above Specification. A chart showing the frequency of falsely confirmed track cases per hour is given in Attachment 3.

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 exceeded international requirements after about one year of observation since the commissioning of the new system. The CAD was encouraged to continue optimising the operating procedures and system in order to enable the system to continuously outperform international requirements.

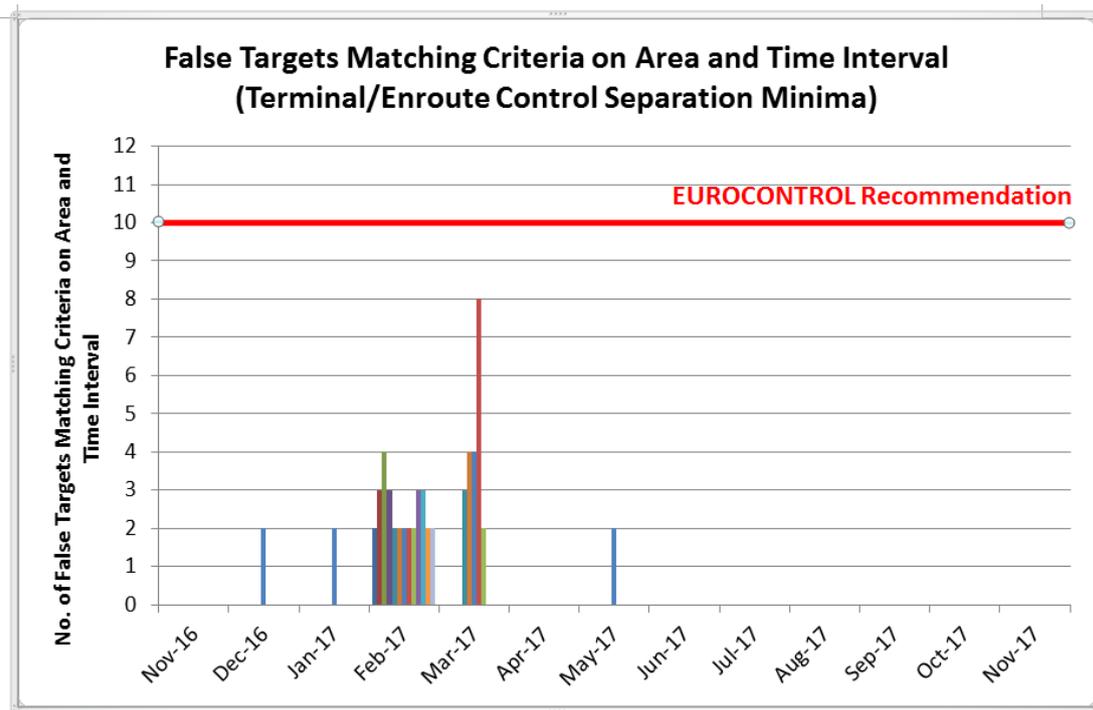
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Attachment 1(a)



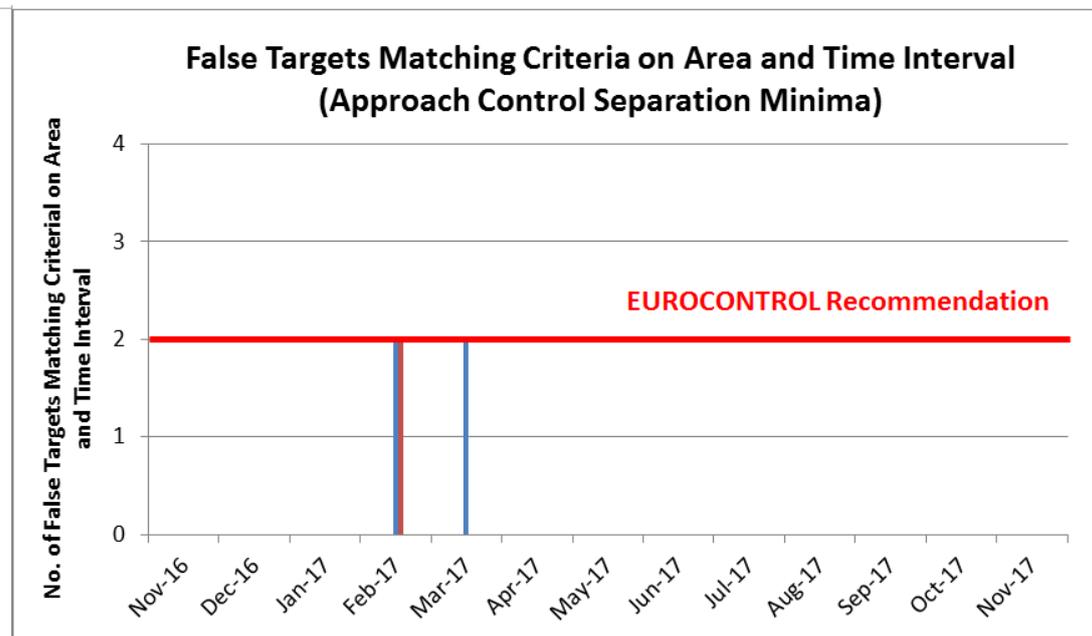
The availability of supplementary flight data (as shown by the dotted line) has exceeded the requirement of 99.5% specified in the EUROCONTROL Specification at all times.

Attachment 2(a)



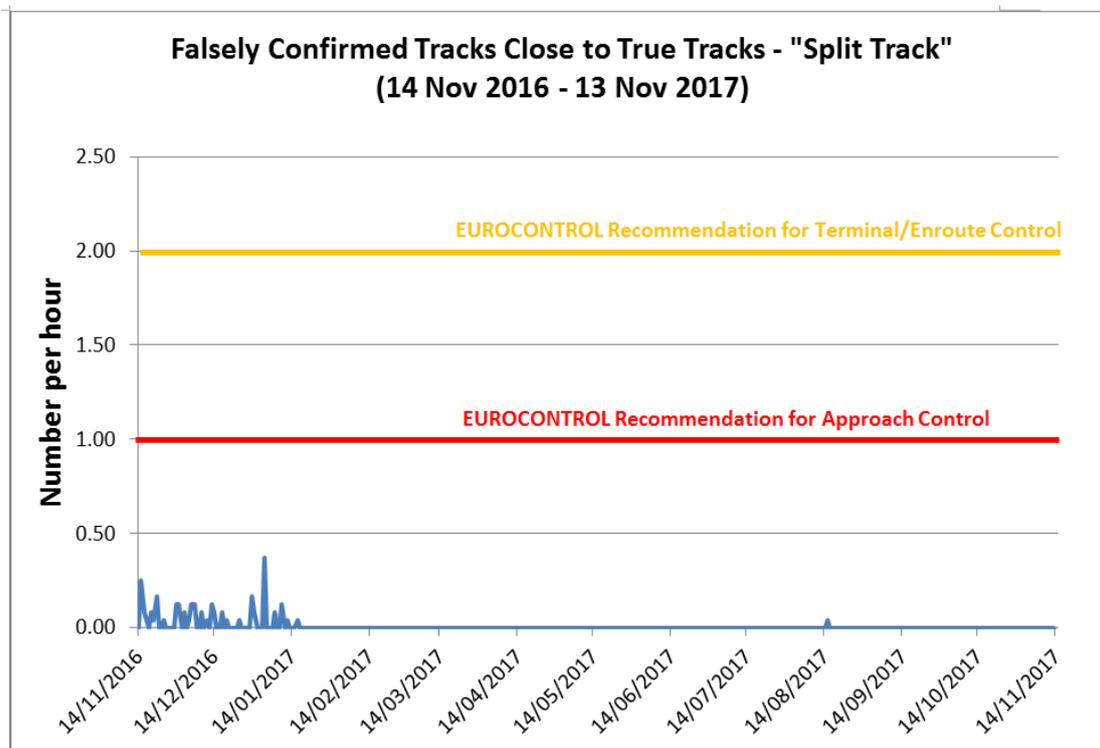
For Terminal/Enroute Control airspace, false target reports (as shown by the bars) were less than the figures specified in the EUROCONTROL Specification.

Attachment 2(b)



For Approach Control airspace, false target reports (as shown by the bars) did not exceed the figures specified in the EUROCONTROL Specification.

Attachment 3



Falsely confirmed track cases per hour (as shown by the waves at bottom left) were less than the figures specified in the EUROCONTROL Specification.

HKATCA supports full implementation of new ATMS

The Hong Kong Air Traffic Control Association (HKATCA) today is glad to learn that the Transport and Housing Bureau (THB) has agreed to the Civil Aviation Department (CAD)'s planned full transition of the new Air Traffic Management System (ATMS) on 14 November, 2016. Our Association members and the other ATC staff will continue to offer with dedication round-the-clock air traffic control services in a safe and orderly manner to the public by using the new system.

We also noted that the THB's independent consultant had reviewed the issue on 27 October, during which a small number of workstations not used for direct communication with flights could not process some non-conventional flight plans, and considered that corresponding effective mitigating measures were in place and the risk of recurrence of the same situation was low. Hence, the independent consultant has decided to affirm his earlier assessment on the Department's readiness for full transition, i.e. it is ready to proceed with full transition in November 2016 as planned.

As a matter of fact, since June, the Phased Functional Implementation (PFI) has been conducted smoothly as planned in a safe, stable and reliable manner. After the 27 October incident, the final stage of PFI continued and the system has been working normally. Enhancement measures were put in place to tackle non-conventional flight plan data. ATC staff have also made significant progress in their competence and confidence in the operations of the new ATMS with the experience gained in the past two weeks by using the new ATMS to handle real time traffic. As such, the HKATCA concurred with the independent consultant's findings and recommendation.

To conclude, it is an urgent and imperative improvement project to upgrade to a new system so as to meet the growing regional air traffic demand in future. In the early stage of the system transitional period, the number of arrivals and departures at Hong Kong International Airport during rush hours will be adjusted moderately in accordance with international practice. In addition, flow control measures will also be imposed to traffic overflying Hong Kong airspace. These measures are introduced to facilitate the ATC staff to accustom themselves to the new system and the associated new operating procedures. As one of the best ATC teams that acquired international recognition, we have been through a series of training and

assessment before we could operate the new ATMS for the provision of air traffic control services to airspace users. Rest assured that HKATC will be able to live up to the general public's expectations and continue to safeguard the safety of our sky in the upcoming festive season with high air transport demand.

Mr Tommy Auyeung, President of the Hong Kong Air Traffic Control Association

November 11, 2016



香港政府華員會

HONG KONG CHINESE CIVIL SERVANTS' ASSOCIATION

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Civil Aviation Department Electronics Engineers' Branch of Hong Kong Chinese Civil Servants' Association echoes the views in the assessment reports by independent consultant appointed by the Transport and Housing Bureau

The Transport and Housing Bureau announced today its agreement to the Civil Aviation Department to fully commission the new Air Traffic Management System (ATMS) next Monday (14 November). The reports by its independent consultant from the United Kingdom, NATS, one on the Full Transition and another one on the incident on 27 October, were also released. Our Association fully supports both the decision to launch the new ATMS and the comments in NATS' reports.

After the incident on 27 October, during which a small number of workstations not used for direct communication with flights could not process some non-conventional flight plans, CAD's electronics engineers quickly identified the root cause of the issue. In parallel, they literally worked day and night with the contractor to implement enhancement on the data processing and address the issue. As NATS pointed out in its report, the risk of recurrence of the same occurrence is assessed as low. NATS maintains their views that the new ATMS and Air Traffic Control (ATC) colleagues are ready for full commissioning.

In gist, NATS complimented CAD on the amount of professional work carried out to a detailed and achievable level in preparation for Full Transition and closure of all relevant recommendations including those from previous assessments. NATS confirmed that CAD has achieved a robust evidence based approach and was satisfied that CAD was ready to proceed with Full Transition as planned. NATS has cast their vote of confidence in the new ATMS and CAD colleagues. It also recognized the efforts and contribution undertaken by CAD's electronic engineers towards full implementation of the new ATMS.

As a team of professional engineers, we are committed to maintaining aviation safety. The new ATMS is designed to meet the latest international standards on technical, safety, ATC operational and maintenance

requirements. CAD has conducted stringent tests on the new ATMS in accordance with international aviation safety management standards and established Government procedures, in order to ensure that the system operation is in full compliance with the contract conditions and safety management requirements.

In future, we will continue to upkeep the functionality and safety of the new ATMS. The advanced features of the new ATMS and CAD's professional ATC colleagues will be mutually complementary to further enhance the CAD's capability in air traffic management.

A handwritten signature in black ink, consisting of a large, stylized 'H' followed by a long horizontal stroke that curves upwards at the end.

Ir Joseph Ho

*Chairman of the Civil Aviation Department Electronics Engineers' Branch
of Hong Kong Chinese Civil Servants' Association*

Teething Issues Reviewed

During its term, the Expert Panel has reviewed and deliberated in detail the following five categories of teething issues:-

Surveillance Information

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

Similar to most modern ATMSes, the new ATMS employs a Multi-Surveillance Tracker (MST) such that it takes in multiple surveillance sources such as Primary Surveillance Radar (PSR), Secondary Surveillance Radar (SSR) and Automatic Dependent Surveillance – Broadcast (ADS-B). For each target, the MST processes any combination of available surveillance sources to generate a fused system target report while weighing in the integrity of the data, historical data with necessary extrapolation and filtering. Where flight plan data is available, the ATMS also associates flight data to the target based on a combination of available flight identifiers to display additional data. Currently there is no surveillance source that can provide pinpoint accuracy or will not generate spurious target reports while all surveillance sources are susceptible to extraneous factors. In simple terms:

- The MST can form an additional Split Track of an aircraft where the MST considers reports from different surveillance sources of the same aircraft as from two distinct aircraft particularly in situations where the positional differences from reports of the different

sources were outside of the fusion window to be considered by the MST of having emanated from the same aircraft, among other consideration factors in the MST algorithm.

- A false target can occur due to reflection, data garbling, terrain and other extraneous factors that would trigger the ATMS to display a false target as “reported” by the surveillance source(s).
- A dropped target can occur due to, for instance, data garbling, on-and-off pick up by any surveillance source(s) particularly in the fringe area where transmission/reception could be erratic.

In all cases, the phenomenon was short lived as the MST would correct and converge with the dissipation/disappearance of the offending situation. 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 been 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 such as aircraft avionics, weather, radio frequency interference, finite detection range of radar, terrain and moving targets, signal attenuation/reflection.

The Expert Panel considered that the implementation of satellite-based ADS-B surveillance technology would have a

distinct advantage over traditional radar technologies and recommended CAD gradually adopting ADS-B coverage within the HKFIR with prudence and in accordance with the SMS process. In fact, marked improvement (i.e. reduction in occurrences of split tracks, false targets and dropped targets) was reported to the Expert Panel with details given in **Annex H**. A clear and encouraging downtrend was observed coinciding with the progressive expansion of ADS-B coverage. The Expert Panel noted that CAD had closely monitored, with regular reviews, on the operational, technical and system aspects to assess the need for further fine-tuning and coverage expansion. The Expert Panel was aware that CAD was on the forefront along with a few other ANSPs on adoption of the ADS-B technology. Members commended CAD's efforts and progressive adoption of ADS-B technology with a successful and fruitful outcome. Nevertheless, the Expert Panel cautioned against expectation of complete elimination of such occurrences given a number of external factors that can affect surveillance data fed into the ATMS.

Flight Data Processing

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

The ATMS associates additional flight plan data with target reports through a unique identifier in addition to the display of essential data such as aircraft position, altitude and Mode A code. This flight plan association is an automatic and periodic process that refreshes and updates associated flight plan data to ensure updated information on display. During both

occurrences, there were manually triggered processes that had pre-empted the flight plan association process, leading to momentary disassociation of flight plan data until sufficient system resources were available to the flight plan association process.

The root cause and the circumstances leading to the momentary flight plan dis-association had been identified by CAD and its contractor. With successful deployment of the software fix on 20 March 2017, there has been no recurrence of similar issue. During its review of occurrences, the Expert Panel held the view that flight plan dis-association issue was not uncommon to other ANSPs but would recommend CAD reviewing requirements available from EUROCONTROL for ATC surveillance system and undertake to benchmark the new ATMS against such requirements with the positive benchmarking results summarised at **Annex E**. Additionally, the Expert Panel was satisfied that additional safety nets such as the ADS-B Surveillance Monitor reference tool and availability of the Fallback, UFS and radio communication system were in place to ensure air safety.

The Expert Panel noted NATS had reviewed these two occurrences and submitted a report to THB (see **Annex I**). NATS concluded that there was no safety impact caused by both occurrences and that given the identification of the cause of the issue, effective workarounds were readily available. The Expert Panel agreed with the observations of NATS and considered the issue closed.

(iii) FDP Occurrence on 8 April 2017

On 8 April 2017, a staff had attempted to save the 5,501st User Preference Setting beyond the pre-defined maximum limit of 5,500, causing the primary server of the Main ATMS to automatically shut down and default to operation by the secondary server of the Main ATMS together with an alert that was not noticed as it was not prominent enough. The staff repeated the same “saving” process and similarly brought down the secondary server. ATMS operation was resumed through the activation of the Fallback ATMS.

During the occurrence, departure flights were withheld for about 15 minutes as a precaution. Targets were at all times continuously displayed on the radar screens throughout the occurrence and all flight plan information was available through ADS-B technology. At no time was safety impacted during the occurrence.

The Expert Panel discussed in detail the course of the event, the root cause and the proposed software fix. The root cause was the software’s inadequacies in displaying prominent warning message to draw the attention of operational and technical staff to the reaching of the pre-set maximum number of User Preference settings. Having exceeded the pre-defined maximum limit, instead of rejecting new user preference settings, the system continued to process the additional settings thereby causing the primary server of the Main ATMS to shut down automatically. The Expert Panel noted that the

management of the occurrence, as in other occurrences, demonstrated the professionalism and training of staff, the procedures in place and the performance of the Fallback System as per designed. The Expert Panel recommended, in addition to the software fix, a holistic review by Raytheon of the pre-set ceilings on the User Preference Settings and other system limiting parameters with potential of causing similar issues.

The review by Raytheon had been completed with all reviewed parameters well within bounds, not posing any immediate or near-term risks due to the rate of utilisation, nature of usage, and/or protection mechanism in software coding such as to reject processing any out-of-bound parameter. CAD had also been monitoring the utilisation trend of all system parameters to ensure system integrity and take proactive actions when necessary. With software fix available in April 2017 and thorough testing at factory and at site performed, the software fix was successfully launched on 15 May 2017. The software fix enhanced warning messages to frontline controllers and maintenance staff at preset thresholds on User Preference settings, raised the pre-set limit and enhanced the mechanism to reject creation of new User Preference settings at the pre-set limit without affecting the normal operation of the ATMS. Additional procedural safeguard was also implemented through proactive monitoring of utilisation rate and pattern, which could signal the need for preventive actions. The Expert Panel was satisfied that the ATMS has been adequately protected from recurrence of the 8 April 2017 issue. The Expert Panel considered the issue closed.

Standalone Systems Subsumed to ATMS(iv) **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 as a memory management issue, commonly affecting large-scale and complex computer systems such that small amounts of physical memory used by the system in its data processing was not released as available system resources and incrementally accumulating to the extent of slowing down and affecting normal processing. 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. With the workaround procedures implemented, there had been no recurrence of similar issue in the interim prior to its rectification by the successful implementation of the software fix on 20 March 2017.

NATS has carried out further review on whether there existed a common root cause, in terms of the engineered system and software of the ATMS, for the flight plan dis-association occurrences on 29 November and 12 December 2016, and the TEFS issue on 18 December 2016. NATS advised that the occurrences were experienced on separate and unrelated components of the ATMS, developed by Raytheon and the TEFS supplier, Frequentis, under their own engineering

development and delivery processes. As such, NATS believed that there was no common root cause behind the issues.

The Expert Panel noted that NATS had reviewed this occurrence and agreed with the observations of NATS. NATS' report submitted to THB on this occurrence is at **Annex J**. The Expert Panel considered the issue closed.

(v) TEFS Server Disruption on 2 May 2017

On 2 May 2017, the presence of stale flight plan data in the system had affected the normal processing and manipulation of flight data by TEFS, leading to interruption of TEFS service. As the issue occurred during small hours with minimal impact on ATC operation, TEFS was re-started with more thorough on-site checks conducted to collect fault information and analysis. Subsequent joint investigation by Raytheon and the TEFS supplier revealed that the root cause of the TEFS occurrence on 2 May 2017 was related to a software bug in the TEFS when cleaning up old flight information, and was unrelated to the TEFS occurrence on 18 December 2016 (Item(iv) above) which had been rectified. Raytheon had worked with the TEFS supplier to deliver a software fix for the problem. After testing in the factory by the ATMS/TEFS experts, CAD's on-site testing as well as satisfactory completion of safety risks assessments, the software fix was implemented on 26 June 2017 to successfully rectify the issue. The Expert Panel considered the issue closed.

(vi) Arrival Manager (AMAN) Disruptions on 12 February, 3 April and 10 June 2017

On 12 February 2017, some arrival flights were missing on the AMAN timeline. Arrival sequencing was handled manually by controllers as per standing practice. The Expert Panel noted at an earlier meeting that the root cause was being investigated by CAD and the contractors concerned. Safety and ATC services were not impacted as well-trained controllers had stepped in with manual control per standard procedures and practices. Subsequently, an AMAN issue occurred on 3 April and 10 June 2017 respectively which were considered to share the same root cause and symptoms of the 12 February 2017 occurrence, being a glitch in the interface between the ATMS and AMAN, leading to the intermittent issues reported. A fix was then developed and successfully launched on 26 September 2017. Given the above and non-recurrence of the issue, the Expert Panel considered the issues of 12 February, 3 April and 10 June 2017 closed.

Human Factors

(vii) AMAN Disruptions on 18 November 2016 and 2 January 2017

The occurrence on 18 November 2016 was caused by the initiation of an ad-hoc system log collection on AMAN as a maintenance activity conducted at a time of high traffic period to analyse system performance. The log collection process had drained significant system resources such that it had affected the normal AMAN processing, inducing a brief two-minute disruption. During the interim, the controllers adopted the “in-trail sequencing” 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 unintentional 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 due to human factors and briefings/lessons learned had been provided to the staff concerned and the relevant operational/maintenance procedures have been revised by CAD. There has been no recurrence of similar issue. The Expert Panel considered the two occurrences on 18 November 2016 and 2 January 2017 closed.

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

A Controller Jurisdiction Sector, or “sector” in short, demarcates the airspace for which a controller(s) is responsible for air traffic control of the aircraft flying within that sector. As a common and international practice, sectors are often combined and a sector can be split up (de-combined) to suit prevailing traffic, staffing and operational needs.

During the 26 December 2016 incident, the selected ATC sector configuration did not match any of the pre-defined configurations that had been adapted in the system. The new ATMS had performed as designed by issuing an error with a resulting non-operational sector, which had not been configured in the system. The issue was readily rectified by re-selecting the ATC sector in conformance with the pre-defined configuration. The glitch was basically human factor related.

Briefings had been provided to ATC staff to prevent recurrence. There has been no recurrence of similar issue. The Expert Panel considered the issue closed.

Non-ATMS Issues

(ix) Voice Communication Switching System (VCSS) Issue on 4 January 2017 (with element of Human Factors)

The VCSS is a system providing controller-pilot voice communication on ICAO assigned VHF frequency channels, which are programmed into the various sectors for ease of access, selection and operation by the controller. On 4 January 2017, a particular radio channel in the main VCSS was not serviceable in one controller position at N-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 to rectify a malfunctioned radio channel during busy hours. 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.

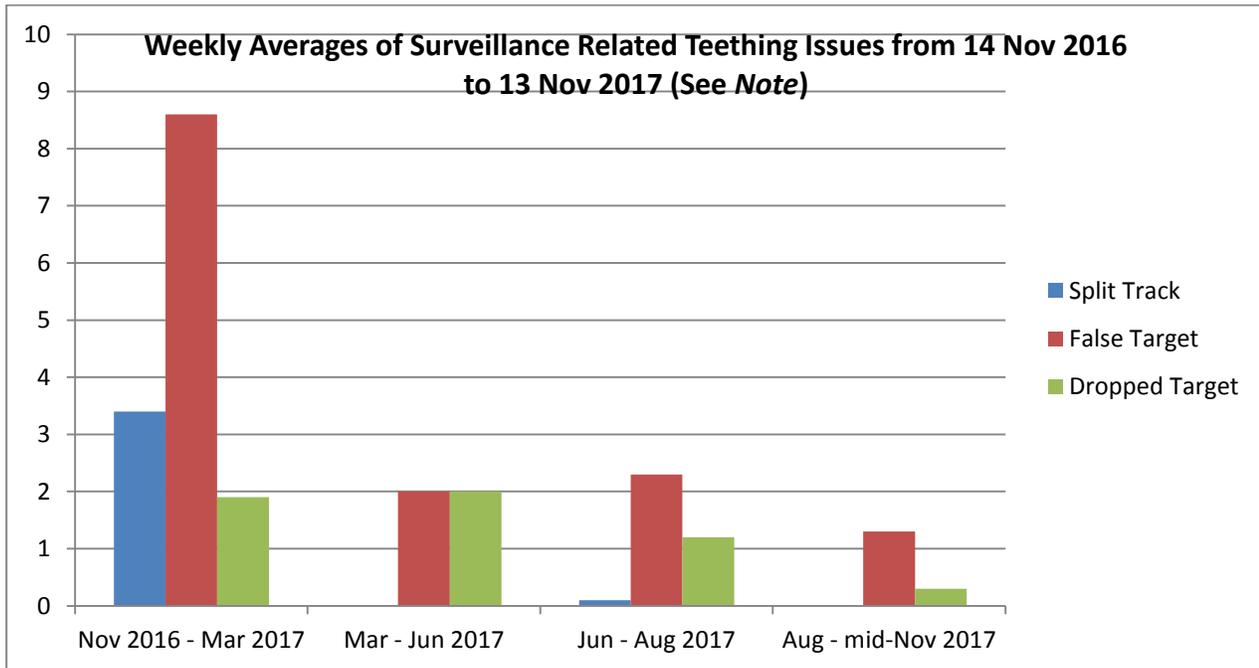
The Expert Panel noted that the VCSS was a separate system provided by another supplier (i.e. not Raytheon) and the occurrence was not related to the new ATMS. Nevertheless, it was included for the Expert Panel's review as VCSS was essential to ATC services. The Expert Panel noted that the brief interruption to the main VCSS had occurred because of the carrying out of maintenance activity, which was not in line with the contractor's recommended practice to minimise

potential interruption. Upon detection of the interruption, the controllers turned to the readily available Backup VCSS as per standard practice. The provision of ATC service was therefore not impacted. As VCSS has been available at all times during the incident, the Expert Panel considered the issue not critical in nature. The VCSS contractor's findings confirmed the human factor nature of the occurrence. With subsequent briefings provided to operational and technical staff on established procedures, there had been no recurrence of the issue. The Expert Panel considered the issue closed.

(x) Temporary Power Interruption to Controller Workstations

On 20 April 2017, a Static Transfer Switch (STS) feeding from dual electricity input sources failed, interrupting the power supply to two controller positions. While operation of the workstations was being transferred to idle positions, both of the affected positions were involved with departure control at the time and departure flights were deferred for approximately 10 minutes out of prudence. As a preventive maintenance, all STS installed had been checked with periodic cycling of the STS between its two input power sources to catch/detect early problems. As a long term improvement and in line with the Expert Panel's recommendation, STS power distribution had been reviewed with a power cable rewiring scheme to confine the impact of power interruption in case of STS failure. The associated re-wiring work for all controller working positions had been completed in end June 2017. The Expert Panel considered the issue closed.

Decrease in Reported Cases on Split Track, False Target and Aircraft Position Not Displayed Temporarily (Dropped Target) with progressive expansion of ADS-B coverage



Note – Figures show a downward trend coinciding with progressive expansion of ADS-B coverage. Complete elimination is not practicable given external factors such as erroneous aircraft transponder, RFI, signal reflection, etc.

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 I – 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

ATMS Occurrence - NATS Report #002 V5.0

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	Closed

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			processes. The effectiveness of the change will be verified through the 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.	<p>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.</p> <p>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.</p>	Closed

Report on Air Traffic Management System Occurrence on 18 December 2016

1. Introduction

1.1 On 18 December 2016, the Civil Aviation Department (CAD) experienced an ATC occurrence as detailed below.

18 December 2016 - An intermittent flight plan data exchange problem occurred between the new Air Traffic Management System (ATMS) and the Tower Electronic Flight Strips System (TEFS), the latter of which was a carry-over from the Standalone TEFS implementation and was integrated into the new ATMS (the previous TEFS was retired at the time of system commissioning of the new ATMS in November 2016). The retired and the current TEFS sub-system were supplied by the same Austrian company. During the occurrence, TEFS workstations could not process the flight plan data of some departure flights. Communication among TEFS workstations was affected; however pre-departure clearance was maintained by the voice per standard practice. Throughout the occurrence, AT3 was operating normally and the operations of the ATMS and the E-ATCC were smooth and not affected.

1.2 The Transport and Housing Bureau has requested NATS to assess the course of actions taken in response to this occurrence, to advise the impact to the safety and operations, 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 occurrence 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;
- c) Impact on staff training and procedures; and
- d) The potential for a common cause across reported occurrences.

2. Incident Management and System Fallback / Recovery

Safety assurance and handling of event during and following the occurrence

2.1 During this occurrence no traffic management measures were deemed necessary. The impact to departures, overflights and arrivals are summarised below:

2.2 For Departures the impact was managed as follows:

- Tower assistants copied the activated flight plan information and pass to Clearance Delivery Controller for verbal delivery of clearances.
- Tower control managed the flow of HKIA departures. As AT3 was operating normally there was not any departure flow restrictions imposed by ATCC
- Enroute restrictions were required to be coordinated verbally with ATCC. As flight plans activated before the occurrence remained available in TEFS and a runway change had been planned, departure traffic delay due to the occurrence was minimal. Tower controllers created strips in TEFS using simple steps. Furthermore, essential information was written onto the electronic strips using stylus pens of the TEFS.
- During the TEFS occurrence, departure flight plans were activated at an Assistant position by assigning SSR codes and SID. There was no additional workload created to ATCC controllers

2.3 There was no impact to overflights and flights to/from Macao Airport

2.4 For Arrivals the impact was as follows:

- There was no impact to HKIA arrivals (because ATCC and AT3 were operating normally).
- Within the Tower flight plans activated in the AT3 before the occurrence remained available in TEFS. For those missing flight plans, Air Movement and Ground Movement Controllers, based on information in the A-SMGCS (Ground Movement Radar fed with AT3 flight plan data), created strips in TEFS using simple steps. Taxi instructions and bay numbers were written onto the electronic strips using stylus pens of the TEFS.

3. Incident Investigation / Tracking and Rectification

Fault diagnosis

3.1 The supplier of TEFS had carried out a detailed investigation in collaboration with the ATMS supplier Raytheon. The cause of the issue was identified and summarized as follows:

- Cause of the Issue - After reviewing the system logs and reproducing the issue in the factory, it was found that there was a software glitch such that under some particular system states, the task of data synchronisation between the TEFS active and standby servers, and the task of backing up current system status, affected each other, causing the two tasks to enter into a “deadlock” situation, with one task waiting for the other to complete while competing for memory resources. The resulting hold-up of memory resources up to a point led to the intermittent performance of TEFS, thus the observed problem. The symptoms disappeared after both active and standby servers were rebooted to restore active/standby roles of the TEFS servers.

Available Workarounds and Permanent Fix Implemented

3.2 Before the fix was delivered, normal system housekeeping procedures for maintenance staff were established and implemented similar to other old/new ATC systems as per the best industry practice:

- (i) Monitor memory utilization of TEFS servers against defined criteria and intervals;
- (ii) Check and record the operational status (active or standby) of each TEFS server periodically;
- (iii) Reboot the concerned server on a regular basis to keep the system in optimal running conditions and, to reboot in case of an upward trend of memory utilization being developed, as a normal preventive measure.

3.3 These measures have been reported as effective before the permanent fix is developed and thoroughly tested by Raytheon and CAD.

3.4 The cause of the occurrence was identified and the fix has been verified at factory and further evaluated on-site with positive results. This fix has now been implemented preventing the identified “deadlock” situation between the two tasks thus allowing the tasks to complete normally.

Testing the Change

3.5 After completing all the necessary factory tests satisfactorily, the fix, developed by the Austrian company, was delivered to the CAD on 16 February 2017 for on-site verification tests and safety assessment in accordance with CAD’s Safety Management System requirements and processes. It was confirmed that the fix has met the objective in addressing the issue and the fix was successfully uploaded on 20 March 2017 for operational use.

4. The Impact on Staff Training and Procedures

4.1 Given the contained impact of the occurrence, the existing engineering and ATC training and procedures are evidenced to be robust. The timely promulgation to maintenance personnel of system housekeeping procedures to support the operation until a permanent fix was established so as to minimise the likelihood of recurrence in the interim.

5 Potential Commonality to Other Occurrences Involving Data Synchronisation

5.1 It is already recognised that the occurrences on the 29th Nov and 12th December 2016 were caused by the same issue, and for that reason were reported together. On both of these 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. This issue was restricted to the Raytheon's elements of the system, and has since been resolved. (See ATMS Occurrence – NATS Report #002)

5.2 As noted in the previous sections the occurrence on the 18th December was caused by a software glitch such that under some particular system states, the task of data synchronisation between the TEFS active and standby servers, and the task of backing up current system status, affected each other, causing the two tasks to wait for completion of each other, with one task waiting for the other to complete while competing for memory resources. The resulting hold-up of memory resources led to the intermittent performance of TEFS, thus the observed problem. This issue was restricted to the ATMS sub-contractor's (Frequentis') elements of the system and has been subsequently resolved.

5.3 Noting that the two occurrences were experienced on separate (and unrelated) components of the overall ATMS, developed by two separate suppliers (i.e. Raytheon and Frequentis) under their own engineering development and delivery processes, there is no common root cause identified in terms of the engineered system and software.

5.4 Further, recommendations were made by NATS and accepted by CAD within the report regarding the 29th November and 12th December (Recommendations 2, 3 and 4, ATMS Occurrence - NATS Report #002) with regards monitoring and identifying possible common points of failure. Acceptance and subsequent closure of these recommendations by CAD provides evidence that any systematic adverse behaviour within the system would be identified as part of the CAD's normal engineering delivery practices.

5.5 On this basis NATS does not believe there is any 'common root cause' across the occurrences and will continue to support THB in providing independent advice to ensure that such root cause, if any, is identified as quickly as possible.

6. NATS Summary and Recommendations

6.1 NATS confirms that 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.

6.2 While a permanent fix has been implemented, NATS recommended and CAD agreed to continue with the established system housekeeping scheme on par with the best industry practice.

6.3 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 occurrence again demonstrates CAD's safety ethos whereby the occurrence was 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.

6.4 As previously reported, 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. With the above-mentioned measures put in place, NATS is satisfied that there are no outstanding recommendations associated with the occurrence.

6.5 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.