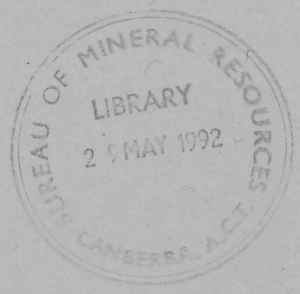

Bureau of Mineral Resources, Geology & Geophysics

R E C O R D

BMR RECORD 1992/25

INTEGRATED SPATIAL INFORMATION SYSTEMS IN BMR

A REPORT ON FINDINGS TO THE BMR IRMC

by

R.F. MOORE, P.N. CHOPRA & H.M.J. STAGG

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c.4

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EXECUTIVE SUMMARY

In the final report of the September 1990 Information Systems Study of the BMR by the consulting firm DMR, a number of recommendations were made to BMR management. The second recommendation (R2) was:

Set up a project to begin an integrated spatial/image/mapping facility as a Bureau-wide networked service.

The present report contains the findings of a working group set up to investigate the requirements for the integrated facility recommended in R2. The terms of reference for the working group were:

To formulate a new BMR project which will begin to address all the issues raised by R2 for consideration by the IRMC. The working group is to clearly detail the outcomes expected from the project, the methodologies to be used and the resources that would be required for 1991/92.

To assess the scope of the project, the working group held an extensive series of interviews with BMR Program staff late in 1991 (Appendix A). A synthesis of the information gathered led to the following conclusions:

1) There is no bona fide reason to establish a new BMR project to address R2. Many of the requirements of R2 are already being addressed by BMR Programs.[+]

2) What is needed if R2 is to be adequately addressed is a means of coordinating and managing the efforts that are already occurring at the Program level. The working group therefore recommends:

> **that BMR develop a mechanism to coordinate the in-house development and application of spatial information systems (point, vector and raster).**

3) To accomplish this coordination, the working group recommends:

> **the establishment of a Spatial Information Systems group in BMR (not necessarily in ISB) to provide coordination, direction, advice and support in the areas of data management, systems and applications development and support.**

This SIS group would be staffed at the outset by existing ISB personnel:

Data Manager (G. Wood)	Database Applications staff (R. Ryburn, S. Lenz)
IPC Manager (J. Creasey)	Data integration staff (P. Chopra)
Systems/Network Manager (P. Miller)	

The aim of the SIS group would be to provide a common BMR focus for these personnel (Section 2.6). Co-location of the staff within the BMR building close to major spatial data users is a priority.

4) With the notable exception of the Arc/Info GIS, all of the major IT systems in BMR have specialist staff who are responsible for the interface with BMR's scientific program. MLUP have employed a GIS consultant on a short-term contract to provide this necessary expertise for its NGMA projects. Other Programs in BMR will also need long-term access to similar in-house GIS expertise. To duplicate this expertise in every Program however would be inefficient and would lead to insularity and potentially inconsistent GIS practice. The working group therefore recommends:

> **the creation of a GIS Development Manager position in the Spatial Information Systems group to provide high level advice to GIS users across BMR Programs.**

The proposed functions of this new position are discussed in Section 2.4.3

[+] With no new Project to formulate, the working group has not produced expected outcomes, methodologies and costings for 1991/92 in this report as had been specified in its terms of reference. Rather, consideration has been given to what are seen as the important management issues which underpin R2.

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BACKGROUND

In the final report of the September 1990 Information Systems Study of the BMR by the consulting firm DMR, a number of recommendations were made to BMR management. The second recommendation (R2) was:

Set up a project to begin an integrated spatial/image/mapping facility as a Bureau-wide networked service.

At a meeting of the Integrated Spatial Information Systems committee (formerly the NGMA IT committee), it was decided a working group of three representing MEG, PMG and NRIC, Prame Chopra, Howard Stagg and Rob Moore respectively, should review the requirement for the establishment of an Integrated Spatial Information Systems Project in BMR and define its scope. The terms of reference for the study were:

To formulate a new BMR project which will begin to address all the issues raised by R2 for consideration by the IRMC. The working group is to clearly detail the outcomes expected from the project, the methodologies to be used and the resources that would be required for 1991/92.

This report contains the findings of the working group and its recommendations.

In an effort to define the magnitude of the project, the working group interviewed key staff from each of the BMR Program areas that were using or needed access to spatial information and spatial information systems. Details of the interviews are contained in Appendix A.

ISSUES AND RECOMMENDATIONS

1. CORPORATE INFORMATION - BMR's MOST VALUABLE LONG-TERM ASSET

The BMR possesses an irreplaceable asset in its corporate knowledge and, in particular, its corporate data. Table 1 shows a summary list of the major datasets. It is imperative that this data be made widely available to users both in industry and within the BMR in a form that can be readily accessed and used. With the rapidly emerging application of spatial information systems to the collection, maintenance, storage, analysis and presentation of these data, there is a need to make these data accessible in an electronic form. In BMR, the need for data in a usable digital format is exploding and a number of significant issues have arisen as a result. These issues will be discussed in this report and recommendations made where appropriate.

2. FACTORS LIMITING ONLINE ACCESS TO BMR DATA

2.1 MANY DATASETS ARE NOT IN A DIGITAL FORM

A number of data sets currently only available in hardcopy form have been identified as being required in support of current BMR programs and as saleable products in digital form . The following data sets were identified as important to at least one BMR work group:

1:5m Tectonic Provinces
1:5m Metamorphic Geology
1:5m Metallogenic Provinces
1:2.5m Regolith Map
1:250k Geology Series

Recommendation 1: That a thorough audit of BMR data be undertaken together with a user survey (BMR/industry) to identify those data important to users/clients but not yet available in a digital form. NRIC's Directory System (FINDAR) would be an integral part of this audit (to store entries and to query BMR holdings).

Action: IRMC/ISB

This recommendation should be taken up in the Advisory Council review of the Database Program in BMR soon to begin.

The 1:250,000 geological map series has been singled out as the major priority and external agencies such as the Bureau of Rural Resources have identified this series as a high priority for their programs (eg Australian Soils Inventory).

TABLE 1 - MAJOR EXAMPLES OF BMR's CORPORATE DATA

DATA	VOLUME	DIGITAL
CONTINENTAL-SCALE GEOLOGY		
- Tasman Fold Belt	Low	No
- Energy Resources	Low	No
- Geology/Structure	Low	No
- Tectonic Provinces	Low	No
- Metamorphic Geology	Low	No
- Solid Geology	Low	Yes
- Metallogenic Provinces	low	No
- Petroleum Titles	Low	Yes
GEOLOGICAL SERIES		
- 1:250,000	High	No
- 1:100,000	High	No
GEOPHYSICAL SERIES		
- Total Magnetic Intensity	High	Yes
- Gamma Spectrometer	High	Yes
- Gravity	Medium	Yes
- Seismic Reflection Data	Very High	No
- Seismic Shotpoints	High	Yes
REMOTELY SENSED DATA	Very High	Yes
ORACLE DATABASES		
- ROCKCHEM	Medium	Yes
- PEDIN	Medium	Yes
- MINLOC	Medium	Yes
- MINDEP	Medium	Yes
- QUAKES	Medium	Yes
- Others not listed here		
NRIC CONTINENTAL DATASETS		
- Vegetation	Low	Yes
- Forest Cover	Low	Yes
- Soils	Low	Yes
- Climate	Low	Yes
- Elevation (1km)	Low	Yes
- Land Tenure	Low	Yes
- Coastline	Low	Yes

Recommendation 2: That the IRMC and appropriate BMR Programs support capture of the 1:250,000 scale geological series in digital form as a matter of urgency and put in place a mechanism to expedite this.

Action: IRMC/CSU/MLUP

The digital capture of the geological series should be coordinated where possible with the AUSLIG AGDB program to digitally capture the national 1:250 000 topographic map series over the next 5 years.

There is a need for two types of digital 1:250 000 geological data to be captured. Firstly, scanned geological maps in which all the data are present in a single layer, will have immediate use within BMR and in industry. These products, while limited in their flexibility, permit rapid onscreen overlay of geological data on images of geophysics and geochemistry and on remotely sensed data. In the second type of digital product, the data are stored in a vector format and are properly structured into layers and where possible are linked to attribute databases (i.e. these are GIS derived products). The latter products will be much more time consuming to produce and consequently, much more expensive.

2.2 THE PHYSICAL LINKS (NETWORK) TO SOME DATA ARE MISSING

Most BMR datasets are currently managed in a digital computer system; the connections between these data are however in a number of cases missing. These systems need to be made more accessible by connecting the database(s) to a network (eg BMRnet) and by making the data available (online). Notable database examples which need to be interconnected include:

. Potential Fields

. Seismic Data (Sections/Shotpoints)

. Remotely Sensed Data

. Oracle Databases

- ROCKCHEM
- QUAKES
- MINLOC/MINDEP
- PEDIN
- GEODX
- PALEO

. Continental Data located at NRIC

- 1:2.5m Geology
- Elevation (1km)
- Climate
- 1:2m Soils
- 1:100k Coastline
- 1:250k Coastline
- Vegetation
- Forest Cover
- Land Tenure

There is obviously an issue of data volume here with the first three databases and the cost benefit of having these data online needs to be investigated. The advent however of very high volume data storage media would probably now allow this to happen. NRIC for example is purchasing a 50 Gigabyte magneto-optical drive (MOD) jukebox system to allow its data to be "online". PRAB have also acquired a laser disk system and ISB is investigating a CD-ROM mastering system for BMR.

Recommendation 3: That options for making large volume production databases (eg potential fields) available "online" be investigated and that IRMC support researching this as appropriate.

Action: ALL/IRMC

With regard to making the NRIC data sets more available, a high speed link between NRIC and BMR is required immediately so that datasets such as those that have licence agreements restricting their use can be better utilised by being located on a network.

Recommendation 4: That appropriate hardwired links be established to all databases in the BMR including NRIC and CSU. This issue has been addressed in the "review of communications in BMR" consultancy. In particular, the NRIC facility must be networked to BMR via a high speed link as soon as possible.

Action: IRMC/ISB

2.3 THE DATA IS NOT IN A DIGITAL FORMAT READILY ACCESSIBLE TO A BROAD RANGE OF USERS

In the past, decisions about the choice of data processing hardware and, in particular, software have been largely driven by program needs without significant regard to data sharing, networking and data integration; this was appropriate at the time but now connectivity, data integration and data standards are very important issues. Geoscientific data are collected in BMR by individual Programs for use in current projects. Considerable cost benefits can result for BMR if other Programs can also make use of these data. The custodians of shared data will also benefit from subsequent "value-adding" by other BMR Programs. Sharing data in this way is however only possible if it exists in a usable format. *The integrated use of data is the most significant development challenge in the use of data in the 1990s*. Systems must address this requirement or they will be discarded.

YOU CAN'T MIX APPLES AND ORANGES

BMR uses a number of significant systems to handle spatial data; these include:

- Oracle	High performance database engine
- Intergraph	Sophisticated publication-quality map production
- Arc/Info	Flexible data analysis with topological structure
- I^2S & ER Mapper	Powerful image processing systems
- Petroseis	Flexible seismic and potential fields data handling
- BMR proprietary	Tailored data processing systems

Each of these systems uses a different method of representing data and the relationships that exist between entities. Some lend themselves well to data sharing because they have a lot in common. Some do not!

It is, for example, difficult to import PEDIN well data into Petroseis. Relationships between the data defined in the database are lost in the translation. Similarly, moving point, line and polygon data from Intergraph into Arc/Info is difficult. It is however impossible to move topologically-structured data from Arc/Info to Intergraph because Intergraph does not support these spatial relationships. This is the cause of some significant inefficiencies and wasted effort. What is the solution? Force everyone to use the same system? This might have been possible if BMR were just starting out but BMR cannot afford to abandon those systems purchased to meet its specific needs. A compromise must be reached.

One short-term solution is to develop links between systems where possible. Exisiting links between databases/systems are shown in Figure 1; desirable links are shown in Figure 2. Where links are impractical or impossible because of incompatibility, systems should be phased out.

Several of the data connectivity issues raised by more than two Program areas interviewed were related to:

2.3.1 Relational Databases

Oracle databases will become more readily accessible as they migrate to the new database server on the BMRnet network. With tools such as SQL*Net, these databases will become more available to programs throughout BMR. This will make databases such as PEDIN and ROCKCHEM readily available. Duplicate (export) copies of databases must be discouraged as their currency is always going to be in question.

Recommendation 5: That the migration of Oracle databases to the new server be expedited and that IRMC supports additional resources as appropriate (e.g. contract staff) for high priority databases.

Action: IRMC/ISB

2.3.2 GIS/Computer Assisted Mapping

A geographic information system (GIS) allows the storage of spatial features and the data that describe those spatial features (attributes) in a structured manner so that spatial context (topology) and attributes can be queried in response to a user's needs. The Intergraph systems in BMR do not possess this functionality because the context relationships are largely missing and the attribute facilities are at best poor. Intergraph however is a mature publication-quality map production system.

Arc/Info in contrast is a flexible GIS which allows sophisticated data storage, manipulation and queries. It has strong links with Oracle which can be used to increase the performance of its attribute database. Arc/Info however does not currently produce publication-quality cartographic products.

Intergraph and Arc/Info are hence complementary and should be used to maximise their separate strengths.

Recommendation 6: That Arc/Info in conjunction with Oracle be used to store and manipulate BMR spatial data (corporate spatial database platform) and the Intergraph system be used to produce the cartographic quality products from data exported from the Arc/Info system.

Action: IRMC TO ENDORSE

This combination is currently being used in the National Geoscience Mapping Accord projects. This however must be seen as an interim solution for several significant reasons:

1. Data translation from Arc/Info to Intergraph is difficult and important data relationships are lost in this process

2. Any changes made to datasets in the Intergraph environment cannot be passed back to the Arc/Info system for automatic update. Changes made to data in the Intergraph environment must also be made in the corporate database. This is an inefficient duplication of effort and a very significant deficiency.

3. GIS in general, and Arc/Info in particular, are able to produce publication quality output now. What's missing is the development of such things as symbol tables and cartographic style libraries. Putting resources into these areas would allow a migration from Intergraph much more quickly.

Recommendation 7: That the application of Intergraph and Arc/Info to the production of publication quality outputs be reviewed as soon as possible, taking into account in particular the work done by MLUP with the NGMA maps.

Action: CSU/ISB/IRMC

Some of the current shortcomings of the Intergraph system (e.g. lack of topology) may be addressed in future releases of the software or in newer Intergraph software systems (e.g. Tigris). Opportunities in these areas should be fully explored. However, if the current nexus between BMR's Intergraph digital cartographic system and its GIS cannot be improved then the Intergraph facilities should ultimately be phased out. The impact of this phasing out would be lessened by the fact that Intergraph workstations can now run the Arc/Info software.

2.3.3 Petroseis

Petroseis is a powerful and flexible system tailored to the processing of seismic and related data. Unfortunately, it possesses very poor external links to other databases. Moving spatial data into Petroseis and exporting spatial data from Petroseis should be addressed by the software developers as a matter of urgency. It is a good example of a system with very good functionality which exists only for itself; links to external databases have not been recognised as important.

Recommendation 8: That Petroseis be required to provide at least improved data import/export facilities and preferably transparent link capability to and from external databases, in particular Oracle.

Action: MGPG/OSPG

2.3.4 BMR Potential Fields Database

Mechanisms for making potential fields data (total magnetic intensity, gamma- spectrometer and gravity data) available to other BMR Programs are at present limited. Facilities for making these fundamental data available online need to be progressed. Ultimately, both processed grids and profiles ought to be available on-line but in the short-term, the former datasets should be given priority.

Recommendation 9: That support be given to making potential fields grid data available online as a matter of urgency.

Action: IRMC/GOMP

2.4 THE FACILITIES TO ACCESS THE DATA ARE INSUFFICIENT OR ABSENT

As the potential of spatial information systems to assist BMR program areas becomes more and more apparent, the demand for access to these facilities has exploded. These facilities can be split into three components: hardware, software and expertise.

2.4.1 Hardware

Because of early decisions taken by NRIC and the Minerals and Land Use Program (MLUP), BMR is in an excellent position to easily meet the needs explosion for high- performance computing, data storage and user workstations. The Sun Microsystems network can comfortably grow at the rate necessary to meet growing demand by adding more fileservers and X-terminals as required. This is a sufficient and extremely cost- effective solution with the added advantage of interconnectivity and easy data sharing. The standardisation on SPARC architecture is further supported by the fact that the major software vendors (eg Arc/Info, I^2S, ER MAPPER) use Sun SPARC machines for their development platforms.

Third-party suppliers of SPARC-compatible workstations, X-terminals and other peripherals (in particular disks) should be investigated and used where appropriate. NRIC have, for example, purchased less than 20% of their disk drives from Sun Microsystems. With the adoption of the X-windows interface, X-terminals are now the standard workstation solution for graphics/image work (eg Arc/Info, ER Mapper) and should be purchased now in preference to Sun workstations as they are significantly cheaper.

Recommendation 10: That the UNIX/SPARC combination continue to be the preferred computing platform for spatial information systems on BMRnet and that X-terminals and X-emulators be used for GIS applications.

Action: IRMC TO ENDORSE

2.4.2 Appropriate Software

Arc/Info has been used in NRIC since 1989 and by MLUP since 1990. During this time, and despite some teething problems, this system has met the GIS needs of both programs and is recommended to other BMR programs as required. The I^2S and ER MAPPER systems have provided complementary facilities for the processing of image (raster) data although Arc/Info is rapidly developing a capacity in this area as well. Oracle in combination with a new database server on the BMR network will provide sufficient database capacity for the foreseeable future. Petroseis is proving to be an excellent system tailored to the needs of Programs needing to store, manipulate and display seismic and related data.

Recommendation 11: That the Arc/Info, I^2S, ER MAPPER, Oracle and Petroseis systems continue to be used for the processing of spatial data in BMR for the foreseeable future.

Action: IRMC ENDORSE

Computer-assisted Mapping (CAM) and GIS systems have provided the mechanism to depict, and more recently process and analyze, geoscience data. These systems have one major limitation. Geoscience data are 3- or 4-D. CAM & GIS systems are at best 2.5D. Complex 3D structures can only at best be represented as level surfaces and time can only be depicted as a collection of level surfaces (eg the palaeogeographic maps). Research in the area of 3- & 4-D GIS and visualisation is

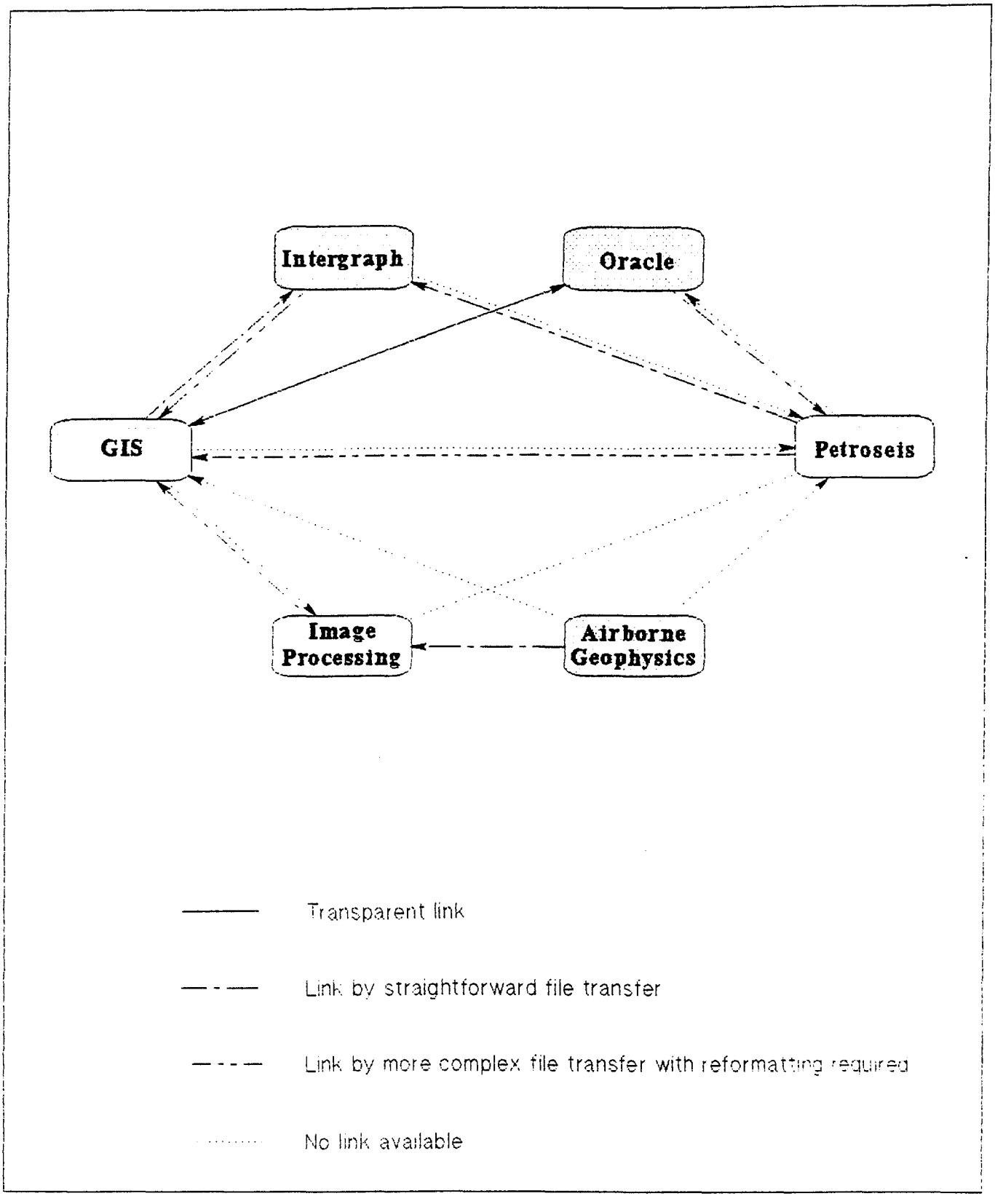

Figure 1 Links between the main BMR spatial IT systems

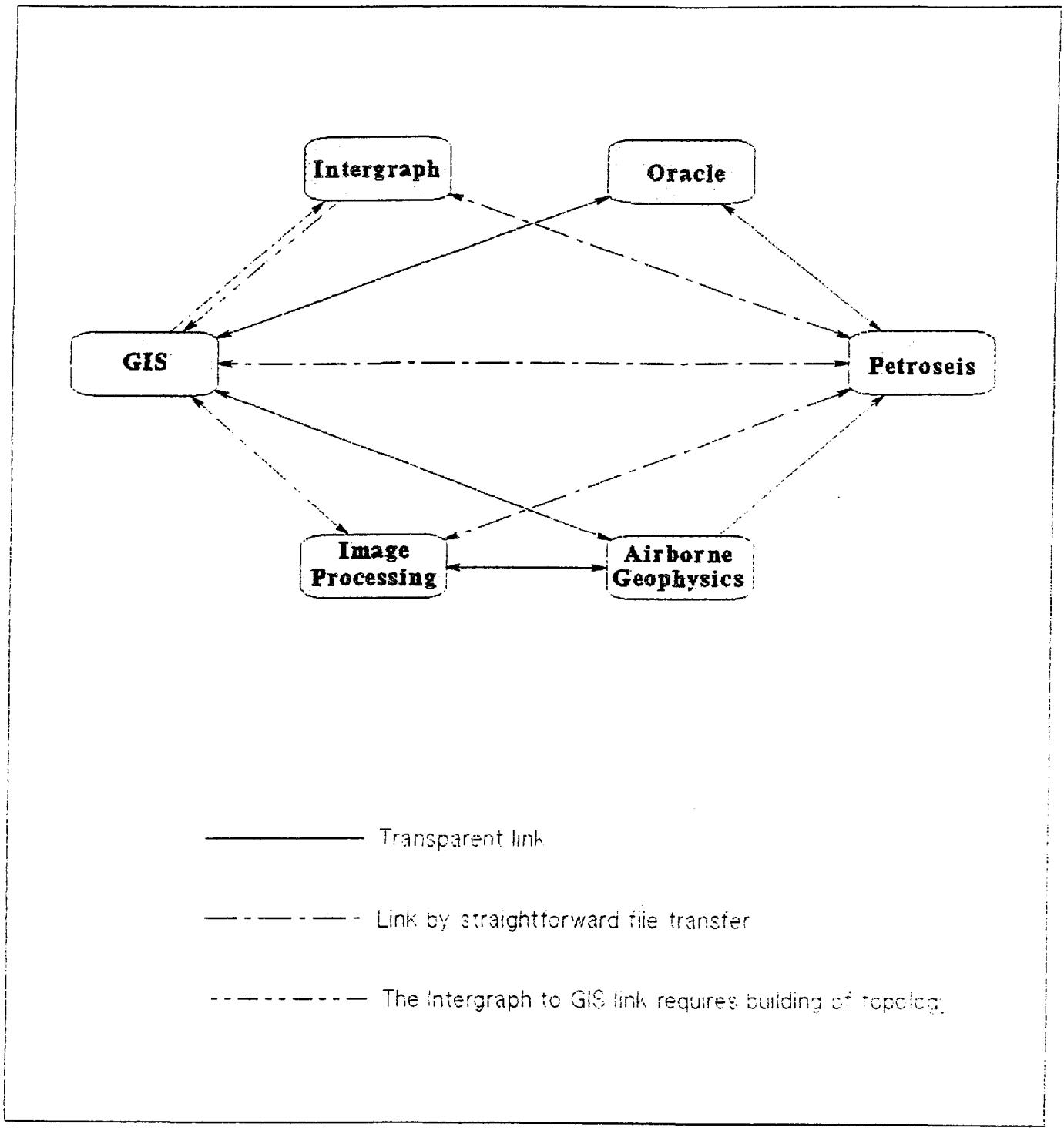

Figure 2 Desirable links between the main BMP spatial IT systems

receiving some priority overseas. BMR needs to establish its requirements in this area and to become involved in its application.

Recommendation 12: That BMR define its needs and priorities for higher dimensional databases and become involved in their application.

Action: ALL

2.4.3 Expert People

A number of roles for staff with specific expertise have been identified; these include Data Standards and Expert assistance.

Data Standards: It is essential that BMR adhere to a set of well developed data standards that meet corporate and not just program objectives. At stake here is the long-term integrity of BMR's corporate databases. NSW have for example recently completed digitising all the 1:250,000 geology sheets. The fact that the data is spaghetti digitising and that the attribute data is not attached to spatial features is not thought an issue. It is! This data costs several thousand dollars per sheet but it has limited usefulness. Minimum data standards must to be defined now! This is being done in BMR by the Data Manager. His recommendations must not be ignored.

Recommendation 13: That data standards for BMR spatial data be developed as a matter of urgency and adopted as soon as possible in all programs in BMR that collect and use spatial data.

Action: IRMC/ISB

Expert Help: GIS and image processing systems are complex facilities. It is essential for efficiency and long term goals that expert help be available to programs early in the project lifecycle when most decisions about data issues and design are taken. This can be done by Programs employing experts (eg the MLUP GIS consultant). It can be argued that Programs should pay for this service (eg employ appropriately skilled staff) but areas that only have a small requirement (eg just beginning) need access to experts so that they don't make the same errors other groups learned the hard way.

One solution is for Programs to take advantage of NRIC's technology transfer programs. Pilot projects with Program areas can be undertaken to demonstrate the utility of new technologies in Program areas unsure of their application. Environmental Geoscience have benefited from this approach.

NRIC also runs a superuser program where staff from Program areas can work in NRIC for up to six months. The officer's salary is paid from funds provided by the Secretary's flex tax while he or she is working in NRIC.

Recommendation 14: That BMR Program areas make better use of NRIC's facilities and expertise through pilot projects and the superuser program.

Action: ALL/NRIC

2.5 GIS MANAGEMENT IN BMR

In addition to NRIC's assistance however, there is a need for local support and management. The BMR GIS network is a complex facility. As the network grows, it is essential that appropriate standards and practices (eg Unix system admin, archiving) be developed and adhered to. This can only be done efficiently and effectively if the network facilities are managed centrally. At least four important functions need to be provided:

- network and operating systems administration
- software maintenance (eg upgrades)
- data archiving
- applications support

These functions need to be provided by specialist IT and applications staff. Approximately eighteen months ago, BMR appointed two staff to the Image Processing Centre (IPC) to provide these functions:

- IPC Manager (John Creasey - SPOB)
- IPC Systems Manager (Peter Miller - SITOC)

Since their appointment, there has been a dramatic increase in the effective use of the IPC to the point that the centre is now running at its full capacity. This staffing model is a very good one and is used in most IT centres in BMR including:

- ASC
- Seismic Data Processing Centre
- Potential Fields
- Oracle Database
- NRIC
- Petroseis

The GIS facilities are now also running at their capacity as evidenced by the current P&E proposal to upgrade the GIS systems to enhance capacity (see Appendix C). At this time, however, there are no permanent staff employed to fill the roles identified above. The IPC Systems Manager is managing the GIS systems but he needs support from another ITO if he is to manage both facilities. The role of GIS support is being provided by a consultant currently employed by MLUP. This temporary arrangement can only provide limited support to other Programs. It also does not address BMR's long-term needs for advice and support on issues such as GIS standards and database design. These functions should not be provided at the Program level as Programs will always have divergent priorities and views of the world. BMR needs a permanent GIS development and support person to assist Program areas to begin to make use of this technology. BMR needs a GIS Development Manager to fill this role.

The functions of the GIS Development Manager should include:

- coordinating the implementation of GIS across BMR's Programs
- Developing GIS data standards
- coordinating links between the GIS and BMR's other spatial IT systems
- facilitating the use of GIS in BMR through practical developments.

These functions can be separated into two distinct responsibilities: firstly, coordinating and managing GIS and secondly, facilitating its use through practical developments. It is quite likely that as GIS becomes more widely used by BMR Programs, two personnel will be required to fulfil these responsibilities. For the present however, the working group recommends:

Recommendation 15: That IRMC support establishment of a new corporate position titled GIS Development Manager to provide a corporate approach to GIS in BMR, to implement standards for GIS and provide high level advice to BMR Programs.

Action: IRMC/ISB

2.6 A SPATIAL INFORMATION SYSTEMS GROUP

Responsibility for spatial information systems (SIS) in BMR could be described as disjointed. For efficiency and a coordinated approach, several existing functional areas could be merged and a new Spatial Information Systems Group be formed in BMR, incorporating essentially existing ISB staff, with the responsibility for the following functions:

- UNIX Operating Systems
- Network
- Data Standards
- Application Software Maintenance and Support

The following positions should be included in the group:

- BMR Data Manager (G. Wood)
- IPC Manager (J. Creasey)
- GIS Development Manager (to be appointed)
- Systems/Network Manager (P. Miller)
- Systems Support Technician/Programmer (desirable future appointment or transfer)
- Database Applications Staff (R. Ryburn, S. Lenz)
- Data Integration Research (P. Chopra)

2.6.1 Functions of the Proposed BMR SIS Group

For reasons of efficiency, it is recommended that those SIS functions that are of a support nature or have a wider impact on BMR as a whole be the responsibility of the SIS Group defined above. Responsibilities of this group should include:

- Managing the network and systems including operating systems maintenance, support, archiving

- Setting computer/peripheral systems standards and investigating options

- Managing and maintaining commercial software (eg Arc/Info); acting as point of contact between vendor and users for support, purchasing, etc

- Developing corporate standards for data definition and storage

- Providing high level advice on matters related to SIS software (eg Arc/Info, I^2S S600, ER MAPPER) and applications (eg image processing, remote sensing, GIS, database design)

Recommendation 16: That IRMC support the formation of a corporate spatial information systems group, not necessarily in ISB, to provide support in SIS to BMR.

Action: IRMC/ISB

The SIS group would operate in much the same way as the Image Processing Centre and the database applications area now do. SIS staff would work with BMR Programs on projects in short-term out-

posted or pilot-project capacities. Priorities between Programs for this project work would be set by the IRMC.

2.6.2 Remote Sensing

There may also be a strong case for including the MLUP remote sensing group in the proposed SIS group because their responsibility in supporting and developing the application of remote sensing in BMR is much broader than the needs of MLUP, even though that Program is, and will probably continue to be, the largest user of remote sensing data.

Recommendation 17: That IRMC commission a report on how remote sensing expertise can be made more available to all BMR Programs.

Action: IRMC/ J. Creasey

GLOSSARY

Arc/Info	A GIS package produced by ESRI, USA
AGDB	Australian Geographic Database
AUSLIG	Australian Surveying and Land Information Group
CSU	Cartographic Services Unit
GIS	Geographic Information System
GOMP	Geophysical Observatories & Mapping
HOP	BMR Heads of Program
IRMC	Information Resource Management Committee
I^2S	International Imaging Systems
ISB	Information Systems Branch
IT	Information Technology
MEG	Minerals & Environmental Geoscience
MGPG	Marine Geoscience & Petroleum Geology
MLUP	Minerals & Land Use Program
MRAB	Minerals Resource Assessment Branch
NGMA	National Geoscience Mapping Accord
NRIC	National Resource Information Centre
OSPG	Onshore Sedimentary & Petroleum Geology
PMG	Petroleum & Marine Geoscience Group
PRAB	Petroleum Resource Assessment Branch
RDBMS	Relational DataBase Management System (e.g. Oracle)
SIS	Spatial Information Systems

APPENDIX A

SUMMARIES OF INTERVIEWS WITH BMR PROGRAMS

This Appendix summarises the main points raised with the working group by the BMR Program staff who were interviewed during the course of this study. The order in which these summaries are presented is not significant.

1) **Petroleum Resource Assessment Branch** (S. Radke)

- Petroleum Exploration & Development Titles Map, which is issued 6 monthly, is currently prepared on the Intergraph system as a graphic element only (i.e. there are no attributes associated with the vectors). The data in this map are of great interest to many of BMR's petroleum-related Programs but are seriously under-utilised because they cannot be integrated with other BMR IT systems.

- a graphical front-end is needed for the PEDIN Oracle database so that data can be displayed on-screen as maps and users can interrogate the database through these maps. This would make the database easier to use and would aid in data quality control.

- a link is needed between PEDIN and Petroseis so that PEDIN data holdings can be integrated with data in the basin analysis system.

- a link is needed between PEDIN and the new document scanning/imaging system that is being used to archive company well completion reports. Ideally, company reports need to be available on-screen at the push of a function key in PEDIN.

- PRAB would be keen to explore options for public dial-up access to PEDIN for sales of the data.

2) **Minerals Resource Assessment Branch** (K. Porritt)

- the MINLOC is a database of mineral occurrences. It contains point data for the most part, though there are some polygons representing pit boundaries and the perimeters of large deposits such as bauxite. A broad range of commodities are included in MINLOC.

- MINDEP is a mineral deposit database. At present it only includes data on gold deposits. It is a highly normalised database comprising more than 60 tables. Plans are currently being developed to produce a less complex version of MINDEP which will be easier to use. The new database will contain less data than the current one (some fields are not going to be transferred).

- MRAB data are currently plotted using the MAPDAT software developed in BMR. Maps are produced at 1:100 000 scale and these are sold along with extracts from the databases. There are a number of problems with these existing arrangements:

  - MAPDAT has some "bugs" in it and these are not being fixed because the software is no longer supported

  - Maps generated by MAPDAT are generally only available on poor-quality pen plotter media

  - the coastlines currently available in MAPDAT are too coarse at 1:100 000 and there is very little cultural data available on MAPDAT plots (e.g. roads and geological map data are not available).

  - MAPDAT cannot produce custom titles and legends on maps

- MAPDAT generated maps are currently used for on-screen data displays using Emutek and Tplot. This is satisfactory but it is not possible to query the attributes of the elements in the map.

- MRAB would like to be able to sell data from its databases through a dial-up procedure in the future.

3) Onshore Sedimentary & Petroleum Geology (P. O'Brien, M. Sexton)

- Petroseis is the main IT system being used

- Data have been successfully transferred from Petroseis to the Intergraph digital cartography system using Petroseis' ability to write **dxf** files. From Intergraph, maps have been produced and data have been transferred to the Mirage software (running on a PC) for the preparation of 35mm slides.

- Data have been transferred from the ORGCHEM database on the Data General MV20000 corporate database server to the PEP well-log database which is part of the Petroseis system on the VAX network. The transfer was tedious. Data had to be extracted from ORGCHEM using an Oracle report then it had to be copied from the MV20000 to a PC and from there to the VAX. The data format had to be manually edited before it was possible to read the data into PEP.

- OSPG would like to be able to access the PEDIN database so that data in PEDIN can be integrated with data in PEP. They see this as a 2-way process with data flowing from PEDIN to PEP and then going back to PEDIN with a value-added component (e.g. formation tops, revised biostratigraphy, revised age limits, sequence stratigraphy, etc).

- OSPG would like to be able to import other BMR datasets into Petroseis. Gravity, magnetics and SEASAT data were mentioned as examples that would be useful. These data would be best imported as grids. Petroseis can import grid data and display it as an 8-bit back-drop.
Petroseis and CPS-3 both have advanced gridding capabilities. CPS-3 allows contour editing, grid editing and gridding with faults.

- OSPG would like to see better access to plotters (particularly the expensive colour ones) on the network. This would reduce the need for each Program with a minor need for such a device to have to purchase one.

4) Marine Geoscience & Petroleum Geology (P. Petkovic, N. Exon, C. Pigram, J. Needham)

- MGPG again emphasised the need to link the PEDIN Oracle database with Petroseis

- the company well completion report data that are being scanned into the document imaging system by PRAB are also a very important source of information. These data need to be available over the network. It was however pointed out that in some cases it was difficult to read the originals of these reports so the quality of the scanned images might not be good enough in some cases.

- the data in the Paleogeographic map project need to be integrated with data in Petroseis. The former data are on an Intergraph system which is capable of reading Petroseis data in **dxf** format. Petroseis on the other hand is unable to read Intergraph outputs. Thus the integration must either be done in Intergraph, or on another system capable of reading **dxf** outputs from both Intergraph and Petroseis. ER MAPPER and Arc/Info both have this capability, but of the two, ER MAPPER would be quicker and easier to use for small integration jobs.

5) **Groundwater** (R. Evans)

- Groundwater have been using Intergraph facilities for several years but are now migrating their work to Arc/Info and Oracle. At present the Oracle databases are being developed on one of the workstations but in time these will be copied to the corporate Oracle RDBMS server.

- most of the work Groundwater does is in the vector and attribute domains and there is little perceived need at present for access to raster data other than for aeromagnetics.

- Groundwater can currently submit print jobs directly into the queue for the Versatec plotter at CSU but they see a need developing soon for a similar plotter in Anzac Park East.

- links to PEDIN would be useful

- links to Petroseis data on the whole would be less useful "because seismic looks deeper than we are generally interested".

6) **Cartographic Services Unit** (J. Hillier, I. O'Donnell)

- CSU have an evaluation copy of Arc/Info installed on an Interpro 2020 (clipper) workstation. This was originally obtained in May 1991 for 3 months but due to lack of suitably trained staff to use it, it has been little used. The evaluation period was extended in September for a further 3 months and it is hoped to extend it again in December.

- One of the CSOs from CSU is at NRIC for 3 months learning to become a "super-user" and another CSU staff member is to be posted at NRIC for similar training in February 1992).

- CSU perceives a number of roles for Arc/Info in their work:

  - Arc/Info will be the platform for a CSU cartographic editorial and consultancy function for GIS-generated maps coming out of BMR programs.

  - CSU will convert Arc/Info coverages generated by BMR programs into Intergraph format by using routines developed for their Arc/Info installation.

  - CSU will build Arc/Info coverages for smaller BMR programs on a cost recovery basis.

  - CSU can use their Arc/Info installation to capture data (i.e. digitising) for BMR programs. This will use lower paid technical personnel and will be more cost effective than having senior BMR geoscientists doing this low level work.

- CSU already have a copy of Oracle running on their system with SQL*NET so they are well placed to develop an Arc/Info facility

- there is an urgent need for a comprehensive audit of CSU's holdings of digital data (what is it, where is it stored, what format is it in, what is its processing history, etc). Details such as these are held in a loose library which may not be complete and is not in digital form (so it cannot be accessed by staff at Anzac Park East).

- the Optronics raster/scanner is very busy. CSU are running 2 shifts each day. Approximately 60% of the time the Optronics machine is used for plotting (i.e. linework, screens and stipples, not continuous tone). The remaining 40% of the time it is used for scanning.

- vectorising of data scanned on the Optronics raster/scanner is a big bottleneck. The Ivec software which carries out the vectorisation, is currently installed on 3 computers (Interpro 3050, 6240 and 2020).

- CSU has just upgraded disc capacity on their Intergraph system so there should be sufficient space for scanned files and the temporary vectorisation files for the time being.

7) **Airborne Geophysics** (C. Reeves)

- the airborne geophysics group have a need for real-time image manipulation of their data and quick hardcopy. The present Argus system lacks these functions.

- the group is fairly self-contained but they would like to be able to get at some BMR datasets. Of particular interest are vector datasets such as coastlines, geological boundaries, drainage, geochemistry and cultural data and attribute data such as mineral occurrences.

- the group also want to be able to mount some of their datasets in such a way that they can be accessed by other BMR programs without personnel having to be involved. To this end, they hope to have a nation-wide dataset of 400 metre grid data available by mid-1992. These data will probably require approximately 300 Mbyte of disc storage.

- rapid access to network colour plotters is needed

- a staff member will have to be trained in GIS and this person will assist the rest of the group.

- a system is needed to display where airborne surveys have been run and the details of those surveys.

- there is a need for aeromagnetic datasets to be able to be printed on demand by the BMR Copy Service. The large range of processing options/preferences for airborne data make it impractical to generate multiple copies of every option and store them for later sale.

8) **Remote Sensing** (C. Simpson, C. Pain, T. Macias)

- every scientist is having to do **all** his/her own computing work:

  - image processing including routine rectifying of images
  - GIS including extensive digitising
  - database work involving data entry

Much of this work is scientifically non-productive. It is:

  - just routine "hack work"
  - reducing scientific output
  - not cost effective to have highly paid staff doing large amounts of this work

There are very few technicians in MLUP now which contrasts markedly with the situation in CSIRO (where there is an unofficial policy of 1 technician for every 3 scientists) and with that in other parts of BMR.

- a permanent GIS expert is needed in MLUP. The current contract employee is working out very well but this is a fixed contract and continuity of this type of expertise is essential.

- corporate GIS will become an important issue in the near future

- remote sensing advice and work is needed in virtually all programs in BMR but at present the Remote Sensing Group is housed within one BMR program which prevents other programs from using its expertise. It would be better if a more corporate approach was taken.

- the present arrangements for GIS and Remote sensing are ineffective in terms of the whole of BMR. It is difficult from within a single program (i.e. MLUP) to support training and technology transfer in order to increase BMR's knowledge base. NRIC can help here but they are seen as too remote to BMR and lacking in sufficient staff.

- disc space on the I^2S system is at a premium

- I^2S workstations are seeing heavy use during normal working hours but probably still only 25% of BMR staff are using them.

-on-going training of new users (i.e ad hoc queries) is reducing the efficiency of the experienced users.

- turn-around for high quality hardcopy output from the image processing systems is a problem as is the cost. The new colour postscript printer may help to a degree, particularly for imagery to take into the field.

- there is a need for better connectivity between the image processing and GIS facilities.

9) **Environmental Geoscience** (R. Burne, E. Bleys, P. Bierworth)

- the Program has been heavily reliant on NRIC and this alliance has been very successful.

- major IT facilities can be Program-based but there needs to be a pool of corporate expertise to assist the Programs. This should include:

- a mathematician
- a remote sensing expert
- a GIS expert
- a database expert

These specialists should not only provide technical advice, they should also be involved in training personnel and in marketing the technologies to the organisation.
NRIC's technology transfer function helps here but problems arise because of the perceived remoteness of NRIC. An NRIC shopfront in BMR and the proposed high speed microwave link would help.

- all geoscientists should be exposed to the techniques that are used with the IT systems (e.g. digitising) so that they understand the limitations and the errors that can be introduced. They should not be doing this routine hack-work all the time however because it is extremely inefficient and not cost effective. Lower paid technicians would be cheaper and more productive.

10) **Minerals & Land Use** (P. Williams and R. Gallagher)

- transfer of GIS data to the Intergraph system is being done through Intergraph design files written by an Arc/Info module. There have been some problems with this approach but work-arounds have been found.

- the biggest problem with transferring data from the GIS to Intergraph stem from the limitations of the Intergraph data model. Topologically structured GIS data are converted into vector strings in the

Intergraph design file format. Thus what were closed polygons in the GIS have to be rebuilt as polygons again on the Intergraph system before operations such as colour fills can be performed. This is a wasteful duplication of effort. There are also problems with island polygons. These must be sent to the Intergraph on a separate level (i.e. as a separate layer) but the GIS has no intrinsic way of distinguishing islands from other polygons.

- the question of how to get Intergraph value-added inputs to the GIS-derived data back into Arc/Info was also identified as a major problem.

- there was strong disagreement with the notion of a corporate pool of GIS expertise. The view was put that GIS should be a Program responsibility. Those Programs which need GIS should invest in the appropriate hardware and software and acquire the necessary GIS expertise. MLUP had found NRIC very helpful with the latter.

- a good colour hardcopy device for GIS maps was needed in Anzac Park East and this should be available over BMRnet.

- the existing SUN 4/470 GIS server (i.e. ZIRCON) becomes very slow if there are more than 8 concurrent Arc/Info users.

11) **NRIC** (I. Musto, D. Kennedy of CSU)

- in those organisations in which GIS has been successful, there is a "core support group for GIS". This is essential and must consist of at least 2 personnel:

- a GIS manager
- a GIS systems programmer

These personnel are often referred to as "the 2 wise men". It was pointed out that most of BMR's major IT systems already have equivalents of these wise people :-

- Image processing (John Creasey, Peter Miller)
- Disco seismic processing (Frank Brassil, Tim Barton)
- Airborne Geophysics (Tony Luyendyk, Gordon Briggs)
- MLUP's GIS (Robyn Gallagher [contractor], Peter Miller [ISB])
- Oracle Database (Mirek Kucka, Rod Ryburn, Sonja Lenz)
- Intergraph (Philip Ryan, Colin Wilcox, Dan Kennedy)
- Petroseis (Howard Stagg, Mike Sexton, Chris Parvey)

- NRIC has provided assistance and has aided technology transfer to a number of BMR Programs. This has been successful given NRIC's staffing constraints. This work is hampered though by the physical distance between NRIC and Anzac Park East.

- NRIC already has running some of the IT links which BMR plans to put into place (e.g. Arc/Info <===> Oracle with each software running on a different host computer linked via SQL*NET).

APPENDIX B

DETAILS OF CURRENT SPATIAL INFORMATION SYSTEMS IN BMR

The capabilities of the current BMR spatial data system

Background

BMR has invested heavily in key items of information technology in order to support the synthesis, interpretation and dissemination of its geoscientific research effort. In each case, a proprietary system has been purchased in order to address a specific range of problems. For example, ORACLE and the Data General MV20000 provide the corporate database platform, Arc/Info and a SUN 4/470 provide a geographic information system (GIS), I^2S System 600 software and 2 SUN 4/280 computers provide corporate image processing, and Intergraph software running on a network of UNIX workstations and a VAX file server provide BMR's digital cartographic facilities.

Each of these technological solutions is admirably suited to dealing with its own specific area of interest. Arc/Info is the acknowledged market leader in GIS and provides a very powerful means of combining vector data. Similarly, the I^2S system is a state-of-the-art image processing facility, and BMR's basin analysis, relational database and digital cartographic systems are extremely powerful in their own realms.

The challenge that must now be met is to integrate these separate technologies into a cohesive **spatial data system** which will meet BMR's overall needs. Such a system is essential if BMR is to effectively integrate the disparate kinds of data with which it works.

The Information Technology systems currently in place

The information technology (IT) systems that are currently used in BMR to store, process and display spatial data are:

- the Arc/Info geographic information system (GIS) operated by MLUP
- the I^2S image processing system operated by ISB
- the Intergraph digital cartographic system operated by CSU and Groundwater
- the Oracle relational database management system (RDBMS) operated by ISB with secondary copies
  of Oracle operated by other Programs (e.g. MRAB, Groundwater and PRAB)
- the Petroseis and PEP basin analysis system operated by OSPG and MGPG
- the ER MAPPER image processing software operated by ISB
- the airborne geophysics processing system operated by GOMP

With the exception of the Intergraph, Petroseis and airborne processing systems, all of the above facilities are duplicated at NRIC.

All these IT systems are proprietary in nature and each uses its own internal data structure or structures to store, manipulate and display spatial data. For this reason, the transfer of data between these systems is, on the whole, rather complex. For example, the I^2S image processing system uses a proprietary file format known as **flab** to store its images. This format is optimised for efficient storage and retrieval of imagery by the I^2S system 600 software. The **flab** format is however, completely unusable by the Intergraph digital cartography system and hence I^2S images destined for

the Optronics or Versatec printers attached to the Intergraph system at NRMA House must first be converted to a format supported by Intergraph (e.g. **cot** format) before they can be printed. Similarly, I^2S images intended for display as back-drops in the Arc/Info GIS must again be converted to a format supported by Arc/Info (e.g. **Erdas** format).

The software links that are currently in place

Some exchange of spatial data between the main IT systems is now possible. These data exchanges are taking place firstly through "off the shelf" software solutions and the use of data exchange standards and secondly through software development work by BMR personnel. The current state of these software links is summarised in this section.

Arc/Info <=====> Intergraph

Vector line-work in the Arc/Info GIS needs to be exported to the Intergraph digital cartography system for the production of hardcopy maps in the BMR map series. At present, cartographic inputs to these maps are handled much more readily in the Intergraph Map Publisher software than they can be within Arc/Info. Future releases of Arc/Info will probably include major enhancements to its cartographic capabilities and this may eventually mean that all BMR's digital cartography will be done in Arc/Info. For the short to medium term however, the Intergraph system will be an indispensable link in BMR's map production procedures.

Arc/Info line-work has been exported to the Intergraph system to date using two different exchange mechanisms.

1) Initial exports used the Autocad **dxf** digital exchange format which is supported by both Arc/Info and Intergraph. Files were written in **dxf** format using the Arc/Info ARCDXF routine and these files were successfully read by the Intergraph system.

2) Subsequent exports of Arc/Info line-work has used an Arc/Info software module which writes Intergraph design files directly. These design files are a native Intergraph format and should, in theory, permit trouble-free transfer of the spatial data in the Arc/Info coverage. In practice however there have been some difficulties with data transfers using these procedures arising apparently from shortcomings in this module.

While vector line-work can be successfully transferred from Arc/Info to Intergraph using these methods, the data holdings in the two systems cannot be successfully integrated because of the very different data models used by Intergraph and Arc/Info.

The Arc/Info data model has two major components: a vector-based topologically structured data model and an attribute database. The former component is responsible for the spatial aspects of the data (i.e. the spatial coordinates of features, be they points, lines or polygons and, in the case of lines and polygons, their topology). The latter component is concerned with all the non-spatial properties of the feature (i.e. its attributes, such as the magnitudes of the gravitational and magnetic fields at a point, or the name of a geological unit represented by a polygon and its age, predominant lithologies and physical properties).

The Intergraph system also supports point, vector and polygon spatial objects but it does so with a non-topologically structured data model. The principal means of distinguishing between different spatial objects in Intergraph is to separate objects into different "levels" (i.e. layers) in the overall dataset. Intergraph also permits the use of an attribute database to store information relevant to the spatial objects it works with, but these attribute data are treated essentially as labels.

The lack of a topological data structure in the Intergraph system produces an insurmountable barrier to true integration of data between Arc/Info and Intergraph. Data can be exported from Arc/Info to

Intergraph in a useful form, but the same cannot be said for the reverse direction. For Intergraph data to be useful in Arc/Info, the data must be topologically structured manually which is tedious and time consuming.

Value-adding by CSU to GIS derived datasets therefore poses a difficult problem if Intergraph is to be used.

I^2S <=====> Arc/Info

Raster images held in the I^2S image processing system can be used as back-drops behind vector coverages in Arc/Info Revision 5 (Rev. 5) by using a software image file format converter written in BMR. I^2S images are converted from the proprietary **flab** format to the equally proprietary **Erdas** format before copying them onto the Arc/Info system.

In Rev. 5 of Arc/Info, image traffic is in one direction since the GIS does not have any image generation or processing capabilities. In the next revision of Arc/Info (i.e. Rev. 6), the GRID module includes some image generation and processing facilities. NRIC already have a copy of Rev. 6 (in Beta testing) and with it, a copy of GRID. It is therefore likely that some Arc/Info generated images will need to be transferred to the I^2S system for further processing and integration with other I^2S data. An **Erdas** to **flab** image file converter has also been written "in-house" for the I^2S system 600 software to facilitate this traffic.

Arc/Info <=====> Oracle

Arc/Info and Oracle both work with attribute data and they need to be integrated for two reasons. Firstly, Arc/Info can benefit significantly by using the Oracle RDBMS as its attribute database instead of using the older and non-relational Info database. Secondly, by integrating the two systems duplication of data holdings can be eliminated and management of the data is simplified.

At BMR, the Arc/Info and Oracle systems are not presently integrated because BMR lacks an expensive Oracle module called SQL*NET on the Data General. This module is necessary because the Arc/Info and Oracle systems are running on different computers (the former runs on the SUN 4/470 computer known as "Zircon" which is operated by MLUP, the latter runs on the corporate Data General MV20000 system). SQL*NET is going to be bought for the new corporate Oracle database server which is expected to be commissioned early in 1992.

At NRIC, the Oracle and Arc/Info systems are integrated. SQL*NET is used to effect this link between the Sun 4/490 (AURIC) and SUN 4/690 (SATYRIC) servers which run the two software systems.

Petroseis <=====> Arc/Info

The Petroseis basin analysis software which runs on the BMR VAX network could benefit from links with Arc/Info so that data could be exchanged. At present no data have been transferred between these two systems.

Petroseis is not well placed to receive spatially referenced data from Arc/Info because it cannot input any of the common vector interchange formats (e.g. **dxf, sif, dlg**). The only potentially usable input route at present is through files of tabulated ASCII data.

Petroseis can however output data in **dxf** format. It is therefore theoretically feasible to export points, lines and polygons from Petroseis to Arc/Info for integration with other spatially referenced data. This data transfer route does however need to be tested because it still remains to be seen whether the **dxf** modules in Arc/Info and Petroseis are written for the same revision of **dxf**.

Petroseis <=====> Oracle

The attribute data held by Oracle, particularly that in the PEDIN database is of very great interest to users of the Petroseis system. At present data are transferred from Oracle to Petroseis by a cumbersome procedure involving the running of tailored reports in Oracle which produce ASCII files of tabulated data. These files are then edited and imported into Petroseis. Changes in the original Oracle data (e.g. updates) require that the whole process be repeated for the entire dataset.

An integrated Petroseis-Oracle system could provide a graphical front-end for Oracle data and a means of producing high quality hardcopy output.

I^2S, ER MAPPER =====> Petroseis

There is presently no way to transfer image data from the I^2S and ER MAPPER image processing systems to Petroseis. Raster data such as SEASAT images and airborne magnetics could, in theory, be displayed as back-drops behind vector data in Petroseis in the PIC format that it supports. However, while this format is a subset of the ISO GKS standard for graphics metafiles, it is not supported by either I^2S or ER MAPPER and therefore some software development work will be required if it is to be used.

Some problems with the co-registration of I^2S and ER MAPPER derived images and Petroseis displays will also have to be solved before these images can be successfully imported into Petroseis. These problems arise because Petroseis places a border around the displayed data which causes the zero position of Petroseis images (i.e. sample 1, line 1) to not be coincident with the zero position of the data.

ER MAPPER <=====> I^2S

The ER MAPPER importdxf routine is capable of reading I^2S System 600 **flab** image files and converting them to the ER MAPPER **ers** format. ER MAPPER is also able to write images out in **bil** format which I^2S is able to read. These procedures allow images to be transferred in both directions between I^2S and ER MAPPER with little difficulty.

Arc/Info & Oracle ===> ER MAPPER

ER MAPPER Version 3.0 provides "hot links" into Arc/Info and Oracle. These "hot links" allow ER MAPPER to dynamically access data held by external programs such as GIS software, CAD systems and relational database management systems. ER MAPPER 3.0 uses a configuration file set up by the user which tells it where the data are held and what operations are needed in order to extract it. "Hot links" can be built for any software product that is compatible with Postscript.

These "hot links" enable data from different systems to be combined on a single display. Another important feature of these links is that the data displayed through such a link are automatically updated on the ER MAPPER display as changes are made to the data in the host system. Thus there

is no need to regularly capture data from external programs before it can be displayed in ER MAPPER. This is an important saving in time and in disc storage (since there is no need to maintain the data in two separate formats).

On the face of it, it may also be possible to establish "hot links" between ER MAPPER and the Intergraph digital cartography system. This however remains to be tested.

Airborne Geophysics System ====> I^2S

The airborne geophysics processing system is being migrated from the Data General MV20000 computer to a SUN 4/490 computer operated by GOMP. This system consists in the main of a suite of BMR developed programs which have been written in FORTRAN. This system again uses data storage formats for the gridded data that it produces which are incompatible with the other BMR IT systems.

Gridded data have been successfully imported into I^2S by using an I^2S system 600 routine developed in BMR. Images of these grids have also been transferred from I^2S to ER MAPPER and they could, if required, be transferred to Arc/Info (using the **Erdas** format as described previously).

Integration of BMR airborne geophysics data (i.e. magnetics and radiometrics) with other BMR raster data and with BMR vector data (e.g. geological map data) cannot be done easily on the airborne geophysics system. Such integration is more readily carried out in one of the main-stream IT systems such as Arc/Info, ER MAPPER, or I^2S.

APPENDIX C

1992/93 P&E Bid
COMBINED BID
MINERALS AND LAND USE, GROUNDWATER AND INFORMATION SYSTEMS

Following from IRMC recognition that there is a growing general need for GIS capacity across BMR this combined bid will provide both a corporate GIS facility for BMR, and retain within Minerals and Land Use and Groundwater Programs (the current major GIS users) adequate capacity to meet their current and future requirements to 1994/95, taking into account the proposed changed arrangements for the management of the GIS hardware. The bid is put forward jointly to co-ordinate efficient acquisition of the technology. The corporatisation of GIS will be achieved through the management arrangements discussed below.

PROPOSED MANAGEMENT ARRANGEMENT:

1. Information Systems Branch will become responsible for the planning and provision of sufficient computer capacity and networking to meet GIS needs within the BMR, including sufficient interface capacity for peripheral devices including digitisers, terminals, disk drives, plotters and printers.

2. In future all Program areas will be responsible for the provision of GIS software licences for their needs.

3. Corporatisation will allow hardware and software capacity for future short-term pilot projects will be provided for by either ISB using an available licence in MLUP or at NRIC. The site chosen will depend on the level of available expertise in programs and negotiation between concerned parties.

4. Program areas will be responsible for the maintenance contracts on software they have purchased.

5. ISB is responsible for providing staff support of system, network, and GIS software management at BMR in order to contain the need for duplication of system support at the Program level.

TRANSITION ARRANGEMENTS

1. The current MLUP file server will form the basis of the corporate GIS. MLUP will relinquish responsibility and custodianship for the server, Calcomp 8-colour pen plotter, associated system software and network to ISB.

2. Peripheral devices which will remain in MLUP custodianship include:

   1 Calcomp 9500 digitiser
   4 Tektronix XP26/29 terminals
   1 SPARCSTATION IPC and associated software
   2 IPI 1.2 Gbyte disk drives

3. Peripheral devices which will remain in Groundwater Program custodianship include:

   1 IPI 1.2 Gbyte disk drive
   2 Tektronix XP26/29 terminals

4. ISB will be responsible for system and network management.

5. Programs will remain responsible for the administration of their own software licences and GIS applications.

6. To ensure current MLUP GIS capability will not be diminished in any way through corporatisation MLUP will remain custodian of the current ARC/INFO licences on both the server and the Sparcstation IPC.

7. MLUP will provide access to a licence and terminal for general use for short term pilot projects and demonstrations.

THE BID

This P&E bid is a planned expansion of the existing GIS to cover corporate requirements over the next 18 months. The immediate beneficiaries will be MLUP and Groundwater Programs, but it also allows for feasibility studies and pilot projects proposed by other Program areas. The minimal bid presented in 1990/91 for purchase of the initial GIS recognised that expansion would be needed if the GIS installation proved successful, and the expansion was flagged on last years P&E submission as a necessity for 1993/4. The proposed corporatisation, and the rapid acceptance of the GIS in MLUP and Groundwater, has resulted in the need to bring the bid forward to this round.

Minerals and Land Use has been leading GIS applications and development in BMR and is continuing to expand the use of digital methods in handling both map and image data to meet its NGMA requirements. The current GIS system has proved to be just adequate for one NGMA project, in terms of available terminals and computer power. The memory limitations of the current system restrict use to four-five concurrent users of ARC/INFO. Use of The SPARC station as a terminal for ERMapper (also an essential tool for NGMA Projects) has severely affected access to the ARC/INFO system.

Disk space on the GIS is also limited. Currently MLUP has 0.5 Gbyte, exclusive of system software, for all GIS and related image files, and Groundwater has 1.0 Gbytes. This has proven to be inadequate for even one major project. The current bid is made to allow continued expansion of map products to digital formats, and allow the integration of image data with map data. Image data is particularly hungry with regards disk storage space, and the memory upgrades are essential for the operation the expanded X-Windows user base under ARC/INFO 6.0. MLUP is extending access to the GIS from 4 to 12 terminals during 1991/92, and require the additional memory to support ARC/INFO 6.0 and the extended user base. Groundwater is extending from 1 terminal to probably 4 during 1991/93.

As a result of corporatisation of the GIS, and MLUP provision of access for pilot projects, MLUP will require a second workstation (SPARCSTATION 2) to restore terminal access to the ARC/INFO system. MLUP access is also currently being seriously compromised by use of its sole workstation for work with the ERMapper software. The SPARCSTATION will also provide network support and boot capacity for PC based X-Windows networks and the necessary access to a workstation particularly for image integration and for other NGMA applications (eg modelling packages, non-X graphics).

The upgrade of the 4/470 to a 4/670 twin processor machine (cost approx $35000) is the essential requirement for the successful corporatisation of the GIS. There is currently inadequate memory in either the IPC or the server to support ARC6.0 and ERMapper applications. There is certainly no capacity for expansion BMR-wide. The through-put on the server is also inadequate to support the widespread expansion to the X-windows environment. The combination of additional memory plus processor upgrade will provide a corporate platform on which program ARC/INFO licences will run well, and the management strategies outlined above can be implemented.

Appendix D LIST OF RECOMMENDATIONS FROM THE REPORT

Recommendation 1: That a thorough audit of BMR data be undertaken together with a user survey (BMR/industry) to identify those data important to users/clients but not yet available in a digital form. NRIC's FINDAR system would be an integral part of this audit (to store entries and to query BMR holdings).

Action: IRMC/ISB

Recommendation 2: That the IRMC and appropriate BMR Programs support capture of the 1:250,000 geological series in digital form as a matter of urgency and put in place a mechanism for this to happen.

Action: IRMC/CSU/MLUP

Recommendation 3: That options for making large volume production databases (eg potential fields) available "online" be investigated and that IRMC support researching this as appropriate.

Action: ALL/IRMC

Recommendation 4: That hardwired links be established to all databases in the BMR including NRIC and CSU. This issue has been addressed in the "review of communications in BMR" consultancy. In particular, the NRIC facility must be networked to BMR via a high speed link as soon as possible.

Action: IRMC/ISB

Recommendation 5: That the migration of Oracle databases to the new server be expedited and that IRMC supports additional resources as appropriate for high priority databases.

Action: IRMC/ISB

Recommendation 6: That Arc/Info in conjunction with Oracle be used to store and manipulate BMR spatial data (corporate spatial database platform) and the Intergraph system be used to produce the cartographic quality products from data exported from the Arc/Info system.

Action: IRMC TO ENDORSE

Recommendation 7: That the application of Intergraph and Arc/Info to the production of publication quality outputs be reviewed as soon as possible, taking into account in particular the work done by MLUP with the NGMA maps.

Action: CSU/ISB/IRMC

Recommendation 8: That Petroseis be required to provide at least improved data import/export facilities and preferably transparent link capability to and from external databases.

Action: MGPG/OSPG

Recommendation 9: That support be given to making potential fields data available as a matter of urgency.

Action: IRMC/GOMP

Recommendation 10: That the UNIX/SPARC combination continue to be the preferred computing platform for spatial information systems on BMRNET and that X-terminals and X-emulators be used for GIS applications.

Action: IRMC TO ENDORSE

Recommendation 11: That the Arc/Info, I^2S, ER MAPPER, Oracle and Petroseis systems continue to be used for the processing of spatial data in BMR for the foreseeable future.

Action: IRMC TO ENDORSE

Recommendation 12: That BMR define its needs and priorities for higher dimensional databases and become involved in their application.

Action: ALL

Recommendation 13: That data standards for BMR spatial data be developed as a matter of urgency and adopted as soon as possible in all programs in BMR that collect and use spatial data.

Action: IRMC/ISB

Recommendation 14: That BMR Program areas make better use of NRIC's facilities and expertise through pilot projects and the superuser program.

Action: ALL/NRIC

Recommendation 15: That IRMC support establishment of a new corporate position titled GIS Development Manager to provide a corporate approach to GIS in BMR, to implement standards for GIS and provide high level advice to BMR Programs.

Action: IRMC/ISB

Recommendation 16: That IRMC support the formation of a corporate spatial information systems group, not necessarily in ISB, to provide support in SIS to BMR.

Action: IRMC/ISB

Recommendation 17: That IRMC commission a report on how remote sensing expertise can be made more available to all BMR Programs.

Action: IRMC/ J. Creasey

APPENDIX E

THE IRMC RESPONSE TO THE REPORT

An extract from the Minutes of the 8th meeting of the BMR Information Resources Management Committee, 10 April 1992.

D.M.L. Berman, Secretary IRMC; Head, Information Systems Branch

The following extract has been taken from the record of the Minutes of the 8th IRMC, as they appear on BMR file 91/107.

Item 3: R2 Report Recommendations

Each recommendation from the R2 report was considered in turn.

Recommendation 1

The recommendation was modified to:

" That ISB prepare an up-to-date list of digital databases; this list, together with current FINDAR entries, be circulated to and reviewed by Programs; the updated list be included in FINDAR".

Recommendation 2

The recommendation was not endorsed. ISB to ask GGDPAC to advise what has already been done in the States. It is a Program responsibility, to be considered with other priorities.

Recommendation 3

The recommendation was not endorsed. It was considered that each case should be evaluated on its merits in terms of the effectiveness and efficiency benefits to Programs

Recommendation 4

This recommendation relates to activities already in hand and does not require IRMC action.

Recommendation 5

This recommendation relates to activities already in hand and does not require IRMC action. Funding of priority database migration projects is a Program responsibility.

Recommendation 6

The recommendation was modified as follows:

"That the BMR preferred computing platform for GIS be Arc/Info & Oracle, and for mapping be the Intergraph system."

"That the Australian Spatial Data Transfer Standard for data interchange be adopted for storage and archival purposes."

Recommendation 7

This recommendation was not accepted.

Recommendation 8

The recommendation relates to action already in hand. The recommendation was modified as follows:

"That OSPG and Marine liaise with Petroseis with a view to achieving improved data import/export facilities and preferably transparent link capability to and from external databases."

Recommendation 9

The recommendation was not endorsed. It was considered that it had been dealt with under recommendation 3.

Recommendation 10

It was acknowledged that UNIX is the most appropriate operating system at present. Activities already in hand are consistent with this. IRMC action is not required.

Recommendation 11

The recommendation was not endorsed. It was considered that it had been dealt with under recommendation 6.

Recommendation 12

The recommendation was noted, in conjunction with recommendation 1. Programs to advise particular requirements to ISB.

Recommendation 13

The IRMC noted the need for data standards and endorsed the recommendation. Programs have a responsibility to interact with the BMR Data Manager (G Wood) and are encouraged to do so.

Recommendation 14

The recommendation was strongly endorsed. It was noted that this already was happening.

Recommendation 15 & Recommendation 16

The recommendations were not endorsed. It was noted that relevant expertise was available in Programs and directed towards Program requirements, that NRIC was available to assist (Recommendation 14), and that HOPs should seek a better interaction with NRIC, through NRIC management, and better co-ordination through the BMR Data Manager.

The formation of a SIS/GIS users group is supported by the IRMC.

Recommendation 17
This recommendation relates to activities already in hand, including J Creasy's middle management development project, and the user groups proposed at recommendations 15 and 16. The recommendation does not require IRMC action.

The IRMC thanked the R2 Committee for its work. It was decided that the project need not be pursued any further in its original form. In essence, the minimalist (Program driven) approach advocated in the Report was supported.

The User Group model was seen as the preferred mechanism for co-ordination of related activity. It was a responsibility of ISB to monitor Program developments, maintain an overview, and periodically raise questions and corporate issues. This model has been evolving in other related computing and science ares, and is needs based, avoiding institutionalisation.

All user groups are to be asked to report on their activities to IRMC each three months. ISB is to identify the groups and those responsible for preparing these reports.

N Williams, R Bradbury and D Berman are to be asked to report on their overseas visits (Williams, Berman), and the perceived current and future directions for SIS.