

**UPGRADE TO THE AUSTRALIAN CENTRE FOR REMOTE SENSING  
A TOTAL GROUND STATION SOLUTION**

Jim Friedel  
MacDonald Dettwiler  
13800 Commerce Parkway  
Richmond, B.C., Canada V6V 2J3  
Tel: (604)278-3411 - Telex: 04-355599 - Fax: (604)278-0531

Carl McMaster  
Australian Centre for Remote Sensing  
P.O. Box 28, Belconnen, ACT 2616  
Tel: (062)52 4111 - Telex: 61510 - Fax: (062)516326

**ABSTRACT**

The upgrade to the Australian Centre for Remote Sensing (ACRES) provides total capabilities for the recording and processing of Landsat Thematic Mapper (TM), SPOT Haute Resolution Visible (HRV) and National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR) sensor data, as well as user interfaces and production control.

The upgrade is comprised of two sites: a Data Acquisition Facility (DAF) and a Data Processing Facility (DPF). The DAF has the facilities for recording TM, SPOT and AVHRR data as well as for quick processing and transmission of imagery via a microwave link. The DPF has facilities for order entry and processing, production control, image processing and analysis, catalogue update and inquiry and accounting.

The upgrade system produces a wide variety of high quality Computer-Compatible Tape (CCT) and film products ranging from raw to geocoded with subpixel accuracy.

The anticipated effect of the expanded range of products and services in the Australian user community is described.

**1.0 INTRODUCTION**

The Australian Government's principal agency for the reception, distribution and processing of satellite remote sensing data is the Australian Centre for Remote Sensing (ACRES). The Centre was originally established as the Australian Landsat Station under the Department of Science & Technology in 1980, but is now part of the Australian Surveying and Land Information Group within the Department of Administrative Services.

ACRES has routinely received LANDSAT Multi Spectral Scanner (MSS) data at its antenna facility in Alice Springs since 1980. This site enables data reception over the total Australian continent and parts of Indonesia and Papua, New Guinea. High Density Digital Tapes (HDDTs) are air-freighted to ACRES Canberra daily, for cataloguing and archiving on the MSS system which is based on Perkin Elmer (Concurrent) processors. The MSS reception facility in Alice Springs and the processing equipment in Canberra were built and installed by MacDonald Dettwiler.

In 1986 a collaborative project between ACRES, the Commonwealth Scientific and Industrial Research Organization (CSIRO) and the Australian Mineral Industries Research Association (AMIRA), established a low-cost temporary modification to the Alice Springs facility enabling the reception of Landsat Thematic Mapper (TM) data and processing to Computer Compatible Tape. This minimally processed product has satisfied the immediate demand for TM data from the experienced users.

Another modification organized by the CSIRO and sourced from Australian suppliers has provided a Marine Observation Satellite (MOS-1) reception and minimal data processing capability at ACRES, Alice Springs.

Following a competitive tendering process, a contract was let to MacDonald Dettwiler in July 1987 to provide ACRES with a recording and product processing capability for Landsat TM, SPOT and NOAA Advanced Very High Resolution Radiometer (AVHRR) data. An X-Band reception and Zenith pass capability is to be provided by Datron Systems under a separate contract.

**2.0 UPGRADE OVERVIEW**

The upgrade is comprised of two sites: the Data Acquisitions Facility (DAF) and the Data Processing Facility (DPF). The upgrade to the DAF included facilities for recording Landsat TM, SPOT Haute Resolution Visible (HRV) and NOAA AVHRR sensor data. In addition, the DAF has capability for performing limited processing at real-time rates and transmission of imagery to the DPF via a microwave link.

The upgrade to the DPF involved a complete product generation and control system and includes facilities for imagery processing and analysis, user order entry, catalogue update and inquiry, production control, and accounting.

**2.1 Data Acquisition Facility**

This operational facility is situated at Alice Springs, Northern Territories. While having to maintain high system availability, the DAF has a low-key role in terms of overall product generation. Figure 2-1 details the information flow at the DAF. The upgrade to the DAF provided the following major operational capabilities:

- Recording and playback for Landsat TM and SPOT downlink satellite data,
- AVHRR Data Acquisition and Archival System, capable of unattended operation,
- Quick Image Capture System (QICS), for processing of subsampled full scene and full resolutions subscene TM, SPOT and AVHRR imagery and remote file transfer to the DPF. Figure 2-1 details the information flow at the DAF.

Raw Landsat TM and SPOT digital image data, together with the station's local time code, are recorded directly onto HDDT. This data can be used as a source of quicklook imagery data at the DAF but is normally transported to the DPF for cataloguing. The image data provided by the AVHRR sensor is stored initially on disk and then archived onto CCT.

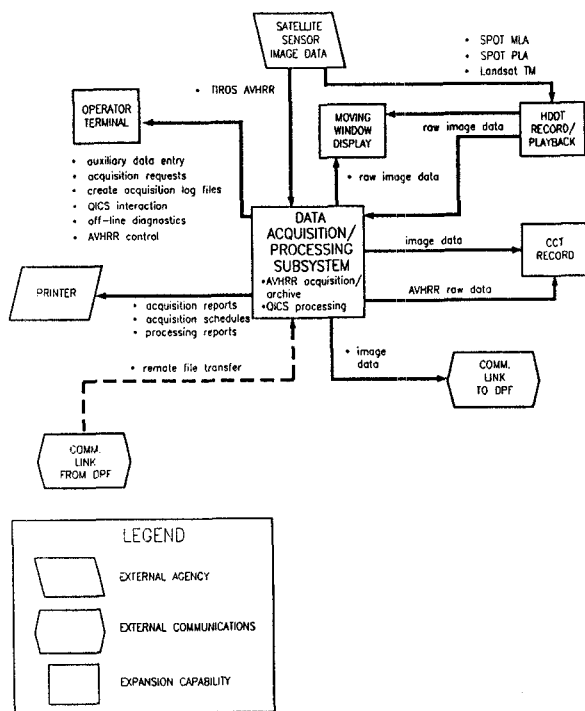


FIGURE 2.1 INFORMATION FLOW FOR THE DATA ACQUISITION FACILITY

To display Landsat TM and SPOT data during real-time acquisition or playback from HDDT, Format Synchronizers and a Moving Window Display (MWD) processor and monitor are provided. The MWD can also be utilized to view AVHRR data on reception, or playback from disk.

The AVHRR Acquisition and Archival System is based on MacDonald Dettwiler's proven Meteorological Data Acquisition System (METDAS). It provides facilities for orbit prediction and reception scheduling in addition to its acquisition and archive role. It also has provision for interfacing directly to an antenna control unit so that unattended data acquisition is possible.

The QICS system provides a mechanism for performing basic geometric and radiometric corrections on subsampled full scene data at real-time rates or on full resolution subscene data at reduced rates. The processing can be done on full passes or single scenes. The processed imagery is then transmitted via a dedicated communications link to the DPF for immediate use, thereby eliminating the time delay caused by having to ship the raw data tapes.

2.2 Data Processing Facility

The DPF is situated at the main ACRES facility in Canberra, ACT. This facility generates all user products and forms the main focus within the user community for enquiries and product generation.

Product generation functions involve all steps commencing at reading the raw data from HDDT (or CCT in the case of AVHRR data), to generating the final product for delivery to the end user.

The DPF can be divided into three major subsystems, each of which has a dedicated CPU. These subsystems are defined as follows:

- **Distribution, Information and Production Control Subsystem (DIPCS)**, which serves as the main external user interface.
- **Interactive and Quicklook Subsystem (IQS)**, which uses the Microimage Quicklook System (MQS) for catalogue and quicklook image production, and a Meridian IAS to perform interactive image analysis functions. The IQS also serves as an interface to the DAF.
- **Image Correction Subsystem (ICS)** which uses the Geocoded Image Connection System (GICS) for the production of bulk, georeferenced and geocoded imagery for TM and SPOT and for the production of bulk and georeferenced imagery for AVHRR. Figure 2-2 shows the information flow at the DPF.

In addition, the subsystems share a MacDonald Dettwiler Color FIRE 240 image recorder for the generation of high quality black-and-white or colour film products.

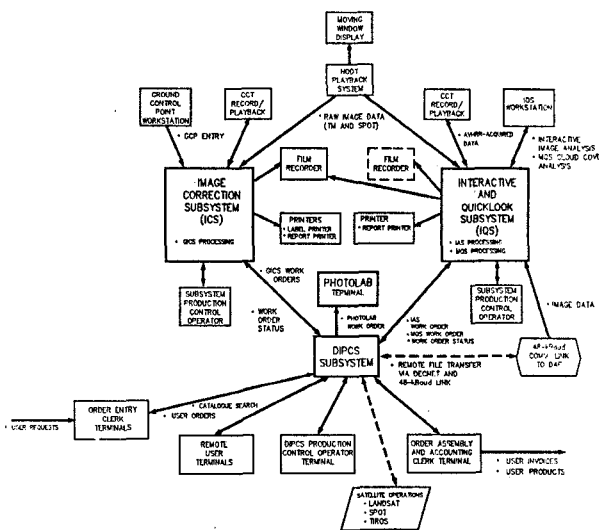


FIGURE 2.2 INFORMATION FLOW FOR THE DATA PROCESSING FACILITY

2.2.1 Distribution Information & Production Control System

DIPCS is an interactive software subsystem which provides the interface between users and the dedicated image processing subsystems. There are facilities for raw and processed data catalogue enquiries and user order entry. Users can enter orders through an order entry clerk or directly themselves, using terminals connected via the Austpac data network.

DIPCS generates work orders for the MQS, GICS and Meridian IAS subsystems, as well as monitoring the status of on-going work on those subsystems. Any film products generated on the subsystems, or requested directly from user orders, give rise to work orders for the photolab. The photolab work orders are handled by DIPCS and the status of on-going photolab work is monitored.

When products are complete, DIPCS passes that information along to the accounting subsystem. Here, packing slips and invoices are generated for distribution to customers. The accounting subsystem also handles other billing and general ledger functions.

2.2.2 MicroImage Quicklook System

MQS, is responsible for generating raw data catalogue updates. When work orders are received from DIPCS, MQS reads and corrects entire passes of TM, SPOT or AVHRR sensor data. Next, interactive cloud cover assessment is performed. Optionally, the system can generate quicklook, daily microfiche and/or cyclic microfiche film products. Catalogue update data is transmitted back to DIPCS.

2.2.3 Geocoded Image Correction System

GICS is the primary product generation subsystem in the DPF for TM, SPOT and AVHRR sensor data products. Product requests are transmitted from DIPCS in the form of work orders. Raw data for the requested products is read, and the necessary correction parameters are generated. If precision products are desired, ground truth is obtained either from previously stored models, from automatic correlation of imagery or using control points marked by an operator.

Using these parameters, GICS resamples imagery to generate raw, bulk or georeferenced products in quadrants or full scenes for TM, SPOT or AVHRR sensors, and geocoded subscene products for TM and SPOT sensors. The products can be resampled into one of many user selectable map projections, using a variety of geoids and resampling kernels. For precision products, an elevation correction can be chosen (a low frequency elevation model containing approximately one point for every 0.25 degree of latitude/longitude) or a full Digital Terrain Model (DTM) correction can be applied. GICS has a pass processing facility for generating models which allow the precision geometric correction of data anywhere in that entire pass with no further ground truth being required.

Once the imagery has been resampled, output products on film or a variety of CCT formats can be generated.

2.2.4 Meridian IAS

The Meridian IAS package, which resides on IQS, is essentially an independent interactive image analysis/enhancement tool. The IAS package contains a complete range of input, analysis and output functions needed to extract available earth surface information from remotely sensed imagery. Work orders transmitted from DIPCS contain instructions for processing imagery that is on disk, obtained directly from GICS, or from CCT. Output products on film or CCT can be generated.

3.0 PRODUCT OVERVIEW

All user products are produced on film or CCTs and may be classed as either 'standard' or 'special'. Standard products are those generated completely within one DPF system while special products may require initial processing by GICS followed by subsequent manipulation by the IAS before output to film or tape. Film products also require additional development by the photolab. DIPCS is responsible for converting special product requests to work order chains and controlling the progress of the products through the various subsystems.

Film and CCT products produced on any of the subsystems can be recorded in the processed data catalogue once processing has been successfully completed. This allows future products to be ordered as copies by identifying the data from this catalogue.

3.1 Quicklook Products

Quicklook images are corrected only for gross geometric and radiometric errors in the raw data. They are framed according to the standard framing scheme for the satellite/sensor and accompanied by identifying annotation. The quicklook film products are produced at a reduced resolution on black and white, in a 70-mm format on 240-mm roll film (9 per frame).

3.2 Catalogue Products

Catalogue film products are produced in either black and white or colour. Each 240-mm frame of film contains up to two catalogue products, each of which contains eighty-four individual scenes in a 6 x 14 array. The scenes can be organized according to acquisition sequence or, for TM data, by coverage cycle. Catalogue products are generated using imagery obtained from archived CCTs or directly from files generated by data acquisition work orders.

3.3 Standard Products

Standard products are produced on the GICS system and can take the form of either bulk, georeferenced or geocoded data on CCT or high resolution film in colour or black and white. The various characteristics and options for these products are summarized in Table 1-1.

TABLE 1-1 STANDARD PRODUCT CHARACTERISTICS & OPTIONS

	BULK	GEOREFERENCED	GEOCODED
Geometrically Raw	*		
Resampled to Spacecraft Projection	*		
Resampled to User Selected Map Projection		*	*
Rotated to North Up Orientation			*
Radiometrically Raw Radiometrically Corrected	*	*	*
Systematic Geometric Accuracy	*	*	*
Optional Precision Geometric Accuracy		*	*
Optional Elevation Correction	*	*	*
Optional DTM Correction		*	*
Choice of Resampling Kernels	*	*	*
Choice of Earth Geoid Models	*	*	*
User Defined Framing		*	

3.4 Special Products

Products which require some processing on the Meridian IAS are classed as special products. Input data may be from CCT or from image data residing on disk which has been previously produced by GICS. In addition to generating film or CCT products by applying one of the many image analysis/enhancement tools available, custom format film products (altered scale, resolution, layout, etc.) can be produced using the Meridian IAS.

4.0 POST UPGRADE

4.1 Impact on Operations

ACRES will continue to use the Concurrent system for MSS cataloguing and processing. It is expected that the demand for MSS products will decrease as users begin to use TM and SPOT. However, as the Australian TM and SPOT archive only goes back to 1986, there will always be some requests for pre-1986 MSS.

The longer term options are to maintain and operate the rapidly aging Concurrent system or to shift the MSS cataloguing and processing to the new system. Considerations in making a decision include MSS product demands, Concurrent system performance/maintenance costs,

deterioration of MSS magnetic tape archive, and LANDSAT 5 MSS transmission lifetime.

Some reorganization of ACRES staff has been necessary without significant increase in numbers. Productivity of the system is expected to be high but experience will need to be gained before optimizing procedures. The new DIPCS subsystem which enables on-line catalogue enquiries, product ordering, invoice and statement generation, is expected to be used by ACRES Distributors and regular clients. ACRES User Services staff will be able to spend more of their time servicing the less knowledgeable clients.

#### 4.2 Impact on User Community

A core group of Australian users have a relatively long experience with MSS and other remotely sensed data in a range of applications, especially mineral exploration. These users have well developed methodologies and systems. With the availability of affordable PC-based Image Analysis equipment, many more organizations, including educational institutions, are introducing remote sensing techniques, providing product prices are attractive.

ACRES new georeferenced and geocoded products will reduce the effort needed by the user in the application of the data. Users will need to make the right choices in the sensor type and processing level to best suit their application.

Geographic Information System (GIS) data bases are being implemented by a number of Australian organizations. The availability of geocoded imagery from ACRES can contribute to the economic updating of these data bases.

The Australian Government has recently approved an on-going topographic revision mapping program at medium scales to be undertaken by the Australian Surveying and Land Information Group.

#### 5.0 CONCLUSION

The 1990s will see the launch of new remote sensing satellites and also begin the era of the polar platforms carrying a multiplicity of earth resources sensors.

Data requirement needs will have to be defined and the appropriate processing agreements and capabilities put into place. ACRES in participation with other Australian organizations is well equipped to meet this challenge.