International Civil Aviation Organization

Seventh Meeting of CNS/MET Sub-Group of APANPIRG
Tenth Meeting of CNS/ATM Sub-Group of APANPIRG

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Agenda Item 4: Aeronautical Mobile Service

HF RATIONALISATION AND MODERNISATION

(Presented by Australia)

SUMMARY

This paper provides a technical and operational description of Airservices Australia's replacement for the current International and Domestic civil aviation High Frequency communications systems.

1 Airservices Australia's HF Operations:

Airservices Australia currently operates and maintains two High Frequency (HF) voice communication networks, used to provide Air Traffic Services to the aviation community within the Brisbane and Melbourne Flight Information Regions (FIR). The Domestic HF network provides coverage of the Australia land mass and adjacent coastal waters, while the International HF network covers the international oceanic air routes, the total area of the Australian FIR constituting 11% of the world's airspace.

The HF networks are used by the Australian Flight Information Centre (AusFIC) Domestically for Air Ground Air (AGA) communications in the Australian Regional and Domestic Air Route Areas (RDARA) and, Internationally, in the Major World Air Route Areas (MWARA)(SP6, SEA3 and INO1). Along with providing communications support for the primary separation service in International Airspace, the HF networks provide:

a) Flight notification processing
b) Third party Directed Traffic Information (DTI)
c) On-request weather and NOTAM information service (FIS) in all classes of airspace
d) In Flight Emergency Response (IFER)
e) Third Party Search and Rescue (SAR) communications
f) SARTIME management
g) Third party Hazard Alert Service

The AusFIC domestic operators manage an average of 2900 calls per day during weekdays. Around 99% of these calls are VFR SARTIME or IFR DTI/SAR Alerting calls and are of short duration – an average of 4 seconds per call. The domestic traffic load reduces by around 50% on weekends.

International calls generally consist of pilots providing position reports at nominated waypoints. The AusFIC operator maintains a screen-based Electronic flight-Strip situation Display System (ESDS), which is updated with position reports as they are received. These position reports are then passed

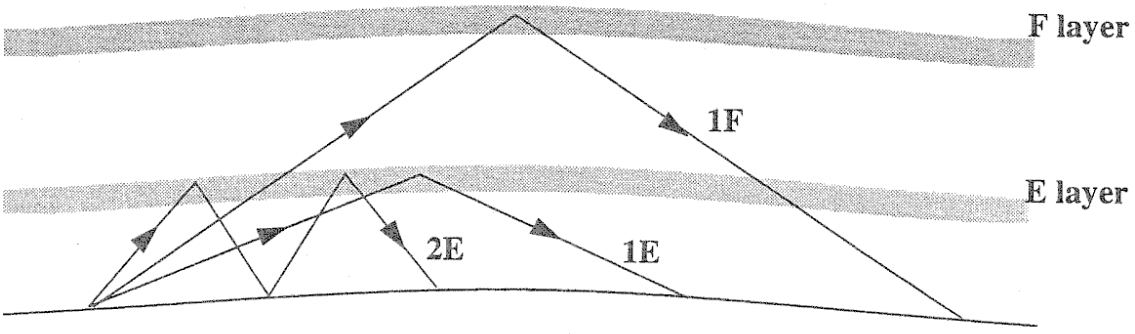
automatically to the relevant Air Traffic Controller in Brisbane or Melbourne from the ESDS via the AFTN into the Flight Data Processing (FDP) system.

The international operators manage an average of 600 aircraft per day on 96 designated air routes, translating to a total of around 2300 HF calls per day. IFR traffic constitutes 99% of these calls. The vast majority of calls are of short duration, with the average length being around 5 seconds. On weekends, international traffic increases by around 10% to15%.

2 HF Communications

Because of the vagaries of ionospheric propagation, a HF signal will often arrive at any point by multiple paths, some of which will provide better signal quality than others. Common propagation paths (or modes) of a HF signal are shown in the diagram below:

Figure 1: Simple HF Propagation Modes (Courtesy of IPS Radio and Space Services)



A signal arriving at the receiving antenna after only one reflection off the ionosphere will generally suffer less degradation through path loss than the signal that has undergone multiple reflections from both the ionosphere and the Earth's surface but other factors also influence the quality of the signal that is ultimately presented to the operator:

- **Multi-path fading**
  If a call arrives at a site by two paths that, due to the difference in distance travelled, are out of phase with each other and are subsequently recombined by a system that can't differentiate between them, they will partly (or completely) cancel each other out. This is known as multi-path fading.

- **RF Noise:**
  Severe storms can affect HF communications a great distance away, as the electromagnetic discharge from these storms manifests as, among other things, RF noise in the HF band. This noise may also effectively propagate via the ionosphere. Therefore an antenna designed to receive HF signals arriving at low elevation angles only (for long distance) may also be susceptible to signal degradation from severe weather over a very large area.

  Another common source of receiver desensitisation at HF base stations is locally generated man made RF noise, often originating from sources such as welding, machinery, power generation and transmission. This form of RF noise is generally vertically polarised and travels predominantly via ground wave, arriving at the receive antenna at low elevation angles.

While most RF noise in the HF band is arriving at a site at low elevation angles, the use of an antenna that concentrates gain at higher angles will not provide the required coverage, particularly for international flights within the Australian FIR.

Figure 2: Skywave Transmission Plot

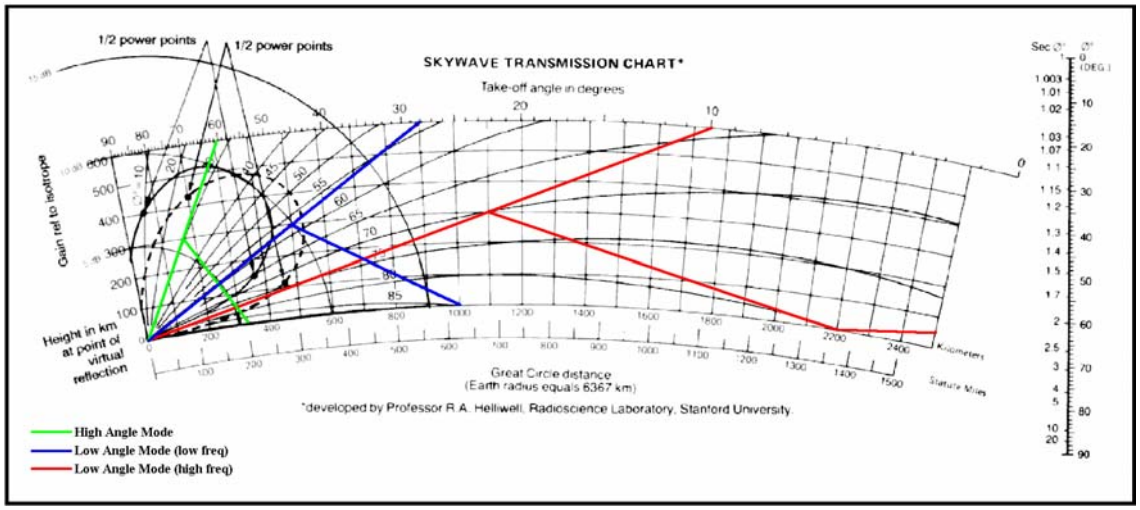


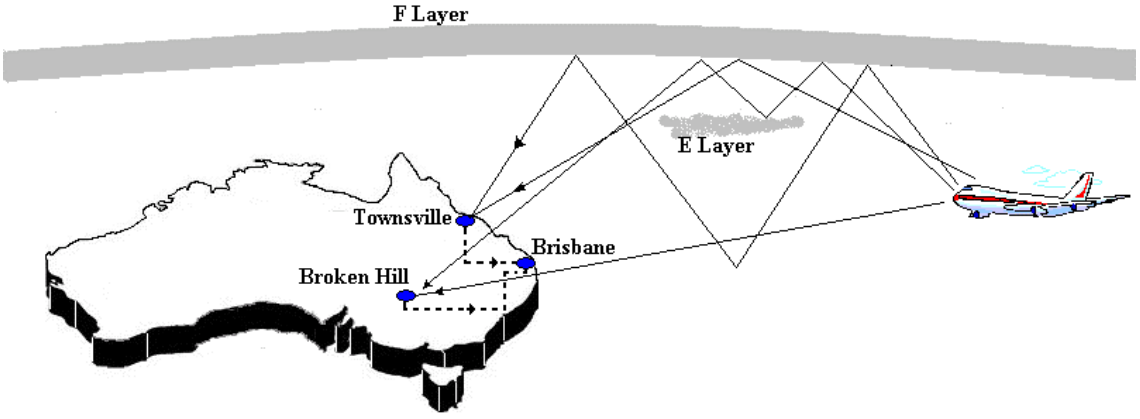
Figure 2 shows that, to achieve a single hop (F1) propagation distance in excess of 2000km, the antenna must have a gain lobe that is below 15˚ at the higher end of the HF band.

3 High Frequency Rationalisation and Modernisation Project

The High Frequency Rationalisation and Modernisation Project (HF RAMP) is not simply a renewal of the current system, but rather represents a considerable advance in the way High Frequency communications are provided in Australian airspace. The new system incorporates some of the most advanced technologies in HF system design, including Signal to Noise Ratio voting techniques, digital compression, voice recognition and utilisation of multiple propagation modes.

The system has been designed in such a way that the required coverage over Australia and in the international airspace within the Australian FIR is achieved from six sites instead of the current seventeen. In contrast to the current system, where most sites service only one frequency region, every site in the new system carries frequencies for multiple regions. A highly efficient configuration was achieved through the use of state of the art equipment combined with sophisticated antenna modelling and coverage prediction software.

Figure 3: Received Signal Paths

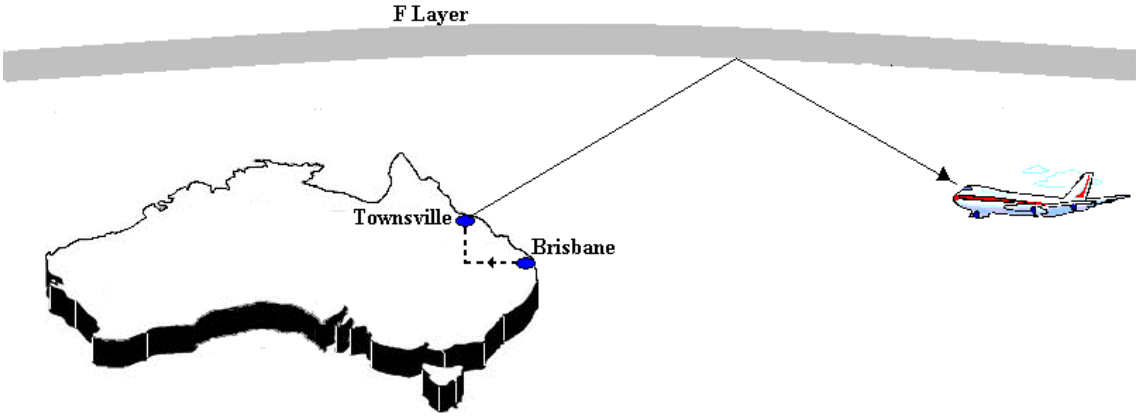


As can be seen in Figure 3, a call from an aircraft a reasonable distance (>500km) from the receiver station can arrive at multiple stations via multiple paths.

In the current system an incoming signal will be returned to Brisbane from every site at which the strength of that signal is sufficient to break the receiver squelch threshold. The returned signals from all sites are then combined before presentation to the operator. The difference in phase and Signal to Noise Ratio (SNR) of the same signal returned from geographically diverse sites often results in almost unintelligible reception. The operator is currently able to select only one site for reception of the signal, but does this with no information from the control system as to which site provides the best SNR. Similarly, in the scenario where a signal is received at multiple sites, the operator's choice of which transmit site to return the call from is based on the operator's best estimate of the aircraft location.

In the new system, however, the degradation caused by both multi-path fading effects as well as from RF noise from local or distant sources will be largely mitigated by the ability of the new antenna system to differentiate between high and low angles of arrival. The antennas utilised by Airservices are capable of connecting high and low angle signals to separate receivers, where they can then be individually analysed to determine signal quality. The system achieves the benefits of path diversity by then comparing the Signal to Noise Ratios (SNR) of both versions of the same signal (a process known as voting) and passing only the best to Brisbane in compressed form via digital terrestrial bearers. In Brisbane this signal will then be voted against the best signal from each other site that has received the same call, with only the best overall signal then presented to the operator.

Figure 4: Return (transmit) Signal Path



Information on the source of the signal presented to the operator, including the frequency, site and mode of reception is then used by the HF Control System to automatically set up the reciprocal path to return the incoming call. This means that, once a call is received, the operator will need to make no manual selection to ensure that he returns the call from the transmit site and mode most appropriate to communicate with the aircraft (as shown in Figure 4).

The AusFIC operators will control the HF system via a new interface, using touch screen displays and a software driven control system. The operators have formed a working group to determine the final layout and functionality of the touch screen display that will replace their existing mechanical switch 'consolette'.

The HF Rationalisation and Modernisation Project was designed, and will be installed and integrated, entirely by Airservices Australia engineers and technical specialists. The procurement phase of the project is currently being undertaken, with installation at the first site, Alice Springs, to commence in March 2004. The system will be fully operational by mid 2005.

4 RECOMMENDATION

The meeting is invited to note the initiatives taken by Airservices Australia to rationalise and modernise HF voice services for international and domestic services.

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