ISN 96031

ESTABLISHMENT OF AN INTERNET BACKBONE WITHIN COSTA RICA

Final Report to the Agency for International Development Grant Project Agreement No. 936-5600.00

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(July 1995)

I. Introduction

In November 1991 a research proposal "Establishment of an INTERNET Backbone within Costa Rica" was presented to the Agency for International Development within the framework of the Science and Technology Cooperation Program (PSTC). The proposal was presented jointly by the University of Costa Rica (UCR), the Instituto Tecnológico de Costa Rica (ITCR), the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), the University of Wisconsin-Madison (UW) and the University of Delaware [1]. The original purpose of the project presented to AID was to establish a digital backbone to provide interconnectivity and state of the art communication between scientists at major universities, research laboratories, industries and corporations in the country with their counterparts worldwide. As a first phase of development of the project the connection of three institutions, UCR, ITCR and CATIE was considered, as well as the interconnection to the INTERNET by upgrading the capacity of the BITNET link used at that time for the BITNET node at the University of Costa Rica. Overall, the project was presented as a pioneer development in communication, internetwork technology and information infrastructure. The implementation of the project was regarded as a major opportunity to access advanced information and communication systems, allowing a large community to share resources at a minimal cost, while at the same time establishing an important national network [2] which eventually would be extended to the region.

II. Project Implementation

A grant for the sum of $ 149,945 to provide support for the establishment of a national research network was officially awarded to the University of Costa Rica on May 14, 1992 with the signature of a Grant Project Agreement by the Ministry of Science and Technology, Dr. Orlando Morales, the President of the University of Costa Rica, Dr. Luis Garita, the Vice-President for Research at UCR, Dr. Primo Luis Chavarría, the Vice-President of the Republic of Costa Rica, Lic. Arnoldo López Echandi, the Ambassador of the United States of America, Luis Guinot, Jr. and Ronald F. Venezia, Director of the Agency for International Development. The estimated project completion date was set to May, 31, 1994.

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a) Project Implementation Letters and UW/UCR Project Agreement

One of the most important aspects for the implementation of the project was the acquisition of high technology equipment sold in the US. The process for the acquisition was quite difficult due to the internal administrative hindering of the standard financial management at the University of Costa Rica coupled with the complex AID procedures. A flexible mechanism to administer the funds using the University of Costa Rica Foundation for Research Development (FUNDEVI) was unfortunately not accepted by AID. As a way out for the crucial overseas purchasing, the University of Wisconsin proposed to finance in advance all necessary equipment as well as provide funds in advance for paying US consultants for the project. Under this agreement, the project would benefit from the important discount prices allowed to the University of Wisconsin for the procurement of equipment. To proceed with the latter arrangement, an agreement: **"Project Implementation Agreement Between the University of Costa Rica, and the University of Wisconsin System"** was worked out with University of Wisconsin officials and submitted to University of Costa Rica authorities on July 3, 1992.

In practice, the project started in late September with the approval by AID of the Project Implementation Letter (PIL) No. 1 and 2 where the initial project budget is modified to maximize the use of funds (see Table 1) and the Host Country contribution is included (basically partial contribution by UCR to salaries for the people involved in the project). In PIL 2 the dollar expenditure of the project is specified in reference to the agreement between the University of Wisconsin (UW) and the University of Costa Rica (UCR). Under this agreement, payments would be made directly to UW by AID. In fact, many difficulties had still to be solved before an agreement was reached between UCR and the University of Wisconsin authorities for the Project Implementation Agreement which was necessary for equipment procurement. The final agreement was finally signed on October 26, 1992 following PIL No. 3 on October 21, stating that the draft of the agreement between UW and UCR was approved by AID.

PIL No. 4 dated December 15, 1992 outlined the procedures through which UCR would obtain advances of funds necessary for the local expenditures of the project. The project was extended by AID for an extra period of three months from its initial termination date May 31, 1994. It was not possible however, to obtain an additional extension beyond September 1, 1994 from AID authorities which would have resulted on better utilization of the grant funds (see the details below) and a better consolidation of the project.

b) Project Budget and Utilization

The $ 149,945 budget for the two year life span of the AID grant is shown in **Table 1**. Let us describe briefly the contents of the budget:

1) <u>Training</u> ($11,550) - Basic training was contemplated for 4 University of Wisconsin experts on the basis of 15 days each (two months total).

2) Consultant ($5,775) - Two University of Wisconsin experts for a period of 15 days each (total one month).

3) International Travel US to CR. ($14,310) - This item was calculated on the basis of 6 round trip airline tickets for the US experts and corresponding per diem expenses for 6 person per 12 days each.

4) Overhead ($8,225) - Computed on a 26% basis for the University of Wisconsin for their consultants, training salaries and international travel.

5) Equipment ($59,797) - For high capacity CISCO routers modems and transceivers. A 5 % margin was included for transportation and incidental costs.

6) International Travel CR to US ($4,935) - For 2 round trip airline tickets for UCR personnel plus corresponding per diem expenses for two persons per 15 days (total one month).

7) Local Salaries ($18,665) - Local salaries where computed on the basis of a quarter time for a local administrative assistant, and two local engineers over a period of two years.

8) Materials and supplies ($310) - Basic office supplies.

9) Local Travel ($1,618) - Car rental and travel per diem for site visits with US experts.

10) Other Direct Costs ($18,760) - Rental and installation of digital inter-city links as well as contribution to upgrade the satellite link to the US.

11) Audit ($6,000) - AID requirement.

The actual use of the budget could be summarized as follows:

Items 1 to 4: For circumstantial reasons the visit of University of Wisconsin experts was delayed on various occasions. Meanwhile, the project, whose actual implementation is described below, acquired it's own dynamic process with a very rapid development and consolidation. Due in part to necessity, the local personnel in charge of the project turned themselves in real experts in a matter of weeks, solving whatever problem was left with their colleagues abroad using the same Internet as a powerful instrument. The visit of US experts never took place and items No. 1 to 4 totaling $39,860 were not used from the AID grant. Unfortunately, it was not possible to obtain an additional grace period from AID after September 1, 1994 either to have the visit of US experts to collaborate on more advanced networking or engineering aspects, or to transfer those funds to item 5 to obtain badly needed additional equipment.

Item 5: The equipment for the project consisted on a high capacity AGS/4 router to serve as point of presence (PoP) in San Pedro, two MGS/4 routers (one serving as PoP in the Province of Cartago and other as gateway for UCR), one IGS/R router as gateway for CATIE and a series 3000 (latter changed for a series 4000) as gateway for ITCR. The equipment included also a battery of band base modems and transceivers. The actual final cost of the equipment covered by AID totaled $ 57,727.

Item 6: International travel funds from Costa Rica to the US, including airline tickets and per diem costs, were managed directly by AID. A first trip to the US by the Project P.I. was carried out on July 1992 for a visit to the Computer Science Department at the University of Wisconsin (UW), the National Science Foundation (NSF) and the Organization of American States (OAS) in Washington D.C. The trip to Wisconsin was important to discuss with UW computer scientists and engineers having great experience in internetworking technologies, running their campus network as well as the State of Wisconsin Academic Network WISCNet. The visit was also very useful to identify crucial equipment and components. Key contacts for this trip were Larry Landweber (Vice President of the Internet Society) and Robert D. Bremel of the University of Wisconsin, Steve Goldstein, Program Director of Interagency and International Networking at NSF and Saul Hahn, Coordinator of the Hemisphere-Wide Inter-University Scientific and Technological Information Network at OAS. Travel funds also covered per diem and lodging expenses of main local engineer assigned to the project for a two week intensive training at CISCO in Menlo Park, California, in August 1993, as well as a trip of the P.I. to a CISCO Workshop Training in Chicago in June 1992.

Item 7: Local salaries were administered under UCR Restricted Fund procedures according to PIL 4. Additional funds were required for this item to cover unanticipated extra social charges for the local salaries.

Item 8: Funds for materials and supplies were transferred to items 7 and 10.

Item 9: Funds for local travel were transferred to items 7 and 10.

Item 10: Grant funds for installation and rental of local and international links were administered under UCR Restricted Fund procedures according to PIL 4. Paymaent was done directly by UCR to Radiográfica Costarricensa S.A. (RACSA).

Item 11: Audit is still under way.

c) Actual Project Implementation

On January 26, 1993 twelve nodes from the Network Research Unit, the Computer Center, the Physics Department and the Geology Department at the University of Costa Rica were connected to the Internet [3] using a 64 Kbps satellite link form Panamsat and a CISCO IGS/R router on loan from the University of Wisconsin. The interconnection with

the US was carried out using a Point-of-Presence established by NSF at Panamsat facilities in Homestead, Florida.

Two months latter, in March 1993, the routing and communication equipment purchased by UW for the AID project is taken out of customs and transferred to the Network Research Unit at UCR. A scale model of the backbone called "backbone on a table" [4] becomes a testing ground to study different routing protocols. Few days latter the routing equipment is consigned to its final destination at the PTT (RACSA/ICE) locations. The Instituto Tecnologico de Costa Rica is connected to CRNet.

Under the sponsorship c. the Ministry of Science and Technology, the University of Costa Rica and the National Academy of Sciences of Costa Rica, CRNet is formally established as the institution responsible for the administration of the Internet in the country in the academic and research sectors. The role of CRNet is defined as follows:

"*To promote collaboration and information exchange between participating institutions, allowing unrestricted access to advanced information and communication at the national, regional and international level, by interconnecting existing networks with the leading worldwide research networks*".

Founding members of CRNet are:

- Universidad de Costa Rica (UCR)
- Insituto Tecnológico de Costa Rica (ITCR)
- Universidad Estatal a Distancia (UNED)
- Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICIT)
- Fundación Omar Dengo (FOD)
- Instituto Nacional de Biodiversidad (INBIO)
- Instituto Centroamericano de Administración de Empresas (INCAE)
- Instituto Interamericano de Cooperación para la Agricultura (IICA)
- Escuela de Agricultura de la Región Tropical Húmeda (EARTH)
- Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)
- Universidad Nacional (UNA)
- Asamblea Legislativa de la República

An important grant from OAS Project REDHUCyT allows to increase the capacity of CRNet routing equipment and links. The Omar Dengo Foundation and the Fundación Nacional de la Universidad de Heredia contribute also with routing equipment which is installed in RACSA/San José and RACSA/Heredia to facilitate the interconnection of new institutions. CRNet network topology in July 1994 is shown in Figure 1. Present network topology is found in the WEB [5]. The number of connected nodes to CRNet grew from January 1993 to December 1993 from 12 to 250. This number was doubled to 500 in July 1994 and doubled again to 1000 in December 1994. The actual number of nodes on the Internet in Costa Rica (and Central America) is updated on a regular basis on the WEB [6]. Present number of connected nodes per institution is included in ANNEX 1.

In February 1994, Nicaragua is connected to the Internet through CRNet, using a terrestrial microwave analog link between both countries. Few months latter Panama is also linked to CRNet connecting its major universities to the Internet. CRNet regional gateways are depicted in **Figure 2**.

III. End of Project Status

The following results were specified by AID to have been accomplished at the end of the project (August 31, 1994)

a) A computerized satellite INTERNET linkage between Costa Rica and the United States will be established and operational;

b) Five hundred (500) persons trained in the operation of the system; and

c) Three Costa Rica Institutions (UCR, CATIE, and ITCR) will share part of the cost of system operation.

Let us review the actual project output in respect to original expectations.

- A 64 Kbps satellite INTERNET link was established and operational since January 1993. The capacity is three fold the planned original capacity (19.2 Kbps) and was doubled to 128 Kbps during the first months of 1995.
- Seven hundred fifty (750) computer nodes were directly interconnected to the Internet at CRNet participating institutions at the project's end (1500 nodes at present including all sectors). The estimated number of users at project's end was between 3750 and 5250. Present number of users has grown to some 15.000 in all sectors. Particular effort was done during the project life to work with personnel responsible of computer centers at CRNet participating institutions in Internet technologies and its utilization, so people in various institutions would be trained in turn in the use of the system. The model chosen from the start of the project was highly decentralized and distributed in the physical and logical design, as well as in administrative and information aspects. In **Table 2** the number of nodes at project's end is compared with other countries in terms of country's GNP. This study from the Internet Society shows clearly the great impact of this project.
- An important project of this nature should be sustainable. In **ANNEX 2** communication costs and cost sharing between institutions are described during the period of March 1993 to June 1994. In 1993, 62 % of the total communication costs in funded by external sources (AID and OAS). During the first semester of 1994, the contribution from external funds is only 25 % (OAS) and at the end of the project (31 August 1994), communication costs are covered by local participating institutions.

IV Conclusion

This project is of major importance for the technological development of the country with a great impact in the area. With its origins in the academic sector, it has rapidly extended to the commercial and government sectors. The project has represented a great opportunity to learn and develop advanced communication instruments with enormous potential for the country education system and economy. Large scale internetwork technologies are introduced for the first time in the country. A state of the art high speed digital backbone is established among major universities and research centers in the country as well as with neighboring countries. The Internet is being extended to all areas of activity. Without access to the scientific potential of the world scientists in the region would remain isolated and unproductive. Without access to worldwide information, the country commerce and industry would remain at disadvantage on an era of increasing globalization.

Acknowledgments

To the University of Costa Rica, the Ministry of Science and Technology (in the past and the present administration), the Agency for International Development, OAS Project REDHUCyT, BID/CONICIT Project, the University of Wisconsin, Fundación Omar Dengo, Fundación Universidad Nacional de Heredia, Instituto Centroamericano de Administración de Empresas, Centro de Formación de Formadores, Organization for Tropical Studies, IBM Corporation, CISCO Corporation, RACSA/ICE engineers and to all my colleagues at CRNet, the University of Costa Rica and all participating institutions.

References

[1] G.F. de Téramond, C. Gutierrez, E. Mata, R. Oreamuno, L. H. Landweber, R.D. Bremel, Establishment of an Internet Backbone Within Costa Rica, Proposal to the Agency for International Development, San José, 1991.

[2] John Nasbit, Global Paradox, Avon Books, New York 1994, p. 54.

[3] The process for the interconnection of Costa Rica to worldwide research networks is described in: G.F. de Téramond, Interconexión de Costa Rica a las Grandes Redes de Investigación Bitnet e Internet, URL http://www.crnet.cr/documentos/interco.html (Junio 1995).

[4] URL http://www.crnet.cr/documentos/bb_box.jpg.

[5] URL http://www.crnet.cr/mapa.html.

[6] URL http://www.crnet.cr/nodos/nodos.html.

Tables

AID PSTC Grant Project Agreement		
1 Training (US)		11,550
2 Consultant (US)		5,775
3 International Travel (US to CR)		14,310
4 Overhead (US)		8,225
5 Equipment (US)		59,797
	Sub-Total US	99,657
6 International Travel (CR to US)		4,935
7 Local Salaries		18,665
8 Materials and Supplies		310
9 Local Travel		1,618
10 Other Dirt Costs		18,760
11 Audit		6,000
	Sub-Total CR	50,288
	TOTAL PROJECT	149,945

Table 1: Project Budget in US $ distributed over a 2 year period

Important Note: Expenditures under items 1, 2, 3 and 4 where not used during the life of the project. Expenditures 8 and 9 where transferred to 7 and 10.

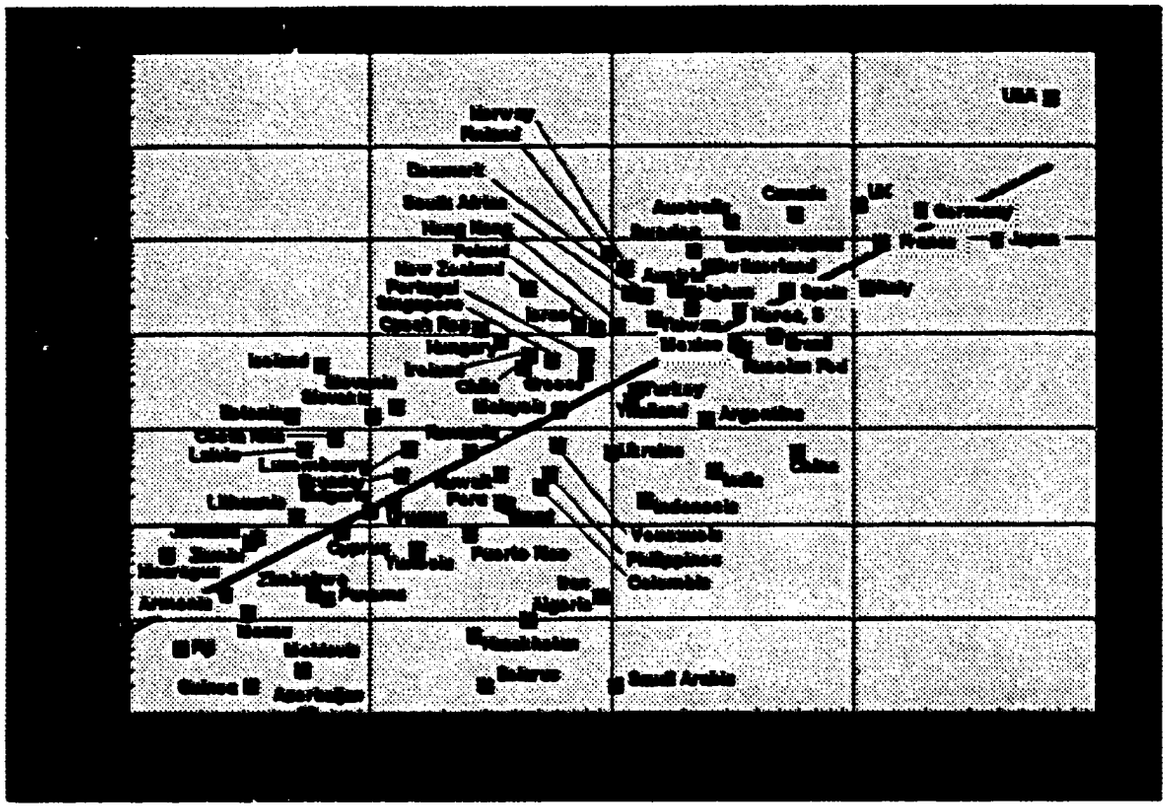


TABLE II: Country nodes per GNP (Source: Internet Society)

Figures

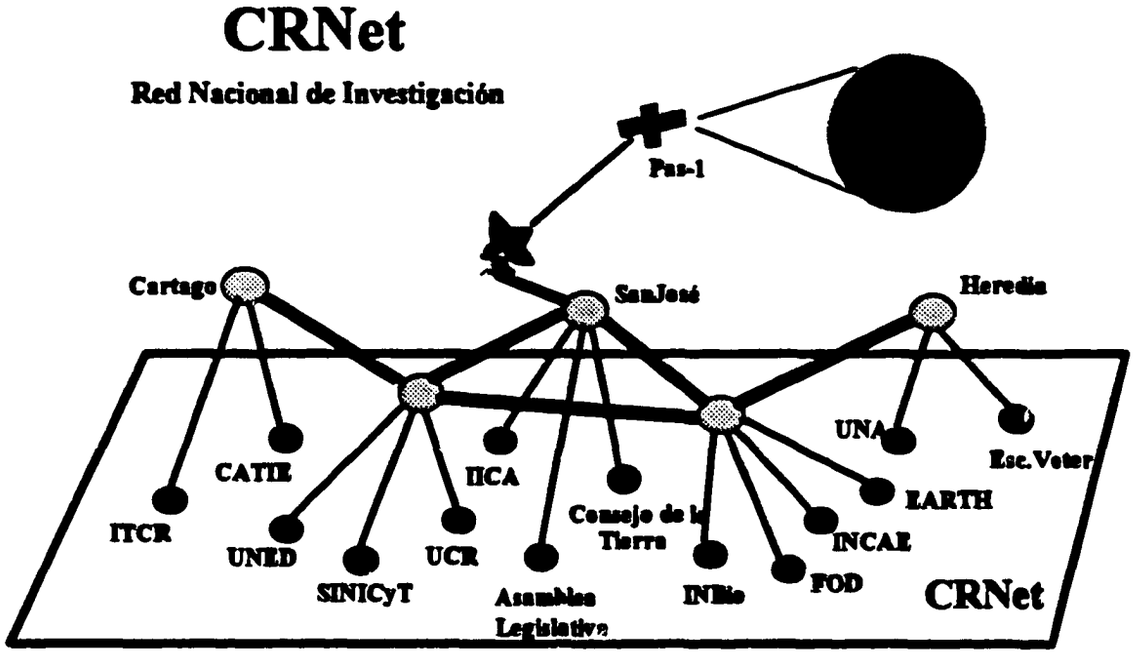


Figure 1. CRNet Network Topology (July 1994)

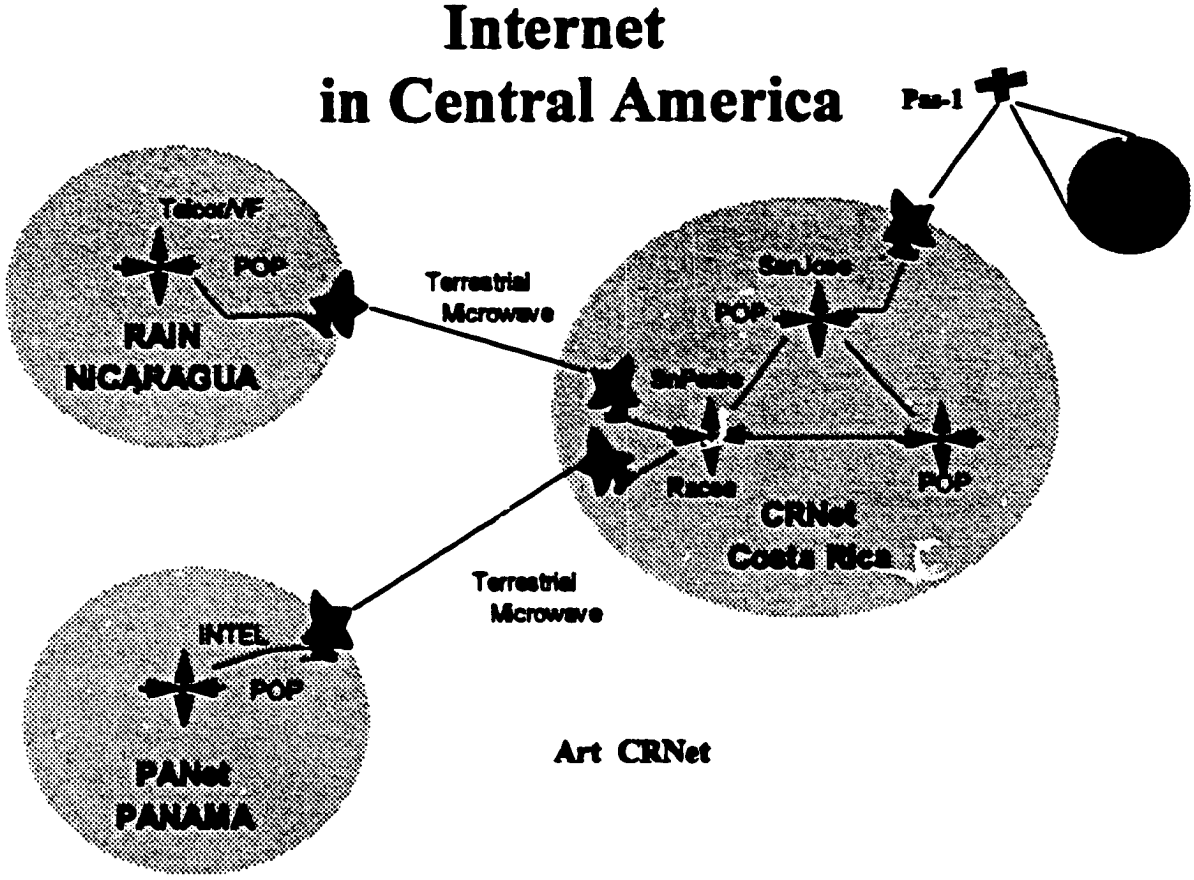


Figure 2. CRNet Regional Gateways

ANNEX 1

INTERNET DE COSTA RICA

Número de Nodos: 1452

El Salvador Guatemala

NODOS	SECTOR	DOMINIO
1	Dominio Superior	cr
1159	Sector Académico	ac.cr
		crnet.cr
169	Sector Comercial	co.cr
123	Sector Gobierno	go.cr

Lista Actualizada al 20 de junio de 1995

INTERNET DE COSTA RICA

SECTOR ACADEMICO [1118 Nodos]

NODOS	DOMINIO	HOME PAGE	INSTITUCION	WHO IS
3	anc.ac.cr		Academia Nacional de Ciencias	
184	catie.ac.cr		Centro Agronómico Tropical de Investigación y Enseñanza	
65	earth.ac.cr		Escuela de Agricultura de la Región Tropical Húmeda	
5	ecouncil.ac.cr		Consejo de la Tierra	
244	fod.ac.cr		Fundación Omar Dengo	
148	iica.ac.cr		Instituto Interamericano de Cooperación para la Agricultura	
76	inbio.ac.cr		Instituto Nacional de Biodiversidad	
60	incae.ac.cr		Instituto Centroamericano de Administración de Empresas	
66	itcr.ac.cr		Instituto Tecnológico de Costa Rica	
29	ots.ac.cr		Organización de Estudios Tropicales	
162	ucr.ac.cr		Universidad de Costa Rica	
1	ulacit.ac.cr		Universidad Latinoamericana de Ciencia y Tecnología	
65	ulatina.ac.cr		Universidad Latina de Costa Rica	
7	una.ac.cr		Universidad Nacional	
3	uned.ac.cr		Universidad Estatal a Distancia	

INTERNET DE COSTA RICA

SECTOR COMERCIAL [169 Nodos]

NODOS	DOMINIO	HOME PAGE	INSTITUCION
6	cool.co.cr		Inter@mérica
101	nacion.co.cr		Periódico La Nación
49	racsa.co.cr		Radiográfica Costarricense S.A.
13	ticonet.co.cr		Ticonet S.A.

INTERNET DE COSTA RICA

SECTOR GOBIERNO [123 Nodos]

NODOS	DOMINIO	HOME PAGE	INSTITUCION
4	aleg.go.cr		Asamblea Legislativa
4	casapres.go.cr		Casa Presidencial
21	conicit.go.cr		Consejo Nacional de Investigación Científica y Tecnológica
5	ice.go.cr		Instituto Costarricense de Electricidad
89	sinicyt.go.cr		Sistema Nacional de Información Científica y Tecnológica

[redacted]

ANNEX 2

COMMUNICATION COSTS

US $ 1993

	UP-LINK	DOWN-LINK	BACKBONE LINKS	PTT ROUTER SPACE	TOTAL/ MONTH
JANUARY					
FEBRUARY					
MARCH	2500	2500	300	100	5400
APRIL	2500	2500	300	100	5400
MAY	2500	2500	600	200	5800
JUNE	2500	2500	600	200	5800
JULY	2500	2500	600	200	5800
AUGUST	2500	2500	600	200	5800
SETEMBER	2500	2500	600	200	5800
OCTOBER	2500	2500	600	200	5800
NOVEMBER	2500	2500	600	300	5900
DECEMBER	2500	2500	600	300	5900
TOTAL 1993					57400

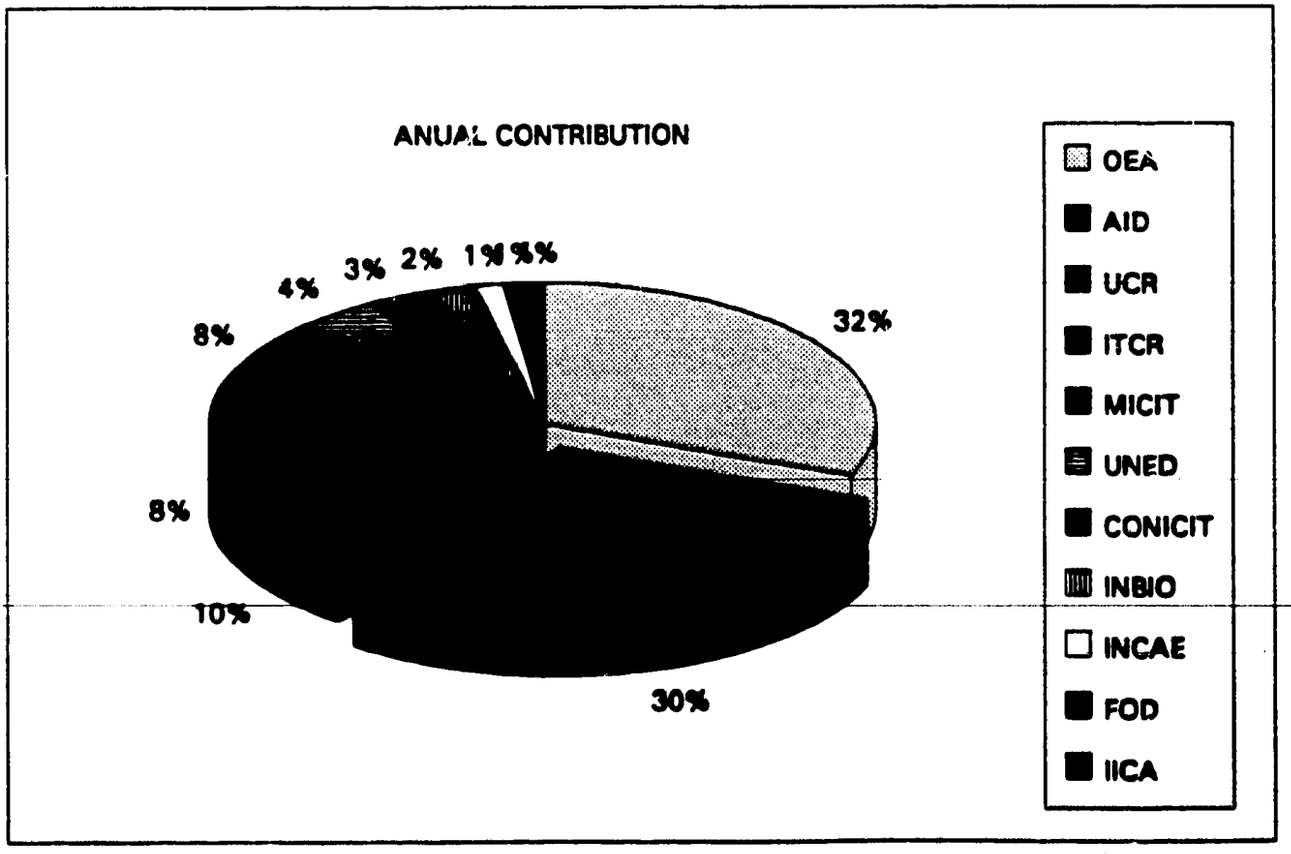
INSTALLATION COSTS

Installation space segment	1000
Installation local backbone links	600
TOTAL	1600

INSTALLATION COSTS COVERED BY AID PROJECT

COSTS SHARING BY PARTICIPATION INSTITUTION FOR 1993

	MONTHS	MONTHLY CONTRIBUTION	ANUAL CONTRIBUTION
OEA	12	1500	18000
AID	12	1400	16800
UCR	10	600	6000
ITCR	8	600	4800
MICIT			4500
UNED	6	400	2400
CONICIT	3	600	1800
INBIO	2	600	1200
INCAE	2	400	800
FOD	2	400	800
IICA	1/2	600	300
TOTAL 1993			**57400**



COMMUNICATION COSTS
FIRST SEMESTER 1994 ($ US)

MONTH	UP-LINK	DOWN-LINK	BACKBONE LINKS	PTT ROUTER SPACE	TOTAL/ MONTH
JANUARY	2500	2500	600	300	5900
FEBRUARY	2500	2500	600	300	5900
MARCH	2500	2500	600	300	5900
APRIL	2500	2500	600	300	5900
MAY	2500	2500	600	300	5900
JUNE	2500	2500	600	300	5900
TOTAL 1st SEMESTER					35400

CRNet

COSTS SHARING BY PARTICIPATION INSTITUTION

FIRST SEMESTER 1994

	MONTHS	MONTHLY CONTRIBUTION	SEMESTER CONTRIBUTION
UCR	6	600	3600
ITCR	6	600	3600
UNED	6	400	2400
CONICYT	6	600	3600
FOD	6	400	2400
INBio	6	600	3600
INCAE	6	400	2400
IICA	6	600	3600
EARTH	6	600	3600
ECOUNCIL	6	320	1920
SUBTOTAL			30720
OEA	**Contribution**		10000
TOTAL			40720