The Australian Academic and Research Network - The Outlook to 1990

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AARNet

The Australian Academic and Research Network

December 1989

The Australian Academic and Research Network - The Outlook to 1990

1. Introduction

As you may be aware, 1989 has seen considerable effort directed towards the establishment of the Australian Academic and Research Network (AARNet). With the year drawing to a close, it is appropriate to draw together the results of these efforts and present an overview of the current status of AARNet, as well as informing you of the current plans for AARNet activities for the forthcoming year, which will be the initial year of operation of the network itself.

As this paper is addressed to a broad audience, it contains a range of information, including an overview of the 1989 activities, the proposed management structures for AARNet now that AARNet is progressing into the implementation phase, the financial aspects of the network, and an enumeration of the pre-requisite actions for each member site participating in AARNet.

While this document attempts to draw together many of the aspects of the activity relating to AARNet, it is not possible to present a detailed enumeration of the finer levels of detail within many of the areas presented here. You are invited to contact the AARNet Section of the AVCC to raise any further queries relating to any aspect of AARNet. The contact officer within the AVCC for AARNet is:

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Please note that this document does contain a number of sections which require a response or local action from every AARNet member institution. In some cases these reponses are required by 15 January in order to meet the ordering deadlines. The sections listing the required actions are highlighted in the body of the text with bold typeface and a margin indicator in the same style as this paragraph. In all cases the responses should be addressed to the AARNet Network Technical Manager at the address above.

A summary of these required activities and responses are provided on the following pages

1.1 Summary of Required Activities and Responses from each Institution

Referring to: Section 6: Configuration of AARNet

Each member site is requested to note the configuration information for their site and advise the AVCC as soon as possible (on or before 15 January) if there are errors or inaccuracies in this configuration.

The University of New South Wales to advise on potential microwave connection.

The University of Western Sydney to advise on proposed location of AARNet interface equipment.

Monash University and CSIRO [Victoria] are requested to provide details of the connection method proposed for the Monash campus and CSIRO's Victorian sites.

Referring to: Section 8: AARNet Contact Officer

For each site it is requested that a contact officer be nominated to AARNet (including name, position, phone, fax, e-mail and address). This officer will be the first point of contact for AARNet operational matters.

Regarding the initial installation of the AARNet equipment, each site will be required to make available equipment rack space within the computer systems equipment room. The requirement for all sites (with the exception of the regional hubs) is for two shelves within the rack to accommodate the cisco unit and a Telecom modem, together with 2 x 240V, 10A power outlets. The local Ethernet network cable should also be positioned within 2m of this rack to allow tapping of the cable for the equipment. Each site is responsible for notifying AARNet by the end of January as to the transceiver requirements (10Base5 or 10BaseT), and will be responsible for arranging for the physical tapping of the local Ethernet cable and installation of the transceiver. During installation a terminal and DB25 terminated lead will also be required.

Referring to: Section 11: Site Requirements - Internet Protocol Support

The requirements relating to IP support are:

- All Internet network numbers in use must be numbers which have been allocated by the Network Information Centre at SRI. If this is not the case you are requested to obtain an allocated network number before you may be connected. (Note that the NIC will no longer be prepared to allocate Class C network addresses to sites already allocated a Class B number.)

- AARNet must be advised of all IP network numbers in use on the local site. This requirement is to endure that the U.S. Internet is aware of the connected status of these network numbers. If you have already advised Robert Elz at Melbourne then this is not required.

- AARNet should be advised by 1 March 1990 of the IP address of the Ethernet interface of the cisco unit, and any applicable IP subnet mask if being used.

- AARNet must be advised if the site is not using RIP to communicate gateway addresses within the site.

- IP systems should preferably be configured with an application (routed) which listens to periodic RIP broadcasts. If this is not possible, static routing, referring to the AARNet cisco address as the default route, is also acceptable.

The requirements of each site with respect to DNS name serving are:

- Each site must either maintain DNS entries for their IP host names or arrange for another site to do so. This name server must minimally hold both name to number and the reverse mappings. AARNet should be informed of the address and namespace of these servers to ensure that the appropriate upper layer DNS server references this data.
- The reverse number mapping (in-addr.arpa. domain) must be registered with the U.S. Network Information Centre.
- Each site is responsible for arranging an authorized secondary name server within Australia for the name server data. AARNet will assist in providing an international secondary name server.

Referring to: Section 12: Site Requirements - DECnet Phase IV support

Each site wishing to become a member of the National DECnet must request an allocated DECnet area number from AARNet, by March 1990.

The requirements for support of DECnet connectivity to the site are:

- To have an AARNet allocated DECnet area number in the range 11 - 60.
- All local area routers in the range 1 - 10 have "maxarea" parameter set to to 60 or below.
- The 6 character DECnet node names should be registered with AARNet to ensure a uniform namespace across the national DECnet.

2. Overview of 1989 AARNet Activities

The major tasks undertaken in 1989 were focused on the planning phase of AARNet. To undertake this planning activity the Australian Vice-Chancellors Committee (AVCC) and the Australian Committee of Directors and Principals Limited (ACDP) provided the necessary financial support, and two committees were inaugurated to examine the issues associated with the implementation of such a national network.

A joint AVCC/ACDP Steering Committee, chaired by Professor K. McKinnon, Vice-Chancellor, The University of Wollongong, was inaugurated in November 1988 to examine the policy issues associated with this project and provide broad direction to the AARNet planning process. This committee also included representation from the Commonwealth Scientific and Industrial Organisation (CSIRO), who had expressed their interest in participating in this project.

At the same time (November 1988) an associated Technical Committee, chaired by Dr R. Erskine, Director, Computing Services, The Australian National University, was formed with a brief to provide expert technical input into the planning process.

The AVCC created a full-time position of AARNet Network Technical Manager as the day-to-day focus of AARNet activity. This position was filled in March 1989 by Mr Geoff Huston.

Following widespread consultation, the technical aspects of AARNet were defined at the start of the year. The major technical requirements, as expressed by the higher education sector and CSIRO, are concerned with ensuring that the national network is capable of direct interface into every local institutional network. The intent of this requirement is to ensure that from the perspective of the scholar or researcher there is no visible difference between using a communications network within a single institution and across the globe.

Available tools and equipment were then evaluated by the Technical Committee for their suitability to meet this requirement, and an initial national network configuration was drafted. This configuration was further refined in May of 1989 in a series of meetings with technical networking groups from each State.

This configuration was costed, and a three year AARNet proposal was presented to the AVCC, ACDP and CSIRO in June and July of 1989. These papers sought the endorsement of these bodies to proceed along these indicated directions, and also sought a firm commitment from all higher education institutions who wished to participate in AARNet to agree to contribute to underwriting the costs of the project.

In August of 1989 a submission to the Australian Research Council (ARC) was prepared by the AVCC and ACDP, seeking funding for AARNet. This submission included further refinement of the network plans including a 5 year outlook from an anticipated start date early in 1990. The submission also indicating how such a financial support program from the ARC could provide a mechanism of managed growth in network resources designed to meet the anticipated user requirements over the same 5 year period.

A Request for Proposals for the supply of Equipment and Services for AARNet was released in September of 1989. This request attracted significant interest from the Australian data communications industry, with over 70 organisations requesting a copy of the document. Over 30 detailed responses were submitted, and a Working Group from the Technical Committee was convened for a three day period for the detailed evaluation activity. After subsequent negotiations a recommendation concerning the preferred suppliers of equipment and communications services was passed to the AVCC and ACDP in early November. This recommendation indicated that cisco systems were the preferred supplier of the routing equipment, and Telecom the preferred supplier of the required digital transmission services. At this point the relevant contracts with the Australian agents for cisco Systems, Ungermann Bass Pty Ltd, are being examined by the AVCC prior to signing.

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In recent weeks considerable time has been committed to presenting AARNet papers to user group conferences, ensuring that information relating to the potential role of AARNet is disseminated as widely as possible. This activity is perceived as an important aspect of the overall AARNet effort, and will receive continued attention as the project progresses.

Following the November decision of the ARC to commit approximately $0.9m funding to AARNet in each of 1990 and 1991, it has also been possible to produce a detailed picture of the 1990 AARNet program, indicating the estimated expenditure program and funding arrangements. These schedules are included in this document.

At this stage the major effort is focused on implementation of the network. The target month for completion of the implementation of the underlying network infrastructure is April 1990, and, due to the delays inherent in the delivery of both equipment and data transmission services, part of the pre-implementation effort will require completion by mid-January 1990.

To provide the necessary levels of technical and operational support for this national effort, a second AARNet officer has been appointed by the AVCC to the position of AARNet Network Coordinator. This position will be filled by Mr Peter Elford, commencing on 15 January 1990.

Following connection of the AARNet members in March and April of 1990, other organisations who have expressed an interest in connection to AARNet (due to common research or academic activity with AARNet member institutions) will be considered for connection to AARNet commencing in July 1990.

In reaching the conclusion of the AARNet planning phase, the AARNet Steering and Technical Committees have now completed their work and have been disbanded. It is appropriate here to express the appreciation of AVCC and ACDP to all the members of these two committees for their efforts over the year in assisting AARNet through an extremely active period of planning activity.

3. AARNet: A National network

One of the major aspects of the AARNet project is that this network is designed as a national project: every participating institution will receive identical services within AARNet. In achieving this objective AARNet will be managed as a single entity, with a national perspective on the provision of services to the user community.

This does not imply that the only mechanisms of service delivery will be through the national AARNet group. The provision of these communications services to the end-user community requires coordinated and cooperative activity not only at the national level, but also progressively more focused activity within each State and within each institution.

The inclusion of State-based Regional Groups into the overall AARNet effort is intended to provide a structural hierarchy within AARNet to ensure that the tasks associated with AARNet can be correctly addressed at both the national level (in defining the common set of provided services which define the AARNet network), and at the regional level (ensuring that local knowledge and resources can be employed) to ensure that AARNet implements the most cost effective solutions in connecting each member site to the network. As the major guiding principle lies in the provision of common networking services to every AARNet member institution, this implies a very high degree of open peer cooperative effort witin the network.

For the planning activity of 1989 each State has convened a technical-oriented group with members (typically local Network Managers) drawn from each member site. These groups have employed an open structure including standing invitations to interested academic and researchers to attend, which has enabled these groups to be an open forum for the formulation of the most effective mechanisms of service delivery to end-users.

It is anticipated that AARNet activity in 1990 will build further on this hierarchical structure, to ensure that that all those involved with AARNet continue to focus effort on the primary objective of service provision to the user population on a national scale.

4. The Management of AARNet

As indicated in Section 2 above, the AARNet Steering and Technical Committees have now completed their tasks. Attention is now being given to the determination of the appropriate management structures for the implementation and subsequent operational phases of AARNet. A management structure was drafted for consideration at the final Steering Committee meeting in December 1989. A small Working Group, which will meet in mid-January 1990, will refine the draft document prior to consideration by AVCC, ACDP and CSIRO in early February 1990.

The major components of the proposed AARNet management structure are:

- The creation of an AARNet Board with representation drawn from the three funding bodies and the ARC. This Board would be responsible for overseeing AARNet activities, and determination of matters of policy concerned with current and envisaged data communications services provided through AARNet.

- The ability of the Board to form AARNet Working Groups. These Working Groups are intended to conduct detailed investigations into particular aspects of AARNet (encompassing technical matters, user requirements, management issues and so on) and provide advice to the Board following such investigatory activity.

- The AARNet Operations Section of the AVCC Secretariat. This section would be responsible for the day-to-day working of AARNet, responsible for both the business management of AARNet and the technical operational management of the network. This section will consist of three full-time staff members within the AVCC structure.

- Regional-based structures to provide local management and assistance in the installation and maintenance of the individual links to each member site connected to AARNet, in cooperation with the AARNet Operations Section. These regional-based groups would allow direct representation from each member site into the overall AARNet structure.

- The Computing Services Section of each member institution. In providing a national network, the ultimate objective is the delivery of communications services to the academic and research user community. Each institution is a critical component in the overall structure of service delivery, and the computing services areas have the major task of assisting users in the use of this facility, and fulfilling the essential role of information dissemination to end users within their site.

Working drafts of both the AARNet Management paper and the AARNet connection papers are attached with this document for your information.

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5. The Financial Aspects of AARNet for 1990.

As you may be aware the AVCC and ACDP have already advised members of the necessary financial commmitment for AARNet in 1990. The following pages present the costings for AARNet and the associated funding arrangements for 1990, together with an estimate of the further 4 year costings estimates.

AARNet - Cost Schedule[1]

	1990 $	1991 $	1992 $	1993 $	1994 $
1. Telecom Data Transmission Charges:					
1.1 Megalink Communications Service	184,920	228,318	228,318	228,318	228,318
1.2 Digital Data Service	192,879	55,775			
1.3 ISDN Microlink		83,994	123,650	123,600	123,600
Subtotal	377,799	368,087	351,968	351,918	351,918
2. International (OTC) Data Transmission Charges:					
2.1 Bitstream Half-Circuit (to Hawaii)	162,000	162,000	282,000	282,000	282,000
2.2 OTC Data Access (X.25)	48,000	36,000	36,000	36,000	36,000
Subtotal	210,000	198,000	318,000	318,000	318,000
3. AARNet National Activities:					
3.1 National Network Management	251,000	251,000	251,000	251,000	251,000
3.2 Facilities Management - National Hub	25,000	25,000	25,000	25,000	25,000
3.3 Application Gateway Equipment		40,000	4,800	4,800	4,800
3.4 Network Management / Monitoring Equipment	64,000	7,680	7,680	7,680	7,680
Subtotal	340,000	323,680	288,480	288,480	288,480

[1] Notes for this cost schedule:

a) All costs are indicated in 1989 dollars

b) The schedule for 1991 to 1994 assumes that there will be no changes in the configuration. In particular the following items are NOT included in this costing:

- High speed trunk link connecting to Queensland (this is considered a high priority addition within 12 months)
- High speed trunk links connecting to South Australia and Western Australia.
- High speed links from the Regional hub to any of the member site.
- Any possible shifts to higher speed metropolitan scale networking technology.
- Further growth in International traffic requirements past a 128K bandwidth link to the U.S. (128k bandwidth is scheduled here for 1992 - this may be required much earlier, and additional bandwidth required by 1991)
- Any other international links in this regional (Japan, New Zealand).

Implementing the above will be on the basis of measured usage growth, and will imply some charges to the forward schedules presented here.

AARNet - Cost Schedule

	1990 $	1991 $	1992 $	1993 $	1994 $
4. National Hub AARNet Communications Equipment:					
4.1 National Hub Routing Equipment	46,429	26,022	11,172	8,622	8,622
4.2 Equipment Delivery & Installation	20,000				
Subtotal	66,429	26,022	11,172	8,622	8,622
5. Regional Hub AARNet Communications Equipment:					
5.1 ACT	56,567	18,576	10,026	10,026	10,026
5.2 NSW	37,328	10,046	4,946	4,946	4,946
5.3 VIC	21,543	2,245	2,245	2,245	2,245
5.4 SA	21,149	15,101	6,704	4,154	4,154
5.5 WA	24,093	5,518	5,968	3,418	3,418
5.6 TAS	18,336	4,925	2,375	2,375	2,375
5.7 QLD	30,493	9,193	4,093	4,093	4,093
5.8 NT	16,300	4,875	2,325	2,325	2,325
Subtotal	225,809	70,479	38,682	33,582	33,582
6. AARNet Connection costs to Institutions:					
6.1 ACT	80,403	37,691	24,641	24,641	24,641
6.2 NSW	401,425	217,052	177,202	177,202	177,202
6.3 VIC	196,326	107,552	81,452	81,452	81,452
6.4 SA	148,804	60,267	47,217	47,217	47,217
6.5 WA	142,710	75,318	49,218	49,218	49,218
6.6 TAS	20,250	14,314	14,314	14,314	14,314
6.7 QLD	269,585	180,832	174,132	174,132	174,132
6.8 NT	15,725	12,814	12,814	12,814	12,814
Subtotal	1,275,227	705,839	580,989	580,989	580,989
AARNet Expenditure: TOTAL	2,495,263	1,692,107	1,589,291	1,581,591	1,581,591

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The funding arrangements for 1990 are as shown in the following schedule. The basis for each institution's contribution to AARNet funding is based on the institution's 1990 operating grant. For comparative purposes the original funding schedule as proposed to AVCC and ACDP in June 1989 is also indicated.

	1990 Network Funding		June Estimates[1]	
	AARNet	TOTAL	1989	1990
	$	$	$	$
Schedule of Contributions by Universities for 1990:				
The University of Adelaide	41,050	54,368	26,526	27,842
Australian National University	83,080	152,589	75,629	76,960
Curtin University of Technology	36,065	93,080	48,052	45,028
Deakin University[2]	21,795	79,675	40,684	38,991
The Flinders University of SA	21,418	31,813	15,210	16,603
Griffith University[3]	24,165	66,187	30,727	35,460
James Cook University of North QLD	17,367	55,580	25,840	29,740
La Trobe University	40,527	86,076	44,906	41,170
The Macquarie University[4]	32,934	71,992	34,427	37,565
The University of Melbourne	82,835	107,642	41,195	66,447
Monash University	55,583	97,012	49,456	47,556
Murdoch University	17,519	55,248	28,372	26,876
The University of Newcastle[5]	33,780	74,664	35,706	38,958
University of New England[6]	36,312	80,420	38,462	41,958
The University of New South Wales[7]	83,172	163,229	78,112	85,117
Northern Territory University	7,646	29,178	8,764	20,414
The University of Queensland[8]	75,343	150,967	69,789	81,178
Queensland University of Technology[9]	26,723	69,337	32,178	37,159
University of Sydney[10]	97,434	177,883	85,129	92,754
University of Tasmania	23,411	40,853	13,621	27,232
University of Technology, Sydney[11]	37,799	82,683	39,546	43,137
The University of Western Australia	40,370	103,966	53,715	50,251

1 The figures in these columns are as presented to the AVCC and ACDP for endorsement in June 1989. These figures included an expenditure program of the purchase of all AARNet equipment in 1989 and operation through 1990. The actual 1990 funding figure includes both purchase and operation components for 1990., and is directly comparable with the total of the 1989 and 1990 June estimates.

2 Includes Warnambool IAE

3 Includes the Mt Gravatt site of Brisbane CAE

4 Includes Institute of Early Childhood Studies, Sydney CAE

5 Includes Hunter Institute of Higher Education, Ourimbah and NSW Conservatorium (Newcastle)

6 Includes Armidale CAE, Northern Rivers CAE, Orange Agricultural College and Coffs Harbour

7 Includes City Art Institute, St George Institute of Education, Sydney CAE

8 Includes Queensland Agricultural College

9 Queensland University of Technology - AVCC Membership from 18 April 1989

10 Includes Cumberland CHS, Institute of Nursing Studies (Sydney CAE), NSW State Conservatorium, Sydney College of the Arts, Sydney Inst. of Education (Sydney CAE)

11 Includes Kuring-gai CAE, Institute of Technical and Adult Teacher Education (Sydney CAE)

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	1990 Network Funding AARNet $	TOTAL $	June Estimates 1989 $	1990 $
The University of Western Sydney[1]	28,406	62,285	29,779	32,506
The University of Wollongong	24,241	60,067	28,717	31,350
	988,975	2,046,794	974,542	1,072,252
Schedule of Contributions by Colleges for 1990:[2]				
Australian Maritime College		2,768	1,152	1,616
Ballarat CAE		5,465	2,274	3,191
Bendigo CAE		4,774	1,986	2,788
Brisbane University College		27,396	12,622	14,773
University of Canberra	15,888	25,927	12,849	13,078
Catholic College of Education, Sydney	4,793	2,845	1,270	1,575
Capricornia IAE	9,997	15,594	7,185	8,409
Charles Sturt University	22,441	37,238	17,830	19,408
Chisholm Institute of Technology		12,691	5,280	7,411
Darling Downs IAE	13,819	21,047	9,697	11,350
Gippsland IAE		4,658	1,938	2,720
Gold Coast CAE		3,438	1,584	1,854
Phillip Institute of Technology		9,575	3,984	5,591
Roseworthy Agricultural College		3,155	1,583	1,572
South Australian CAE	25,249	27,811	13,928	13,883
South Australian IT	20,448	21,578	10,826	10,752
Swinburne		11,363	4,728	6,635
Tasmanian State IT		5,439	2,263	3,176
Victoria University of Technology[3]	51,080	52,000	28,806	23,194
Victorian College of the Arts		2,045	851	1,194
Victorian College of Pharmacy		1,481	616	865
Victorian College of Ag. & Hort.		790	329	461
Western Australian CAE	23,965	50,215	26,601	23,614
Australian Defence Force Academy[4]	3,823	26,590	13,187	13,403
Victorian Regional University[5]		49,110	29,526	19,584
	191,502	424,993	212,895	212,097

[1] Includes Werrington, Napean CAE, Hawkesbury AC, Macarthur IHE

[2] Where a figure is not indicated for the 1990 schedule of contributions to AARNet, this institution is either in the process of a merger with a University (or merger decisions are unclear), or has indicated to the ACDP that the institution does not with to participate in AARNet.

[3] This institution is the merger of the Royal Melbourne Institute of Technology and Footscray Institute of Technology. This merger is uncertain at the time of writing.

[4] Operating grant derived from EFSTU figures

[5] This University was a possibility in previous merger scenarios, and was included in the June 1989 AARNet funding estimates

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	1990 Network Funding AARNet $	TOTAL $	June Estimates 1989 $	1990 $
Schedule of Contributions by CSIRO for 1990:				
CSIRO	200,000	274,000	114,000	160,000
CSIRO - NSW	34,722	44,953	23,499	21,454
CSIRO - QLD	23,078	37,269	18,392	18,877
CSIRO - VIC	35,646	49,110	29,526	19,584
CSIRO - SA	33,979			
CSIRO - WA	33,861	17,367	9,928	7,439
	361,286	422,699	195,345	227,354
Australian Research Council Funding	900,000			
QTInet - Queensland State Private X.25 network[1]	53,500			
AARNet TOTAL	2,495,263	2,894,486	1,382,783	1,511,703

[1] This amount is funded from Queensland Institutions who are members of QTInet

6. Configuration of AARNet

The costings indicated above are based on the following configuration of AARNet. Each member site is requested to note the configuration information for their site and advise the AVCC as soon as possible (and before the 15th January) if there are errors or inaccuracies in this configuration.

6.1 Configuration of the International Links

The University of Melbourne has entered into a contract with OTC for the provision of a satellite-based 64K data circuit from the University to the University of Hawaii (the U.S. component of the link is funded by NASA in support of their program communications requirements within Australia). The University of Melbourne is currently holding discussions with OTC in order to convert this satellite channel to a cable-based 64K channel over ANZCAN.

From November 1989 AARNet has undertaken to pay the costs associated with this contract, and has indicated to the University of Melbourne that AARNet would wish to transfer the OTC contract to the AVCC during 1990.

At this stage the 1990 budget includes the costs associated with this 64K circuit. It is noted that the capacity on this circuit is estimated to be adequate only for a further 6 - 12 months, and that while the AARNet forward estimates include a 128K bandwidth circuit in 1992, additional funding in 1991 (and possibly for the later part of 1990) from both AARNet and NASA may be required to maintain the link at a capacity equal to user requirements.

In addition to this permanent link, funding is also included to cover the costs of additional international X.25 calls. These calls are used in support of e-mail transfer to reach parts of Europe and Asia for Australian e-mail. They are also used to ensure a continued e-mail service to Australia when the U.S. circuit is temporarily down.

6.2 Configuration of the Australian Backbone Network

The backbone network is that used to interconnect each Regional hub to form a single backbone network. The configuration of this component of AARNet is the installation of Telecom 48K DDS circuits from each of Adelaide, Perth, Darwin, Brisbane, Sydney, Canberra and Hobart to a central hub in Melbourne. These circuits are to be installed in late March 1990.

In July 1990 two additional circuits will be installed using the Telecom 2M Megalink service: a Melbourne - Canberra link, replacing the existing 48K DDS link in July, and a Sydney - Canberra 2M link replacing the 48K Sydney - Melbourne link.

In March 1991 it is intended to replace all of the 48K circuits with equivalent 64K ISDN circuits, and also provide a dynamic dial-up digital ISDN facility to provide backup support in the event of link or node failure.

Additionally the requirements for extension of the 2M link with a Sydney - Brisbane will be evaluated in response to usage requirements on the lower speed circuit.

A map of the initial configuration (April 1990) is shown in Figure 6-1 below.

Figure 6-1: April 1990 Configuration of the AARNet Backbone Network

6.3 Configuration of the AARNet Regional Hubs and Tail Links

In the following configuration schedule each member institution is configured with a single link from AARNet to the major campusof the institution. In those situations where the institution has multiple campus locations, it is the institution's responsibility to link these locations together as part of the local area network. Such a local area network may well include additional facilities, such as voice (or perhaps video) channels within a circuit switched configuration. While AARNet is pleased to offer advice on the configuration of such extended institutional networks, it remains the responsibility of the member institution to provide such internal connectivity.

There are 8 regional hubs configured within the network, located in the capital city of each State. The equipment configuration of these hubs are as indicated in the schedules below:

6.3.1 AARNet National Hub

This hub is to be physically located within the University of Melbourne. The configuration of the hub is:

cisco router:

AGS/2	router chassis
CSC-4T	4 x high speed serial lines
CSC-1E2T	1 x Ethernet adaptor, 2 x high speed serial lines
CSC-4S	4 x mid speed serial lines

Proteon router:

P4100	1 x Ethernet adaptor, 1 x mid speed serial line

2 x Ethernet transceivers, AUI cables
7 x Telecom 48K DDS modems (Perth, Adelaide, Darwin, Brisbane, Sydney, Canberra, Hobart)
1 x Scitec Saturn 10 modem (2M link to Canberra termination)

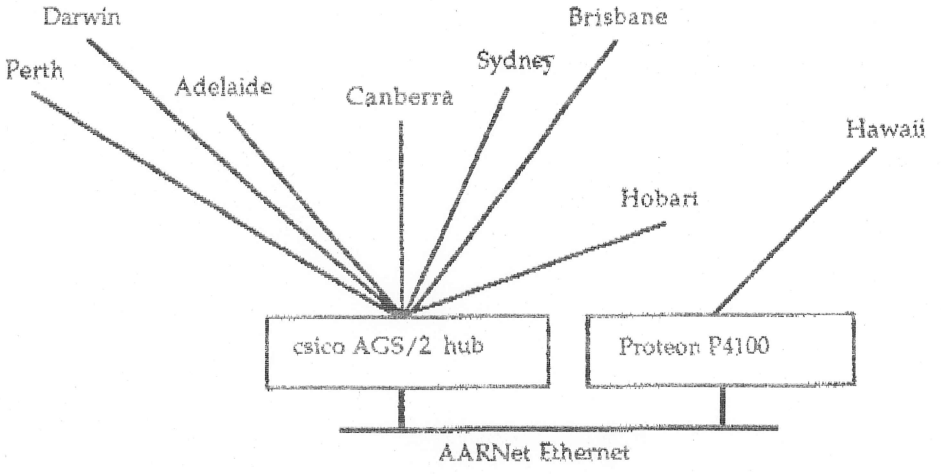


Figure 6-2 Configuration of the AARNet National Hub

6.3.2 Victorian Institutions

The configuration for Victoria is indicated in Figure 6-3 below:

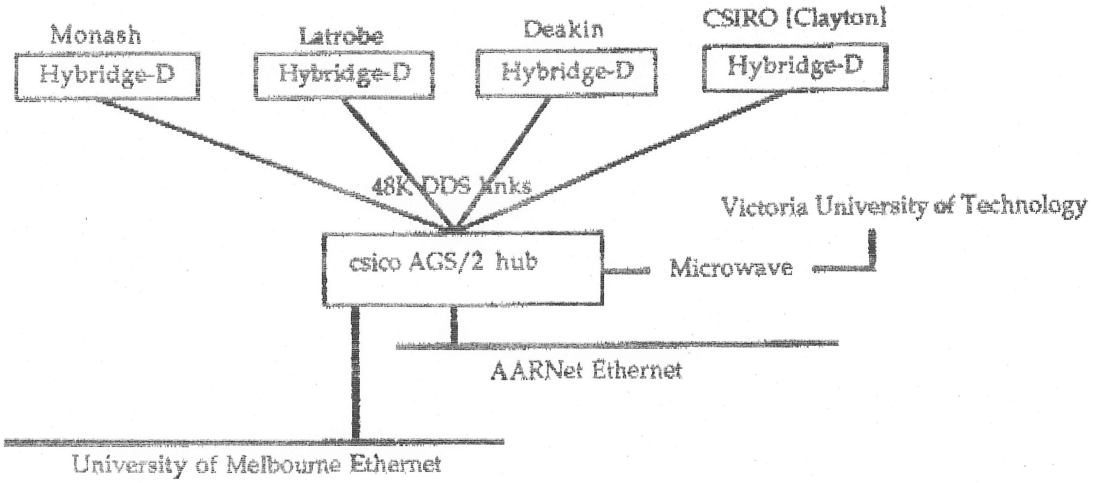


Figure 6-3 AARNet Victorian configuration

6.3.2.1 Victorian Regional Hub - University of Melbourne

This hub is to be physically located within the University of Melbourne. The configuration of the hub is:

cisco Router:

AGS/2	router chassis
CSC-2E2T	2 x Ethernet adaptors, 2 x high speed serial lines
CSC-2E2T	2 x Ethernet adaptors, 2 x high speed serial lines

Ethernet transceiver, AUI cable

4 x Telecom 48K DDS modems (Monash, Latrobe, Deakin, CSIRO (Clayton))

6.3.2.2 Monash University

The 1990 configuration for Monash University is a 48K DDS link direct to the Victorian Regional Hub at the University of Melbourne:

cisco Hybridge-D	Ethernet, high speed serial line
Ethernet transceiver, AUI cable	
48K DDS modem	(to Regional hub at UoM)

* It is noted that alternative configurations are being investigated for this connection using a 2Mb service interconnecting CSIRO (Clayton), CSIRO (Port Melbourne) and the Victorian Regional Hub - notification is required before orders are completed in mid-January if an alternate arrangement is proposed.

6.3.2.3 Victoria University of Technology

The 1990 configuration uses the planned Ethernet microwave link from the city campus of VUT to the Regional Hub within the University of Melbourne. The microwave link is intended to be terminated in the regional hub unit using one of the Ethernet adaptors.

6.3.2.4 Latrobe University

The 1990 configuration for Latrobe University is a 48K DDS link direct to the Victorian Regional Hub at the University of Melbourne:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoM)

6.3.2.5 Deakin University

The 1990 configuration for Deakin University is a 48K DDS link direct to the Victorian Regional Hub at the University of Melbourne:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoM)

6.3.2.6 CSIRO [Clayton]

The 1990 configuration for CSIRO [Clayton] is a 48K DDS link direct to the Victorian Regional Hub at the University of Melbourne:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoM)

* It is noted that alternative configurations are being investigated for this connection using a 2Mb service interconnecting CSIRO [Clayton], Monash, CSIRO [Port Melbourne] and the Victorian Regional Hub - notification is required before orders are completed in mid-January if an alternate arrangement is proposed.

*Additionally notification is required from CSIRO for the connection of the CSIRO [Port Melbourne] facility (managed by Leading Edge) and the required configuration at that site, and notification is required if the connection arrangements relating to CSIRO [DIT, Barry St, Carlton] are to be altered from their current configuration.

6.3.3 Australian Capital Territory Institutions

The configuration for ACT is indicated in Figure 6-4 below:

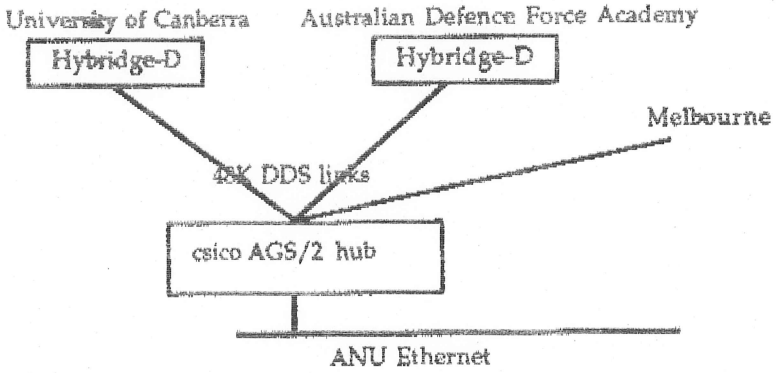


Figure 6-4 AARNet ACT configuration

6.3.3.1 ACT Regional Hub - Australian National University

This hub is to be physically located within the Australian National University. The configuration of the hub is:

cisco Router:
- AGS/2 router chassis
- CSC-1E2T 1 x Ethernet adaptor, 2 x high speed serial lines
- CSC-4T 4 x high speed serial lines

Ethernet transceiver, AUI cable
3 x Telecom 48K DDS modem (Melbourne, Univ of Canberra, ADFA)
2 x Scitec Saturn 10 modems (2M link to Melbourne and Sydney terminations)

6.3.3.2 The University of Canberra

The 1990 configuration for the University of Canberra is a 48K DDS link direct to the ACT Regional Hub at the Australian National University:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at ANU)

6.3.3.3 Australian Defence Force Academy

The 1990 configuration for ADFA is a 48K DDS link direct to the ACT Regional Hub at the Australian National University:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at ANU)

6.3.4 New South Wales Institutions

The configuration for NSW is indicated in Figure 6-5 below:

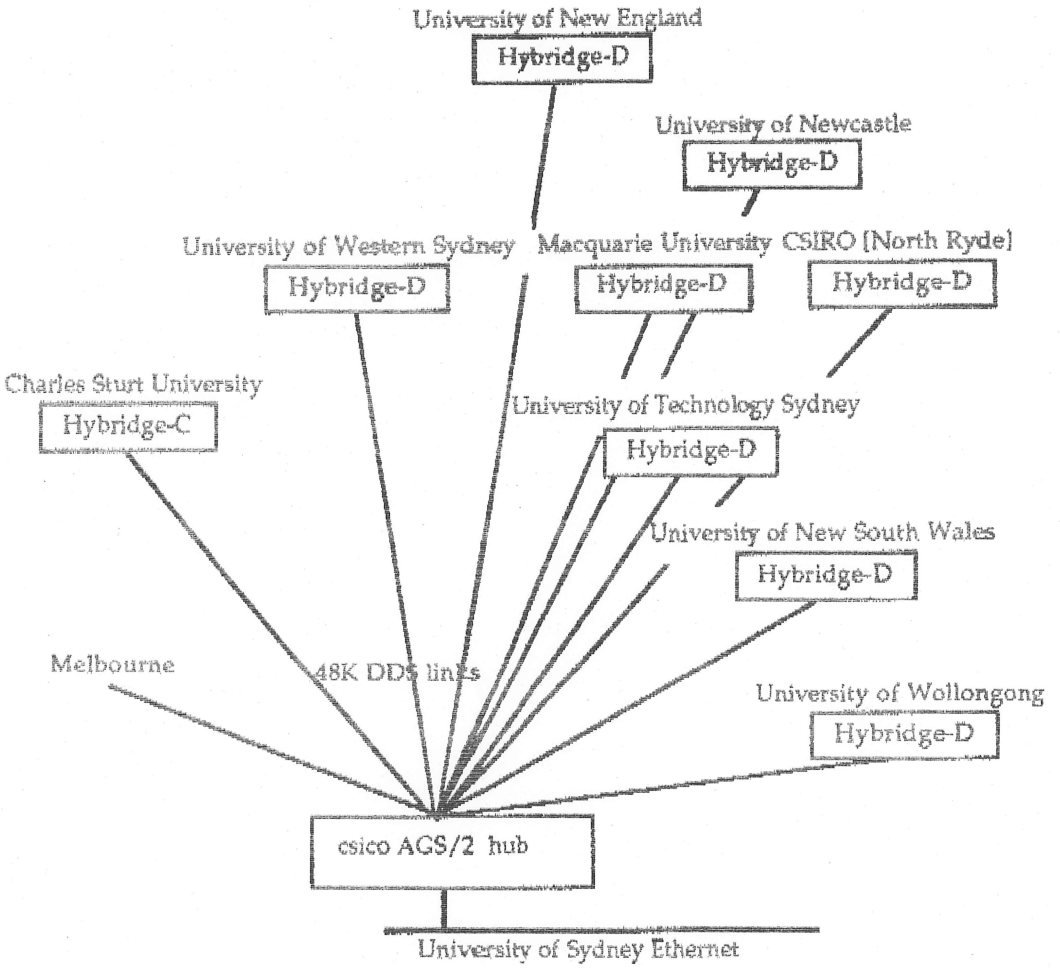


Figure 6-5 AARNet NSW configuration

6.3.4.1 NSW Regional Hub - The University of Sydney

This hub is to be physically located within the University of Sydney. The configuration of the hub is:

cisco Router:

AGS/2	router chassis
CSC-1E2T	1 x Ethernet adaptor, 2 x high speed serial lines
CSC-4T	4 x high speed serial lines
CSC-4T	4 x high speed serial lines

Ethernet transceiver, AUI cable

10 x Telecom 48K DDS modem (Melbourne, UNSW, UTS, UoNewcastle, Macquarie, UWS, UoWollongong, UNE, CSU, CSIRO [North Ryde])

1 x Scitec Saturn 10 modem (2M link to Melbourne termination)

6.3.4.2 University of New South Wales

The 1990 configuration for UNSW is a 48K DDS link direct to the NSW Regional Hub at the University of Sydney:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoS)

*** It is noted that UNSW are currently evaluating alternative proposals for connectivity to the University of Sydney. It UNSW wish to proceed with an initial microwave configuration then AARNet should be notified by 15 January.**

6.3.4.3 University of Technology, Sydney

The 1990 configuration for UTS is a 48K DDS link direct to the NSW Regional Hub at the University of Sydney:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoS)

6.3.4.4 Macquarie University

The 1990 configuration for MU is a 48K DDS link direct to the NSW Regional Hub at the University of Sydney:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoS)

6.3.4.5 University of Newcastle

The 1990 configuration for the University of Newcastle is a 48K DDS link direct to the NSW Regional Hub at the University of Sydney:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoS)

6.3.4.6 University of Western Sydney

The 1990 configuration for UWS is a 48K DDS link direct to the NSW Regional Hub at the University of Sydney:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoS)

*** Could UWS please advise AARNet of the location of the termination of this link.**

6.3.4.7 University of Wollongong

The 1990 configuration for the University of Wollongong is a 48K DDS link direct to the NSW Regional Hub at the University of Sydney:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoS)

6.3.4.8 University of New England

The 1990 configuration for UNE is a 48K DDS link from Armidale direct to the NSW Regional Hub at the University of Sydney:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoS)

6.3.4.9 Charles Sturt University

The 1990 configuration for CSU is a 48K DDS link from the Bathurst campus direct to the NSW Regional Hub at the University of Sydney:

cisco Hybridge-C Ethernet, mid speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoS)

6.3.4.10 CSIRO [North Rydel

The 1990 configuration for CSIRO [North Ryde] is a 48K DDS link direct to the NSW Regional Hub at the University of Sydney:

cisco Router:
AGS/2 router chassis
CSC-1E1T 1 x Ethernet adaptor, 1 x high speed serial line
CSC-4T 4 x high speed serial lines
Ethernet transceiver, AUI cable
1 x Telecom 48K DDS modem (UoSydney)

* This equipment forms the hub of a NSW CSIRO star configuration, and additional cards will be required within this cisco unit to connect other CSIRO sites to this CSIRO hub.

6.3.5 South Australian Institutions

The configuration for SA is indicated in Figure 6-6 below:

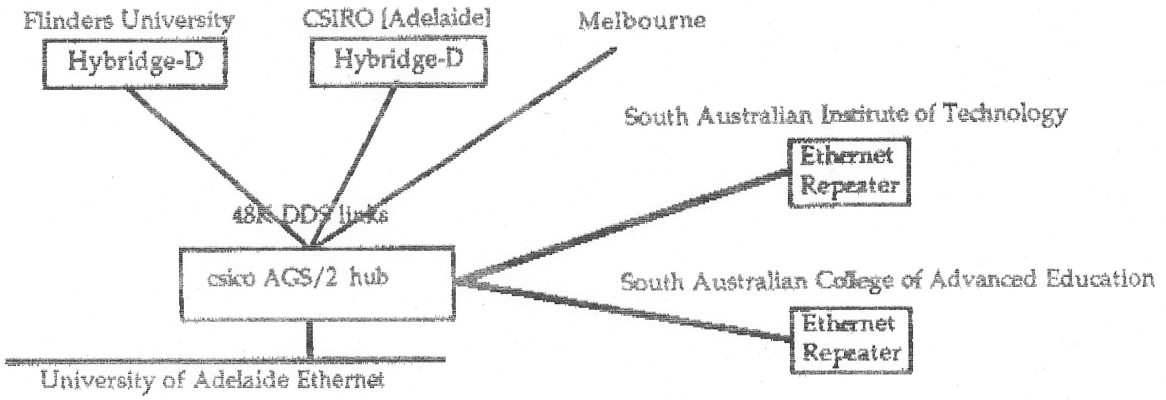


Figure 6-6 AARNet SA configuration

6.3.5.1 SA Regional Hub - University of Adelaide

The SA Regional hub is to be physically located within the University of Adelaide. The configuration of the hub is:

cisco Router:
- AGS/2 router chassis
- CSC-2E2T 2 x Ethernet adaptors, 2 x high speed serial lines
- CSC-1E2T 1 x Ethernet adaptor, 2 x high speed serial line

Ethernet transceiver, AUI cable
3 x Telecom 48K DDS modems (Melbourne, Flinders, CSIRO [Adelaide])

6.3.5.2 Flinders University

The 1990 configuration for Flinders is a 48K DDS link direct to the SA Regional Hub at the University of Adelaide:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoA)

6.3.5.3 South Australian Institute of Technology

The 1990 configuration for SAIT is an optical fibre cable run from the city campus of SAIT to the regional hub at the UoA. The required configuration is:

Fibre optic cable with 2 x Fibre optic transceivers
Ethernet repeater (for SAIT fibre end)

6.3.5.4 South Australian College of Advanced Education

The 1990 configuration for SACAE is an optical fibre cable run from the city campus of SACAE to the regional hub at the UoA. The required configuration is:

Fibre optic cable with 2 x Fibre optic transceivers
Ethernet repeater (for SACAE fibre end)

6.3.5.5 CSIRO [Adelaide]

The 1990 configuration for CSIRO [Adelaide] is a 48K DDS link direct to the SA Regional Hub at the University of Adelaide:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at UoA)

6.3.6 Western Australian Institutions

The configuration for WA is indicated in Figure 6-7 below:

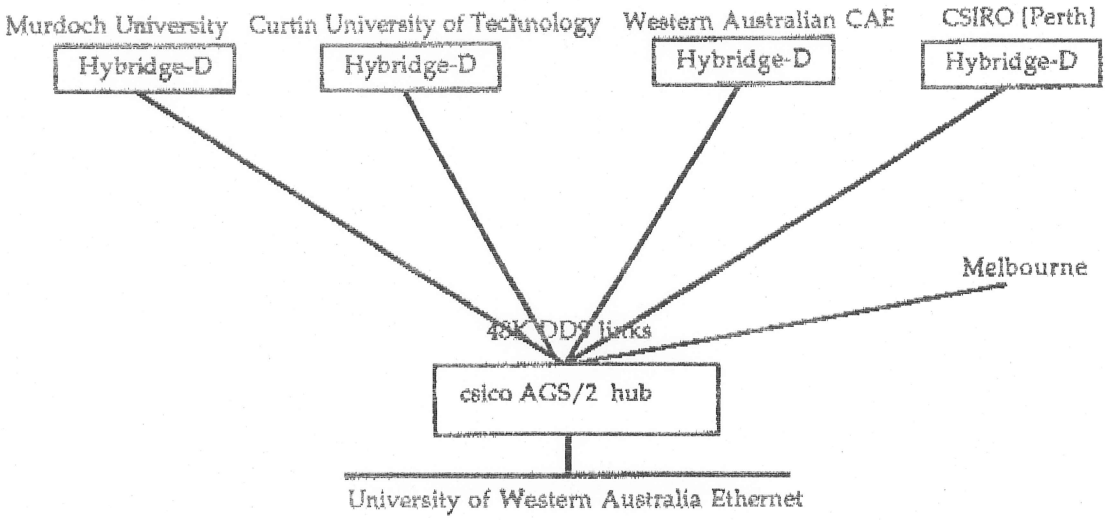


Figure 6-7 AARNet WA configuration

6.3.6.1 WA Regional Hub - The University of Western Australia

This hub is to be physically located within the West Australia Regional Computer Centre (WARCC). The configuration of the hub is:

cisco Router:
- AGS/2 router chassis
- CSC-1E2T 1 x Ethernet adaptor, 2 x high speed serial lines
- CSC-4T 4 x high speed serial lines

Ethernet transceiver, AUI cable
5 x Telecom 48K DDS modem (Melbourne, Murdoch, Curtin, WACAE, CSIRO [Perth])

6.3.6.2 Murdoch University

The 1990 configuration for Murdoch is a 48K DDS link direct to the WA Regional Hub at WARCC:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at WARCC)

6.3.6.3 Curtin University of Technology

The 1990 configuration for Murdoch is a 48K DDS link direct to the WA Regional Hub at WARCC:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at WARCC)

6.3.6.4 Western Australian College of Advanced Education

The 1990 configuration for Murdoch is a 48K DDS link direct to the WA Regional Hub at WARCC from the Perth campus of WACAE:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at WARCC)

6.3.6.5 CSIRO [Perth]

The 1990 configuration for CSIRO [Perth] is a 48K DDS link direct to the WA Regional Hub at WARCC from the Perth campus of WACAE:

cisco Hybridge-D Ethernet, high speed serial line
Ethernet transceiver, AUI cable
48K DDS modem (to Regional hub at WARCC)

6.3.7 Tasmanian Institutions

The configuration for Tasmania is indicated in Figure 6-8 below:

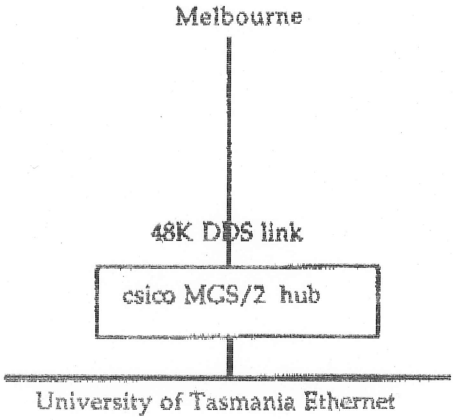


Figure 6-8 AARNet Tasmania configuration

6.3.9.1 Tas Regional Hub - University of Tasmania

This hub is to be physically located within the University of Tasmania. The configuration of the hub is:

cisco Router:
MGS/2 router chassis
CSC-1E2S 1 x Ethernet adaptor, 2 x mid speed serial lines
Ethernet transceiver, AUI cable
1 x Telecom 48K DDS modem (Melbourne)

6.3.8 Queensland Institutions

The configuration for Queensland is indicated in Figure 6-9 below:

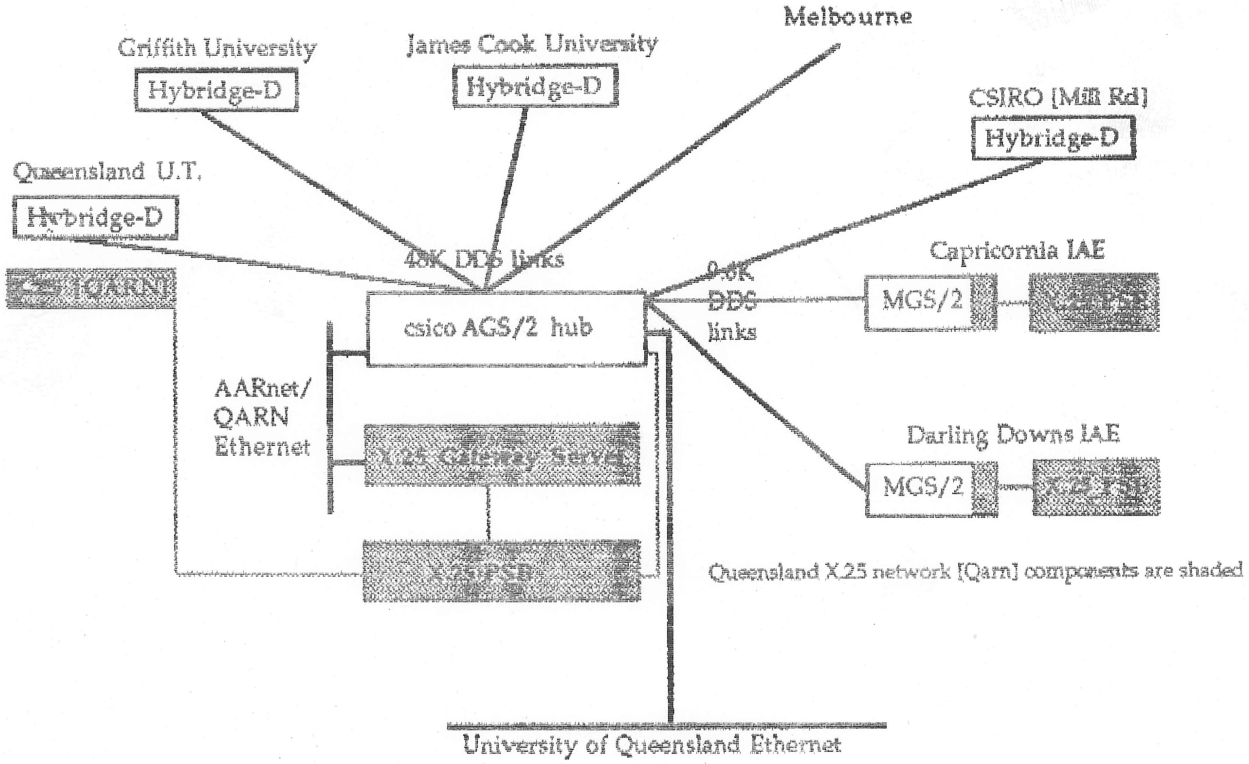


Figure 6-9 AARNet Queensland configuration

6.3.8.1 Old Regional Hub - The University of Queensland

The Regional hub is to be physically located within the University of Queensland, within the Prentice Computer Centre. The configuration of the hub is:

cisco Router:

AGS/2	router chassis, plus X.25 software
CSC-2E2T	2 x Ethernet adaptors, 2 x high speed serial lines
CSC-4T	4 x high speed serial lines
CSC-4T	4 x high speed serial lines

Ethernet transceiver, AUI cable

4 x Telecom 48K DDS modem	(Melbourne, JCU, QUT, Griffith)
2 x Telecom 9.6K DDS modems	(CIAE, DDIAE)

Additionally in support of QTInet, a Packet Switch server will be installed to provide gateway services between QTInet and AARNet. Equipment requirements will be investigated in February 1989 for this application.

6.3.8.2 Griffith University

Griffith University is already linked to Prentice Computer Centre (UoQ) via a 2M Megalink service. This configuration proposed the switching of the existing 56K DECnet link to a multi-protocol link with cisco link termination equipment on both ends of the link. No allowance has been made for any modem equipment. It has been assumed that the 56K circuit is terminated with V.35 line terminators at both ends.

cisco Hybridge-D	1 x Ethernet adaptor, 1 x high speed serial line

6.3.8.3 James Cook University of North Queensland

The 1990 configuration for JCU is a 48K DDS link direct to the Queensland Regional Hub at the University of Queensland:

cisco Hybridge-D	Ethernet, high speed serial line
Ethernet transceiver, AUI cable	
48K DDS modem	(to Regional hub at UoQ)

6.3.8.4 Queensland University of Technology

The 1990 configuration for QUT is a 48K DDS link direct to the Queensland Regional Hub at the University of Queensland:

cisco Hybridge-D	Ethernet, high speed serial line
Ethernet transceiver, AUI cable	
48K DDS modem	(to Regional hub at UoQ)

The current QTInet link will also be maintained as a parallel X.25 service to this site.

6.3.8.5 Capricornia Institute of Advanced Education

The 1990 configuration for CIAE is a 9.6K DDS link direct to the Queensland Regional Hub at the University of Queensland:

MGS/2	cisco chassis, plus X.25 software
CSC-1E2S	1 x Ethernet adaptor, 2 x mid speed serial interfaces
Ethernet transceiver, AUI cable	
Local X.25 serial port	
9.6K DDS modem	(to Regional hub at UoQ)

6.3.8.6 Darling Downs Institute of Advanced Education

The 1990 configuration for DDIAE is a 9.6K DDS link direct to the Queensland Regional Hub at the University of Queensland:

MGS/2	cisco chassis, plus X.25 software
CSC-1E2S	1 x Ethernet adaptor, 2 x mid speed serial interfaces
Ethernet transceiver, AUI cable	
Local X.25 serial port	
9.6K DDS modem	(to Regional hub at UoQ)

6.3.8.7 CSIRO [Mill Road]

The 1990 configuration for CSIRO [Mill Road] is a 9.6K DMS link direct to the Queensland Regional Hub at the University of Queensland:

cisco Hybridge-D	Ethernet, high speed serial line
Ethernet transceiver, AUI cable	
9.6K DMS modem	(to Regional hub at UoQ)

6.3.9 Northern Territory Institutions

The configuration for the Northern Territory is indicated in Figure 6-10 below:

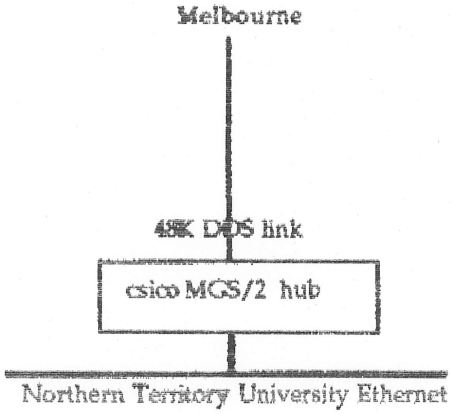


Figure 6-10 AARNet Northern Territory configuration

6.3.9.1 NT Regional Hub - Northern Territory University

This hub is to be physically located within the Northern Territory University. The configuration of the hub is:

cisco Router:
MGS/2 router chassis
CSC-1E1S 1 x Ethernet adaptor, 1 x mid speed serial line
Ethernet transceiver, AUI cable
1 x Telecom 48K DDS modem (Melbourne)

AARNet

7. Implementation Schedule for AARNet

The current schedule of events leading to the implementation of AARNet in the first half of 1990 is planned as follows:

December 1989	Completion of contracts for the sale and maintenance of AARNet equipment
January 1990	Preparation and release of first schedule of equipment and data transmission orders to be lodged with Ungermann Bass (supplier of cisco equipment) and Telecom Australia. It is anticipated that all preparatory confirmation of the configurations can be completed by 17 January, allowing the orders to be released on the 22nd January.
February 1990	Evaluation and ordering of additional equipment, including SLIP servers in the regional hub sites, and network monitoring and management equipment.
March 1990	With the 2 month lead time on the ordering of equipment and data links, the equipment is anticipated to be available for site installation during March and early April. The equipment and link installation for AARNet will take an anticipated 4 - 5 weeks.
April 1990	Testing of the network configuration. It is anticipated that AARNet will be commissioned into production on 23 April. At this stage AARNet will be supporting a national TCP/IP network
May 1990	Commissioning of the national DECnet network.
June/July 1990	Testing and tuning activities. Installation of additional links to service affiliate members of AARNet.
July 1990	Commissioning of the 2M link between Melbourne, Canberra and Sydney.

8. Actions required at each AARNet site

To date activity has concentrated on the technical aspects of the implementation of the network itself. It is anticipated that the requirements of service provision will require a broader level involvement in the AARNet activities including the involvement of various activity sectors (such as the libraries) and the involvement of the user services provision sectors within each institution.

8.1 AARNet Contact Officer

For each site it is requested that a contact officer be nominated to AARNet (including name, position, phone, fax, e-mail and address). This officer will be the first point of contact for operational matters (including AARNet and Telecom network trouble shooting).

This contact officer will also receive AARNet material, such as AARNet Newsletters, intended for local distribution within the site. The site is responsible for the local dissemination of this material, as the distribution will be via the network to each contact officer (such material will be distributed in both plain text and postscript formats to enable local printing if desired).

8.2 AARNet Equipment Installation - Site Preparation

Regarding the initial installation of the AARNet equipment, each site will be required to make available equipment rack space within the computer systems equipment room. The requirement for all sites (with the exception of the regional hubs) is for two shelves within the rack to accommodate the cisco unit and a Telecom modem, together with 2 x 240V, 10A power outlets. The local Ethernet network cable should also be positioned within 2m of this rack to allow tapping of the cable for the equipment. Each site is responsible for notifying AARNet by the end of January as to the transceiver requirements (10Base5 or 10BaseT), and will be responsible for arranging for the physical tapping of the local Ethernet cable and installation of the transceiver.

The installation consists of the Telecom installation of a modem (DDS NTU), and the installation of a cisco unit. The cisco is connected to the modem via a V.35 plug cable termination at each end. The cisco is attached to the local Ethernet via a standard AUI cable and transceiver. All cabling is provided by AARNet. During installation a terminal with a standard DB25 plug termination is required to plug into the cisco (this terminal is only required during installation - it may be removed following successful installation, but note that troubleshooting activities may require a console terminal to be connected to the unit).

The site contact officer will be contacted at a later stage to indicate whether the site requires AARNet to perform the physical installation of the cisco unit.

8.3 Provision of User Services

In the area of the provision of users services and assistance each site will be responsible for the delivery of such services. Assistance in providing such services will be maintained by peer expertise provided by the news service (in the newsgroup aus.comms), and via AARNet distributed material.

9. An Overview of the AARNet Network Technology.

This section provides some background material relating to the choice of multi-protocol router/bridge units (brouters) for AARNet.

A common approach to implementing a Wide Area Network (WAN) is to nominate a single network protocol suite, and construct a network using those tools that are supported within the protocol suite- in this way WANs may be implemented using a single protocol, such as IP, DECnet, X.25, SNA, and so on. The interface between the WAN and each site is implemented normally by the use of a router[1] interface between the Local Area Network (LAN) and the WAN, as shown in Figure 9-1.

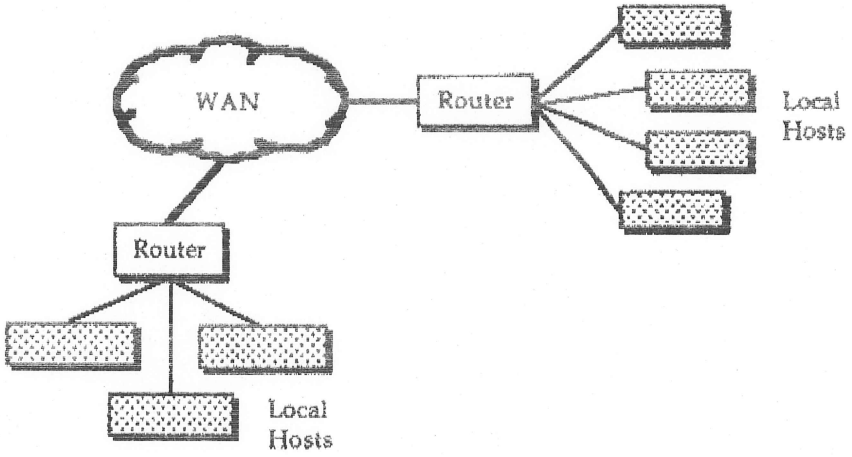


Figure 9-1 Protocol-specific WAN using Router Interfaces

The benefits of this approach to networking in the WAN environment is that the WAN uses the network layer of the supported protocol to route traffic through the network, and with such protocol-specific network packet routing assistance the WAN can support relatively large and complex topologies without catastrophic degradation of network performance.

However there are real limitations imposed by support for a single network protocol - commonly each member of a networking community uses a number of different network protocols to support the total computing environment. To address this heterogenous requirement of networks an alternative approach is to construct a WAN which does not contain protocol-specific elements. In attempting to avoid protocol sensitivity within the WAN a basic approach is to remove routing support from the WAN, and construct a WAN using the equivalent of Layer 2 (Data Link) protocol-independant elements.

Using this approach the point of attachment of the WAN into each site is not a particular interface unit, but instead is the Local Network itself, and the function of the WAN is to provide a transparent bridge between all connected LANs. In this situation the requirements of the WAN are to deliver data packets from a source LAN to the correct destination LAN. An additional constraint is imposed on the WAN architecture due to the

[1] A Router is an implementation of the lowest 3 layers of the OSI reference model protocol stack. Layer 3, of the Network layer, is aware of the topology of the network, and makes local (and in some protocols, global) decisions about where locally generated traffic should be switched within the WAN to ensure ultimate delivery to the destination address.

fact that LAN architectures are generally datagram-based, rather than circuit-switched, so the WAN must be capable of providing a point of attachment which is based on datagram switching.

This approach, as indicated in Figure 9-2, effectively allows the WAN to carry all the protocols which are supported on the member LANs, overcoming the single protocol limitation of the previous approach.

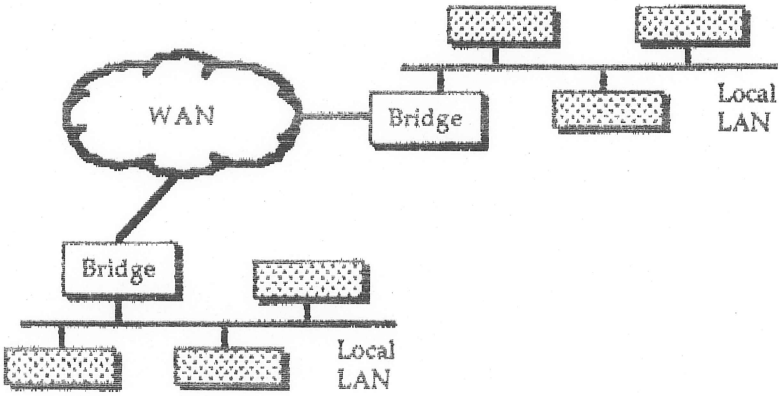


Figure 9-2 A Bridged WAN

The Bridge LAN/WAN interfaces provide LAN extension by acting as anonymous units which inspect all packets on one LAN and forward all relevant packets into the WAN for ultimate delivery without end-to-end alteration of packet contents. The forwarding function is controlled by a "learning" function in the bridge, allowing the bridge to know the relative positions of LAN devices by inspecting the source address in every packet. Packets are only passed through the bridge for forwarding if the destination address location is unknown, or known not to be located on the received side, or the packet is a broadcast packet.

While this approach works relatively well in small WAN configurations, problems arise with large bridged WANs due to a number of factors;

Every bridge must learn the relative positions of all devices on all LANs attached to the WAN. When the size of this device address table exceeds the capacity of the bridge units the bridge will start to forward packets across the WAN unnecessarily, causing performance degradation.

There is no common standard for routing information (as there is no routing information required within a LAN per se because of the common network bus architecture of a LAN). For complex WAN topologies which may include routing problems such as loops and equal cost multiple paths, the bridges must intercommunicate using a commonly understood routing protocol to determine the optimal path between any 2 device addresses, so the lack of a common standard is a significant concern.

Many protocols in common use on LANs make assumption about LAN delivery characteristics (low datagram delivery delay, low broadcast overhead, high packet delivery reliability). Because the bridges are not visible to the devices attached to the LAN, and also as the internal intra-WAN links are typically of lower bandwidth than the LANs, some protocols will fail intermittently when used across such a Bridged WAN, due to either timer expiry, or in ability to recover after a burst of packet loss.

The third approach is to combine both of the above WAN techniques into a multi-protocol Bridge/Router (or Brouter). Such units are similar to Bridges, in that they are capable of Data Link Layer packet delivery

between LANs, but also are similar to the protocol specific routers such that they are equipped with protocol-specific routing functionality for a number of supported networking protocols.

Such units are connected to the LAN, and similar to a bridging function, monitor all LAN datagrams. Within the brouter the protocol identification field of the datagram is inspected, and the packet is passed to the protocol-specific routing process within the brouter. The decision to forward the packet to the WAN is therefore based on protocol-specific network layer information contained within the datagram. If the protocol is not configured within the brouter at the network layer, the datagram is passed to the layer 2 bridge process (if configured), allowing the brouter to perform an address-based forwarding decision for the datagram.

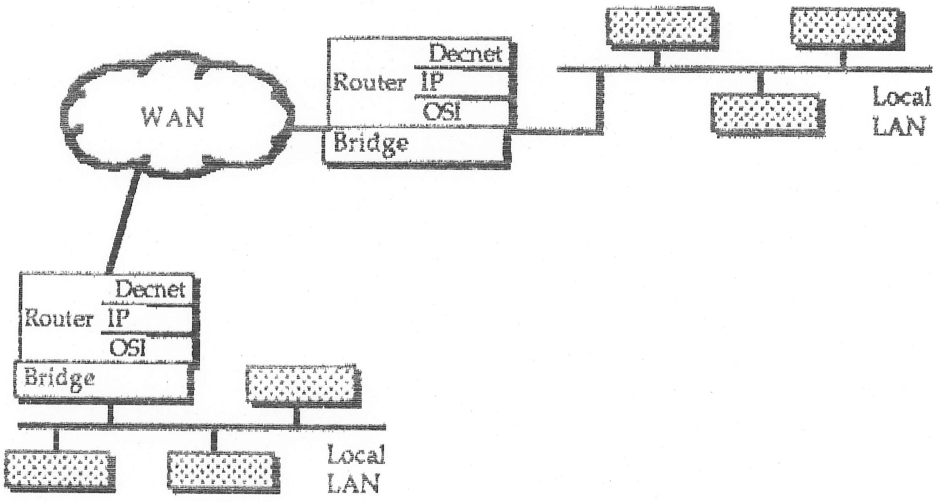


Figure 9-3 A WAN using Bridge / Routing Interfaces

This results in a number of virtual networks coexisting on a single network infrastructure. The WAN itself is constructed on a single set of physical links all running the same Data Link protocol layer. On each of the Layer 2 links a set of simultaneous Network Layer virtual links are constructed. With reference to Figure 9-3 the resultant WAN is simultaneously an IP, DECnet and ISO OSI WAN when viewed at the Network Layer, and also may be viewed as a Layer 2 Bridged WAN for an additional set of nominated protocols.

As well as being capable of implementing a range of network protocols, the architecture of brouters have considerable flexibility in the data transmission interfaces. The units are typically implemented using an open bus architecture, configured with a cpu, and a number of physical interfaces. This allows configurations ranging from a single Ethernet and serial line interface to configurations supporting multiple Ethernet, token ring, X.25 and low and high speed serial line interfaces within a single chassis. Current directions include support of the emerging FDDI LAN technology as well as the emerging 802.6 Metropolitan Area Network (MAN) standards. Some brouter units also support G.706 framing on serial lines to enable integrated voice and data circuits, effectively allowing PABX and brouter equipment to share a single physical link.

As much of the functionality of these units is based within software technology these units are extremely flexible in terms of responding to the evolutionary trends in both the underlying data transmission technologies and the developments of networking protocols.

10. AARNet Supported Networking Protocols

The engineering design of AARNet includes the support for a number of different networking protocols to coexist within a single infrastructure of physical communications links. The initial phase of the network will support three protocol stacks; TCP/IP, DECnet™ Phase IV and ISO OSI (using CLNS Layer 3).

Attention will also be given to the appropriate mechanisms to support access into the international Packet Switched Networks using the X.25 interface protocol once the initial phase of the network has been set into production.

The protocol which will be supported immediately is the Internet protocol suite, commonly referred to as TCP/IP. The development of this protocol suite was sponsored by the U.S. Defense Advanced Research Projects Agency over the last decade in response to the engineering requirements for the support of the national research network within the United States. TCP/IP is now the major networking protocol in use within the U.S. academic and research networking environment. The wide availability, low cost, and suitability of the protocols in both the local and wide area network domains and adoption of these protocols, not only within the Unix™ environment, but also on systems ranging from supercomputers to personal computers have led to the widespread use of this networking protocol throughout the Australian academic and research environment. TCP/IP is the only commonly available vendor-independent protocol which is in use today.

DECnet™ is a vendor-specific protocol developed by Digital Equipment Corporation. Due to the widespread use of Digital's VAX/VMS™ range of computing equipment within the Australian academic and research environment, the DECnet protocols are in common use within Australia. Unlike TCP/IP some of the characteristics of DECnet present some problems in terms of creating large DECnet networks: the relatively small addressing space, and the lack of a central address registration authority have resulted in most sites using the same addresses within each LAN. As a prerequisite to a national DECnet within AARNet those DECnet hosts to be placed on the national network will require re-addressing. To allow this to happen within a reasonable timeframe, it is not intended to provide DECnet support within the AARNet router units until May/June 1990.

The International Standards Organisation has sponsored the introduction of the set of networking standards termed the Open Systems Interconnect as being an international vendor-independent standard to allow the interconnection of systems using a common network protocol. Much effort has been invested into the applications within the standard suite, and the standards concerning mail delivery (X.400) and directory services (X.500) are in use within Australia today. The same cannot be said of the lower layers of the protocol stack, and as this stage parts of the protocol concerning routers have not reached standard status to date. Concerning these lower layers of the protocol stack, there are two alternatives in the implementation of the network layer: using a connection oriented circuit model, or using a connectionless datagram delivery model. The nominated profile for AARNet is based on the Connectionless Network layer services (CLNS). As these lower layers of the ISO OSI protocol stack are not in common use within Australia at present, there is no committed date for ISO OSI support over AARNet. Under these conditions it is anticipated at this stage that support for a national ISO OSI network service may be required in 12 months time.

In conjunction with these comments regarding ISO OSI, Digital have announced that the next release of DECnet, Phase V, will use OSI protocols as the network layer protocol. At this point in time it is understood that this implementation of OSI within DECnet evidently contains a number of critical non-standard components layered on top of the standard OSI protocols (support for multiple end-addresses for VAXClusters, the use of an introduced congestion avoidance bit within both the end-systems and intermediate-systems are examples). This effectively implies that the transition to a DECnet Phase V network by AARNet will not be viable until early 1991.

AARNet

11. Site Requirements - Internet Protocol Support

In supporting the Internet protocol within AARNet the following arrangements have been made in conjunction with the U.S. Internet. Australia is part of the Autonomous Region (AR) which includes all current Pacific links from Hawaii (Japan, New Zealand). The AR extends within the U.S. to the NASA Ames Research Centre, which controls the FEBA[1] West site. Within this AR the routing arrangements with respect to the link into Hawaii are that only the default route is supplied into Australia. All connected network numbers are passed back via Hawaii to FEBA West.

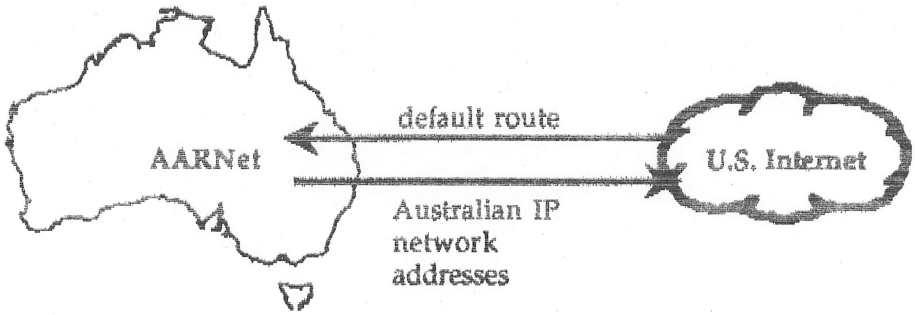
With respect to each AARNet site comparable arrangements will be installed: the AARNet cisco router will be configured to broadcast a default route into the local area network (using the RIP protocol), and will pick up the local network numbers listening to RIP.

These arrangements are indicated in Figure 10-1 (overleaf).

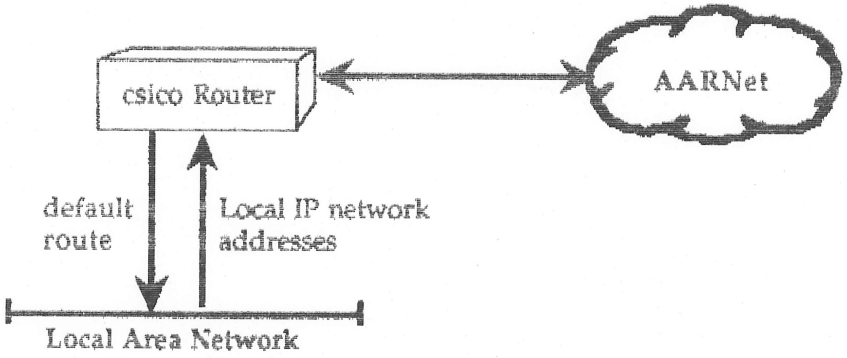
The requirements relating to this level of IP support are:

- All Internet network numbers in use must be numbers which have been allocated by the Network Information Centre at SRI. If this is not the case you are requested to obtain an allocated network number before you may be connected. (Note that the NIC will no longer be prepared to allocate Class C network addresses to sites already allocated a Class B number.)
- AARNet must be advised of all IP network numbers in use on the local site. This requirement is to ensure that the U.S. Internet is aware of the connected status of these network numbers. If you have already advised Robert Elz at Melbourne then this is not required.
- AARNet should be advised by 1 March 1990 of the IP address of the Ethernet interface of the cisco unit, and any applicable IP subnet mask if being used.
- AARNet must be advised if the site is not using RIP to communicate gateway addresses within the site.
- IP systems should preferably be configured with an application (routed) which listens to periodic RIP broadcasts. If this is not possible, static routing, referring to the AARNet cisco address as the default route, is also acceptable.

[1] FEBA (Forward Edge Battle Area) is the name given to the interconnection point of the various backbone Internet networks used within the U.S. Internet. FEBA West supports the interconnection of the National Science Foundation network (NSFnet), the NASA Science Internet (NSN), the Department of Energy's Energy Science Network (ESnet), and remnants of the DARPA Internet, as well as the U.S. unclassified military network (MILNET).



National IP network routes



Local Network IP routes

Figure 11-1 IP Routing Structure

The next layer of IP support is that of the Internet name service, DNS. This application is used to allow the network to provide the mappings between internet addresses and domain-based names (previously performed by each host supporting a local copy of the hosts file). The name scheme used within AARNet is based on the ISO country code for Australia as the top level domain, ".au".

Because of the current requirements of the ACSnet software, most sites are currently registered within the subdomain ".oz.au.". At the 1987 Australian Networkshop a number of other subdomains were also allocated, including ".csiro.au.", ".edu.au.", ".com.au." and ".gov.au.". It is not the intention to continue to register additional names within the ".au." domain". AARNet member sites would normally remain registered within the ".oz.au." domain in conformance with their ACSnet address, or may elect to register within the ".edu.au." domain.

The requirements of each site with respect to name serving are:

- Each site must either maintain DNS entries for their IP host names or arrange for another site to do so. This name server must minimally hold both name to number and the reverse mappings. AARNet should be informed of the address and namespace of these servers to ensure that the appropriate upper layer DNS server references this data.
- The reverse number mapping (in-addr.arpa. domain) must be registered with the U.S. Network Information Centre.
- Each site is responsible for arranging an authorized secondary name server within Australia for the name server data. AARNet will assist in providing an international secondary name server.

More information on DNS is available from AARNet, or specific queries should be posted to the newsgroup "aus.comms".

12. Site Requirements - DECNet Phase IV support

In supporting DECnet Phase IV, it should be noted that the associated protocols used by Digital for related applications will not be supported across AARNet. In particular the maintenance protocols such as MOP and other management protocol stacks are not supported. Also not supported over AARNet is Digital's LAT protocol (terminal server protocol), as the timers associated with this protocol are not reliably tuneable into the WAN environment.

The major issue associated with DECnet support is the requirement for a single address space. To date each site has used DECnet address starting with area 1, and in many cases has elected to use a number of area numbers within each site. To allow these systems to be interconnected over DECnet requires each participating site to renumber their DECnet systems to within a National address allocation scheme.

The address scheme to be used within AARNet is:

- Areas 1 through 10 are to be "private" areas. Systems configured within these area numbers will not participate directly in the national DECnet, and will not be directly accessible from remote DECnet sites.

- Areas 11 through 60 are to be allocated to AARNet sites on the basis of a single area number allocated to each registering site. Huw Davies (LaTrobe) is coordinating this area number registration. You may request a site-specific DECnet area number by contacting AARNet in the first instance, and it is recommended that all sites do so by March 1990. Note that Area 24 is "reserved for future use", and initially area numbers 51 through 60 are reserved for New Zealand until notification is received from New Zealand on their intended arrangements with DECnet.

- Areas 61 through 63 are allocated to AARNet for DECnet routing.

The requirements for support of DECnet connectivity to the site are:

- An AARNet allocated DECnet area number in the range 11 - 60.

- All local area routers in the range 1 - 10 have "maxarea" parameter set to to 60 or below.

- The 6 character DECnet node names should be registered with AARNet to ensure a uniform namespace across the national DECnet.

At this stage it is anticipated that DECnet will be activated on a national basis some 3 - 4 weeks after the initial setup of AARNet and TCP/IP. There is be no direct DECnet connectivity in the NASA SPAN DECnet/Department of Energy HEP DECnet in the first instance, but area 24 will be reserved to allow possible address mappings for individual node connectivity.

11. Additional Information

While the previous two sections provide information relating to the lower layers of the network protocol stack within the context of AARNet, they do not address the areas of application support. In particular areas of electronic mail delivery mechanisms, news distribution, remote access management, and similar have not been addressed within this document.

It is intended to provide information on these components of AARNet in late January in the next AARNet document to be circulated. The issues to be covered in this forthcoming document include:

- Electronic mail delivery mechanisms. This area includes information of the sendmail application of the Internet protocol suite (RFC822 mail), and the necessary mechanisms required to support direct use of the IP mailers within AARNet.

  Additionally the DECnet mail support mechanisms for DECnet mail (MAIL-11) across AARNet.

  It also includes the plans in support of mail application gateways, including IP mail, MAIL-11, X.400, MHS mail (the ACSnet mail delivery mechanisms) and other mail systems, as well as detailing the arrangements in support of international mail.

- USENET News delivery, indicating the preferred approach of migration to the Internet Network News Transfer Protocol as the news delivery agent through AARNet, and the preferred topology of NEWS distribution.

- A more comprehensive examination of the Internet Distributed Name Server (DNS) application, and the local requirements for DNS support. Included in this is a wider area of directory support services within AARNet.

- The continued role of MHS within AARNet (the applications used within the ACSnet network), including interface/gateway arrangements between AARNet and ACSnet networks.

- Security considerations, including the security paper tabled at the December AARNet Steering Committee meeting.

- The organisational structure proposed for the operational management of AARNet.

- Support structures for the delivery of services to users.

- Network monitoring arrangements, including the ability for each member site to account/monitor the site-based usage of AARNet through the Management Information Base (MIB) maintained within the local AARNet router interface.

Suggestions of other areas which require further examination are of course welcome, and in the first instance should be addressed to the AARNet Network Technical Manager.

AARNet

The Australian Academic and Research Network December 1989

ATTACHMENT A
WORKING DRAFT PAPER : 11/12/89 AARNet Management

Attachment A: AARNet Management (Working Draft Paper)

COVER NOTE

This paper was prepared for the AARNet Steering Committee meeting, held on 14 December at the University of Sydney. The paper is included in this document for the purposes of providing information to all AARNet members as to the general intentions with respect to the future governance of AARNet.

Please note that due to the time constraints in releasing this document immediately following this meeting, the views expressed within the AARNet Steering Committee with respect to this document have NOT been included in this draft. It is intended to pass this paper, along with the views of the AARNet Steering Committee to a Working Group for further consideration over January, and then to pass the resultant paper to AVCC, ACDP and CSIRO for consideration.

If you have comments regarding the matters covered within this paper, please forward them to the AARNet Network Technical Manager in the first instance (before 23 January), and they will be passed to the Working Group for consideration.