P13B.12 **IMPLEMENTATION OF THE RNDSUP S-BAND DOPPLER RADAR SYSTEMS FOR USE IN THE AUSTRALIAN WEATHER RADAR NETWORK**

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1. INTRODUCTION

In 2003 the Australian Bureau of Meteorology (hereafter referred to as the Bureau) received government funding to acquire Doppler radar systems for designated areas of Australia assessed as being most at risk to severe thunderstorms (Canterford, 2007). The Bureau has since purchased four Meteor 1500S klystron based Doppler radars from Selex SI GmbH (Gematronik Weather Radar Systems) of Germany. The reasons behind the chosen specifications are described, together with an outline of the tower and building infrastructure design. Features of the 1500S system are also described including aspects relating to the integration of Gematronik radar sub-systems with the Bureau of Meteorology's in-house RAPIC system for data encoding, distribution and display.

2. PROJECT HISTORY

The Australian Bureau of Meteorology operates over 60 weather radars on mainland Australia and some offshore locations. The installed base of radars is comprised of several different radar types and signal processing platforms, with some radar equipment having been installed in the 1970s. In 2003 the Bureau received Federal Government funding ($AUD62million over 5 years) to accelerate the replacement of the oldest radars, and install new radars based on Doppler technology to provide improved forecasting capabilities into major cities and regional centres.

This project, called the Radar Network Doppler Services Upgrade Project (RNDSUP), provided the framework for phasing out of 15 older radars (some installed as far back as the 1970s), and the introduction of six Doppler capable radars at strategic sites to provide high resolution data to aid in severe storm forecasting. Of these six new Doppler radars, four were approved to be 1 degree S Band types, and a tender was prepared during 2004 to assess the market for supply of the equipment.

The outcome of the tender process was the award to Selex Sistemi Integrati (Gematronik Weather Radar Systems) of Germany for supply of four S Band 1 degree Klystron systems with the GDRX digital receiver for deployment in Adelaide, Brisbane, Melbourne and Sydney.

3. PROJECT OVERVIEW

The Bureau has an extensive Engineering Services section as a part of the Observations and Engineering Branch (OEB). This section has a broad knowledge base in site acquisition, facilities design and equipment installation. Also part of the OEB is the Radar Group that has an extensive range of skills in radar equipment design and development, particularly in the field of radar control and signal processing. Therefore the contract was structured for the provision of the radar equipment and training services by Selex, whilst all site facilities, tower, radome, and other equipment and services were provided by, or sourced by, the Bureau. In particular, the towers were provided by manufacturers in Victoria, and the radome was supplied by Beijing Metstar in China.

The Bureau has a history of designing hardware and software to meet its own particular requirements. In particular, the Bureau has developed its own radar data presentation software called 3D-RAPIC (Purdam, 2007). This software interfaces to radars using a specific heavily compressed format. Therefore a major requirement for the introduction of the new S1 radars into the Australian network was the necessity to produce data to interface to this software. The development of this software package was undertaken by the Bureau's Radar Group.

4. THE RADAR SPECIFICATION

The S1 radars were designated for major Australian capital cities. These locations, with their potentially severe clutter environments, lead to a requirement for a Klystron system. This type of transmitter/receiver combination can achieve in excess of 50dB clutter suppression, this being important in the detection of precipitation over cities that can product extremely high radar returns from tower blocks.

Receiver dynamic range was specified to be greater than 90dB using a 14-bit A/D converter. The receiver architecture was also chosen to be scalable to future needs, and the specification called for the signal processing functions to be carried out in a standard PC environment. This released the design from reliance on custom processing hardware with a limited life cycle. In addition, 'general purpose' computer hardware is getting more powerful and cheaper every year. The ability to use general purpose operating systems such as Windows or Linux is also of great important as there is a wealth of algorithm development being performed around the world based on these platforms.

The upgradeability of the radar for future service improvements was also mandated, in particular for dual polarisation. The potential future upgrade to dual polarisation is facilitated in these radars by the antenna and pedestal being dual polarisation ready. This required the use of dual polarity feeds for the antenna, and the ability to introduce (with minimal change) the additional waveguide run in the tower, and on the radar equipment cabinets.

The Bureau's specification was also developed to call for extensive BITE capability within the radar system. This was because it was recognised that the system complexity would require much of the fault diagnosis to be built-in. The importance of each radar to local weather forecasters would also necessitate prompt return to service times.

5. TOWER AND BUILDING DESIGN

The tower design was undertaken by GHD of Adelaide. At the inception of the project, the Bureau had not installed and operated a 1 degree S Band radar and therefore did not have a tower capable of supporting an 8.5 metre antenna and radome. One of the major design goals was to ensure a rigid enough structure to allow the overall system to achieve a 0.1 degree pointing accuracy under the anticipated wind loadings. Further design criteria were the achievement of personnel and equipment access complying with Australian Standards (see Figures 1 and 2).

The radar shelter design (also by GHD) was driven by the requirements for ease of general technical access to the radar equipment cabinets, and in particular, exchange of the klystron tube (see Figures 3 and 4). The radar room air conditioning was also required to cope with a radar head load of approx 8 kW, and an air exchange rate of approx $1000m^3/h$.

6. RADAR INSTALLATION AND COMMISSIONING TRAINING

The contract with Selex provided for structured training episodes for radar system operation, configuration, maintenance and installation services, with these training events occurring both in Germany and Australia. Radar installation and commissioning training of Bureau personnel was consolidated during the first radar installation in Adelaide (at Buckland Park). Subsequent installations have seen more and more direct involvement and responsibility being taken by Bureau personnel.

Another aspect of the project was the introduction of a 'test bed' radar at the Bureau Training School in Melbourne (see figure 5). This radar installation provides a training platform for maintainers, and acts as a working radar platform to evaluate hardware and software updates/enhancements without impacting operational sites. The radar equipment used for this installation will be moved and become the radar for Sydney.

7. PROJECT STATUS

The timeline for the introduction of the first S1 system was extremely aggressive. From contract signing to entering the trial phase, the Buckland Park radar was completed in less than 12 months. The receiver system for this first radar was the Gematronik DRX, as the development of the new GDRX receiver was not completed at that time. The second and third radars in Brisbane and Melbourne respectively were installed with the GDRX processor, and the Buckland Park radar has recently been upgraded to include the GDRX.

At the time of writing (June 2007) two S1 radar sites are operational (Adelaide and Brisbane), and one site (Melbourne) is in the pre-operations trial phase. Planning for the fourth site (Sydney) is in an advanced state. This fourth site will receive the 'test bed' radar.

8. CONCLUSION

The RNDSU Project has provided a framework upon which the Bureau has made a quantum leap in its provision of new radar based severe weather forecasting and warning services, and the new S1 radars in particular have provided the basis of a new level of service provision to the Australian public.

References

Canterford 2007: Implementation of an End-To-End Radar Network and Doppler Services Upgrade Project, R.Canterford, B Gunn, R Webb; AMS 33rd Int Conf. on Radar Meteorology, Cairns, Australia, August 2007.

Purdam 2007: 3D-Rapic—The Australian radar visualisation system, P. J. Purdam, BMRC, Melbourne, Victoria, Australia; AMS 33rd Int Conf. on Radar Meteorology, Cairns, Australia, August 2007.

Figure 1 - Adelaide S1 Radar at Buckland Park

Figure 2 – Tower Base/Entrance and Radar Shelter

Figure 3 – Radar Equipment Room

Figure 4 – Klystron Transmitter

Figure 5 – The Melbourne Test Bed Facility