TAAATS IMPLEMENTATION- A SAFETY PROGRESS REPORT

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This paper is a progress report of Airservice's TAAATS implementation up to June 1999, concentrating on the safety aspects of the project. What is TAAATS? TAAATS is an acronym for Australia's new ATS system - The Australian Advanced Air Traffic System.

TAAATS is a complete upgrade of Australia's civil air traffic system. It is replacing the old ATS system which operates using some concepts unchanged since the 1940s, with modern technology and practices. The new computer- based system integrates advanced flight data processing with modern radar and Automatic Dependent Surveillance (ADS) processing to provide controllers with graphical displays of all known aircraft information.

TAAATS Implementation

The transition to TAAATS commenced in 1998 and the majority of the ATS units are expected to have transitioned by the end of 1999. The transition was designed to be conducted in a series of small manageable steps and involves a period of parallel operations of the old and new air traffic systems during which there is a gradual transfer of functions to the new system.

TAAATS implementation commenced with the commissioning of the Brisbane Flight Data Processor and SSR code allocation for the northern FIR in mid 1998. This was followed in the later half of 1998 by the transition of the CS/REEF ATC groups. This included Cairns Tower and Terminal Area (TCU) and the En Route REEF group. This area was selected as the first area to transition as the area comprised a suitable test bed. The area contained a remote radar Tower & TCU, some low level and high level Sectors, and some non radar oceanic area.

During the transition period records were kept and then following the commissioning of the CS/REEF area a Post Implementation Review was conducted to examine the data and apply the lessons learnt to the following Groups.

One of the key safety management aspects of the transition was the development of Hazard Logs and Safety Case methodology. This is discussed later under Safety Management, however in essence the CS/REEF potential hazards were identified by the local ATS staff and the risks were assessed and mitigated against. This proved to be a successful methodology as the transition, and early day operations, of these Groups went without any major safety events arising. There were many lessons learnt during the transition; including items such as traffic management; the use of paper strips in the Tower; and the adjustment to MSAW parameters (minimum safe altitude warning).

In 1998 following the Cairns/Reef transition came the transition of Keppel & Alma Sectors in Brisbane and the Bass Sectors in Melbourne.

In early 1999 Brisbane Tower & Terminal Area, Coolangatta Tower, plus the surrounding Enroute Groups of Fraser and Byron had transitioned to TAAATS. Melbourne, Canberra and Perth Towers have also transitioned, to be followed by Sydney and Adelaide Tower & Terminal Areas. The next large geographical areas to transition are the Oceanic airspaces, the Sectors surrounding Sydney, Adelaide & Perth Terminal areas, and the residual western and northern Australian airspace.

Although it is still early days, by all measurements of success, TAAATS transition is proceeding safely, on time and is generally ‘transparent’ to the industry.

In measuring the success to date of TAAATS against some of the stated aims which include improved levels of safety, improved Air Traffic Service, better traffic flow management, and improved cost tracking; early evidence would indicate success in these areas. In particular the introduction of automation for ATC coordination and the provision of computer based alarms and alerts for the controllers has been a significant step in improving the level of safety.

TAAATS Safety features.

It is worth briefly reviewing the added safety features that TAAATS is bringing to Australia’s aviation system.

Systems.
The single TAAATS system replaces a multitude of older ATS systems previously used throughout Australia. These systems included several different radar display systems such as AUSCATS and IRDS. The Auscats system previously used in Adelaide, Melbourne, Coolangatta and Cairns permitted several radar sensors to display an aircraft paint, however the IRDS system used in Sydney and Queensland, only permitted an aircraft return from one sensor (hopefully the best sensor available). TAAATS replaces this variety of equipment with one system that uses Multi Radar Tracking which allows many sensors to interrogate the aircraft and display the most accurate position information.

The old systems were also based on paper strips for flight information and recording control instructions. The flight progress strips were the primary tool the controller had available outside radar coverage, and the controllers air situational awareness was based on recording on the strips and keeping them in the correct order. All of this has been replaced by the introduction of electronic flight data (electronic strips) and the ability of TAAATS to integrate ADS and flight plan tracks (when neither radar or ADS is available).

Overall safety has been increased in the new system by integrating into one display the pilots flight plan and other aeronautical data, the improved display of aircraft position, the introduction of automation, and the provision of alarms & alerts.

Building services.
In addition to introducing new ATS equipment the TAAATS project included moving into new accommodation. The TAAATS Centres included additional safety benefits stemming from higher integrity buildings and services.

The two TAAATS Centre buildings have been designed to withstand specified levels of natural disaster, and for rapid recovery after such an event. The building services have been designed to ensure high reliability & availability with no single points of failure. Central computing facilities are powered through 4 battery backed uniterruptible power supply (UPS) units, and each controllers workstation has its own battery backed UPS.

Heating, ventilation and air-conditioning systems are designed for similar high reliability operation, as they are essential for reliable computer and electronic systems performance. Three chillers are available, although the critical loads can normally be handled by one alone.

The operations room and equipment centers are protected from radio and radar interference by copper and aluminium foil linings in the walls, floors and ceilings. The highly reflective windows, which allow only one or two per cent natural light through, have been treated with molecular aluminium as a part of shielding of the sensitive instrumentation from unwanted radio frequency interference.

Lighting levels within the TAAATS Centres were subject to extensive expert scrutiny and research. Room lighting is achieved by indirect diffused lights reflected off the ceiling to give a precise illumination level to the controller. This was required in order to achieve a balance with screen brightness, contrast, data clarity and room brightness. Sound levels within the TAAATS rooms were also controlled by the use of building and finishing materials used within the room.

Safety Alarms & Alerts

TAAATS has many safety alerts built into the system software, aimed at providing a safety net which can alert the controller whenever an aircraft deviates from its expected path. These include:

- Aircraft Emergency, Radio Failure, and Unlawful Interference Alarms
- Short Term Conflict Alert - alerts if the radar trajectories of two aircraft indicate a potential conflict
- Minimum Safe Altitude Warning
- Danger Area Infringement Warning
- Route Adherence Monitoring
- Cleared Level Adherence Monitoring
- ADS Route Conformance Warning
- Duplicate Secondary Surveillance Radar codes detected
- Missing Position Reports Alert

TAAATS System architecture

The TAAATS architecture has various failsoft features, including

- Air-Ground communications bypass with a separate handset direct to a radio transceiver. (This feature has already been proven during a temporary failure of a REEF Sector console when the workstation was merged onto another console and then discovered that the radio was not transmitting. The controller picked up the emergency handset and used the air/ground bypass whilst they selected another workstation for use).
- Tower communications are completely separated from the Centre and TCU communications.
- Radar Bypass direct to each workstation, with its own UPS. Permits the short term continuation of radar control after a failure of the Flight Data Processor - is also used during the installation of system software & data upgrades.
- All controller workstations are identical and interchangeable; roles are software configurable.
- The Voice Switch (VSCS) replaces the old electro/mechanical buttons for both radios and intercom lines on the old consoles, with a single touch sensitive unit that is software driven and having the ability to instantly change roles as the need arises.
- There is a separate system for En Route and Terminal Area Radar Data Processing.
- The Tower radar data processor can operate autonomously direct from the local airport radar.
- All controller workstations maintain copies of current flight plan database; current flight data information is retained if the FDP connection is lost.

Flight Data.

Electronic flight strip presentations have replaced paper flight strip procedural control systems except in control towers where some paper flight strips are still used. Flight notifications, meteorological information, and Notices to Airmen are automatically received by TAAATS from the Aeronautical Fixed Telecommunications Network (AFTN) and the National Aeronautical Information Processing System (NAIPS). This reliance on accurate information is discussed later.

Automation for Controllers.

TAAATS automates the majority of previous coordination activities. Previous incident statistics indicated that around half of all Australian ATS reported incidents were related to a breakdown of coordination. There is still some manual coordination required in TAAATS, Eg to non radar Towers and coord on

certain air routes, however the majority of the previous verbal coordination activities are replaced by automation.
To date there has been an extremely low number of coordination related incidents from TAAATS. The few that have occurred so far have been during the early consolidation period after the controller's training.

Changeable Sectors.
Quite frequently a Sector's volume of airspace is required to change. This may result from factors such as altered air routes, new airways facilities, changed airspace classifications, temporary restricted areas etc. To effect changes to Sector consoles in the old system often required lengthy and laborious manual modifications. Because TAAATS is software driven it permits the rapid change required to a workstation.

Another feature is the ability to move to another console and to merge roles. As all the TAAATS consoles are the same, the software permits a controller to transfer their current sector configuration to another console. This happens when the technicians have to work on a console. During periods of reduced aviation activity (generally at night) the various Sector roles (roles conducted from a workstation) can be merged onto one console to achieve efficiency.

TAAATS Safety Management

Risk Management
The active management of all safety risks has been an integral part of the project management for the implementation of TAAATS. A data base of safety related issues has been maintained (Hazard Log), and mitigation strategies put in place to ensure that all are satisfactorily addressed. This record contributes to the Safety Case which is an essential component of the documentation which is maintained throughout the life of the system to ensure its safe operation.

In addition to a 'Parent' TAAATS Safety Case, individual Safety Cases have been produced by each Functional ATS Group before they transition to TAAATS. These local Safety Cases have identified specific risks associated with each group and mitigation strategies that have been put in place. These mitigators are translated into practical Safety Requirements that are required to be in place during the life cycle of the item.

The commissioning process for the various elements of TAAATS has included a rigorous 'bottom up' sign-off process. This process has required all key staff to signoff that various action items have been completed and that the system is ready for operational use. Each Team Leader must ensure his team is fully compliant and ready.

Recording for Reliability Analyses and Incident Investigations
The TAAATS design incorporates extensive capabilities for recording both the performance of equipment and specifically selected data which is processed and displayed on controller screens. Equipment performance is closely monitored to ensure that the required reliability and availability is in fact being achieved.

All voice communication, and all radar, ADS, CPDLC and Flight Plan data is recorded and stored for up to a month. In the event of an air safety incident this information provides a comprehensive record of actual events to support investigation and analyses.

Software development & validation
It is important to understand that TAAATS is a software-based system, and as such is critically dependant on an effective software operating system, and accurate static and dynamic data sets.

Software for TAAATS has been progressively developed with new builds rectifying previous problems and incorporating any new end user requirements. There have been numerous software builds since commencement of the project. There are currently several groups who control the configuration of

TAAATS and its future direction. These groups include (amongst others); The national Configuration & Control Board, national and local TAAATS Configuration Group, and a Software Functionality Review Group.

These groups are controlling the configuration of the national airways system, including TAAATS software and data, and have moved away from band aid approaches to software problems into developing a strategic plan for the system architecture for at least 10 years ahead.

The TAAATS software is supplied by the contactor and is then tested and released by Airservices ESST (Eurocat Software Support Team) and engineering support. This team is responsible for configuration management, investigation of software faults or modification proposals, testing and verification, provision of training and the quality assurance of contractors work.

To date there has only been one reported occurrence of the need to revert back to the previous version of software. A new version of software was loaded onto the operational platform one night and despite the previous testing that had occurred it was found to be causing problems. The software was then withdrawn from the platform and they reverted back to the previous reliable version.

The main issues raised by controllers to date has related to software functionality, in particular human machine interface items. Several of these items have been addressed and there is ongoing research into the remainder. Some of the HMI issues that have caused concern to date have been; room lighting levels, and console brightness/contrast levels; the colour palette used on the screens (particular concerns over not readily observing aircraft violating the controllers airspace); and the provision of controller prompts (such as timers; methods for indicating the readback of flight levels; manual coord confirmation; and the need for scratch pads).

ATC training & validation

ATC training is still ongoing. The controllers working the areas that are now in TAAATS have all been successfully trained and rated on the new equipment and procedures. The controllers from the remaining non-TAAATS areas (eg Sydney) are currently undergoing their training in staged phases.

ATC training is comprised of 4 phases:

- Computer Based Training covering the equipment, and interactive modules requiring familiarity with human/machine interface (around 20 hours)
- Classroom lessons with examinations (around 9 days)
- ATC TAAATS simulator used in a graduated approach to practical application leading up to difficult traffic situations and abnormal or degraded mode of system operation.
- Validation, check and rating on the simulator, immediately followed by mimic then ghost operations during transition.

A new ATC performance appraisal system has been specifically developed by the University of Queensland & Airservices to align with TAAATS operations. The new assessment tool is designed to encourage the development of expertise over and above basic competence. The new assessment model has been successfully applied in various areas of the transition to date, and will be expanded as more assessors are trained in the application of the model. In addition to the new performance appraisal system, Airservices is also delivering to instructors and assessors the national standard Workplace Assessor training.

Transition, Operations, & Supervision

After a specific group of controllers have been trained and rated on operations in the TAAATS environment, they generally transition their functional group of Sectors (or TWR/TCU) in a series of ‘waves’. This transition methodology was an outcome from the experience of the initial Cairns/Reef group.

During the transition phase live operations are conducted from the old facility whilst the first wave of staff monitor from the TAAATS facility. During the monitoring phase controllers are 'Mimicking' all the actions required in TAAATS (Eg assigning levels, conducting coordination etc). This mimic phase is employed for around a week. After the 'mimic' phase is the 'ghost' phase. Frequencies, intercom lines, and control responsibility are cut over to TAAATS generally for either a morning or afternoon shift. The old facility then monitors the traffic & operations being conducted from the TAAATS facility in case the old facility needs to resume control. This has only happened once to date, after it was discovered that some OCTA aircraft that were displayed in the old facility were not being displayed in TAAATS. This problem was quickly rectified.

The transition of the functional group proceeds as second and third waves are trained and operations from TAAATS extends from several hours to 24 hours/day. This process generally takes around 4 weeks to achieve.

Once staff are in TAAATS they have the following assistance and operational supervision to ensure safe operations:

- FIR Manager. Responsible for the overall management of the Centre and the strategic oversight of all ATS operations within the FIR
- OSS **-** Operational System Supervisor. Responsible for the day to day tactical operational management of system configuration.
- Duty Aisle Team Leader/Area Configuration position. Team leader duties for the consoles within the aisle and responsible for managing the workstation configuration for a defined workgroup.
- Planner Controller. Supports the controllers within a geographical group by managing the aeronautical and flight planning data, and assisting in coordination duties and oversighting traffic management within the group.
- Flight Data Coordinators. Responsible for the correction and re-entry of aeronautical messages which have not been processed automatically by the system.
- TCI & TSS. Technical Customer Interface & Technical Systems Supervisor. Responsible for fault reporting and rectification of all airways facilities within the FIR

System Risks

External influences

The advantages to be gained from TAAATSare achieved through its networking and computational abilities. The availability of flight data information to the controller and the accuracy of that information is dependant on the accuracy of data submitted by pilots and operators.

Errors have been occurring due to some aircraft not submitting flight plans that comply with the TAAATS (and AIP) required ICAO format. This format complies with ICAO guidelines and was necessary to enable TAAATS. These errors have resulted in reported incidents ranging from aircraft being delayed, or being cleared on a route different to that planned by the pilot, or the aircraft proceeding on FMS data that was different to the flight data held by TAAATS. These errors are considered significant by Airservices.

Flight planning errors have been occurring mainly in the use of planning via SID & STARS, and data contained in incorrect fields. A flight plan will be automatically rejected by TAAATS if it does not comply with the published requirements. The rejected flight plans go to an error queue at the TAAATS Flight Data Correction officer console, where the error is manually corrected if possible and the flight plan is then processed into a valid flight data record and re-submitted to the system. Without a flight data record the controller is unable to process the aircraft.

TAAATS can also be influenced by data from other external sources such as other domestic and international ATS systems, and data houses. TAAATS automatically exchanges coordination messages across boundaries and exchanges electronic data. Although the transition has not yet extended to operations around domestic and internal boundaries, this data exchange has been tested. Recent initial tests have also been conducted between TAAATS and the new RAAF ATS equipment (ADATS) and with FIJI.

Internal risks

Internal risks to the safe operation of the ATS system in TAAATS have been identified by local ATC groups as part of the Safety Case and hazard log methodology that is now required by Airservices before any major change to the National Airways System. These risks have been assessed for likely frequency and degree of impact. All the risks have been treated in some way.

Some of the identified risks to date have been; ATC Human Factors **-** lapses and slips in procedures and Human Machine Interface (Eg manual coordination requirements). To date there have been a very low number of these incidents occurring compared to errors reported from the previous system. It would appear that the number of lapses reported is tending to reduce with the increased controller experience and practice with the system; Situational Awareness **-** the controller's tools and keys to maintain situational awareness in the electronic TAAATS environment are very different to those used in the previous systems. Similarities may be drawn to the conversion of pilots from analogue instruments to glass cockpits. To date there has been no evidence that after receiving TAAATS training that the controllers situational awareness level is any less than previously.

The mitigators against these perceived risks concentrate on the training, checking, and licencing regime; a controller cross checking items; and operational supervision. Failures of the system are reported and investigated, causal factors are identified, and action is taken to prevent re-occurrence.

Engineering failures such as computer or workstation failures, satellite and landline failures, software & data problems are also seen as an internal risk. Most of the TAAATS related engineering problems to date have occurred off -line or were identified before cutover occurred. Failures that have occurred after a system was commissioned have been investigated and rectified. Mitigators against engineering problems include the commissioning testing process followed by the mimic/ghost transition process. There is also duplication and a number of alternate systems available, plus the ATS employing degraded mode operations procedures.

Future directions

The short term plans for TAAATS includes the completion of the national transition by the end of 1999, allowing time to consolidate before the Olympics. The transition of the Oceanic Airspace will include the operation of ADS & controller pilot data link (CPDLC). The transition of the Northern & Western Australian airspace (TOPS Group) will involve large areas of non-radar airspace where there will be significant improvements in controller's displays. The transition of the busy Sydney Terminal Area is planned for August 1999.

TAAATS integration with other modern ATC systems will also occur in the short term. TAAATS will need to integrate and exchange data with the RAAF's ADATS project, and New Zealand's, Fiji's, and Indonesia's electronic ATS systems.

Other short term directions will see the ATS system move to a national Air Traffic Flow Management system that employs various elements including both strategic and tactical flow management tools. One of these tools is MAESTRO which is an adjunct to TAAATS.

Summary

In summary the TAAATS transition to date has achieved the required milestones and is still proceeding on schedule. By all measurements TAAATS is meeting the safety requirements and other key performance indicators that were required of it. TAAATS comes with additional safety benefits compared to previous ATS systems, however despite its good safety performance to date, Airservices will continue to monitor the implementation and apply its rigorous safety management processes to the future TAAATS operations.