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# Electronic Networking in Africa

Advancing science and technology for development

## Workshop on Science and Technology Communication Networks in Africa

can Academy of Sciences/American Association for the Advancement of Sciences

A Summary Report

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## Workshop on Science and Technology Communication Networks in Africa

August 27-29, 1992
Nairobi, Kenya

The African Academy of Sciences/American Association for the Advancement of Science

A Summary Report

The Sub-Saharan Africa Program of the American Association for the Advancement of Science is grateful to the Carnegie Corporation of New York for supporting the Workshop on Science and Technology Communication Networks in Africa and the publication of this report.

# Electronic Networking in Africa

## *Advancing science and technology for development*

### Background

The decision to convene the African Academy of Sciences (AAS)/American Association for the Advancement of Science (AAAS) "Workshop on Science and Technology Communication Networks in Africa," held August 27-29, 1992, in Nairobi, was based on the recognition that undependable telephones, an unreliable postal system, vast distances, and expensive airfares all serve to isolate African scholars and hinder communications within Africa and overseas. These difficulties thwart their ability to conduct research, share data and results, keep abreast of current scholarship, and contribute to solving development problems faced by their countries. The advent of computer-based electronic networking has provided an enabling mechanism towards a solution to this predicament.

Electronic networking, which refers to any of several forms of information exchange between two or more computers through any of several methods of interconnection, is rapidly spreading throughout much of the world as a fast, reliable, and, in most applications, inexpensive form of communication. It is inexpensive because of its speed, and because it can use existing public phone lines as a medium. Multiple messages can be sent in a single phone call, lowering the cost still further, while error-correcting modems can ensure reliability of transmission.

The most common network application is electronic mail (e-mail), whereby messages originating from one computer can be sent via some medium to another computer or computers that are connected to a network and have an electronic address. The medium may be public phone lines, private dedicated lines, or a radio frequency. It is also possible to use electronic networks to transfer binary files between computers, and to "log on" to a remote computer in order, for instance, to search a database for information. These specialized functions are dependent upon the particular network protocol used, may not work between protocols, and can be quite expensive (particularly time "on-line" at long distance).

Other common applications include "bulletin board systems" (BBS), generally used for the posting and retrieval of information items, and "conferencing systems," which allow multiple users to post messages that are seen and responded to by other users, creating an electronic conversation. Both services are usually organized around some common theme or themes, include provisions for private e-mail messages, and may be contained within a single software package.

Electronic networking is an evolving phenomenon, and it has its drawbacks. For example, there are those who have concern about the privacy and security of their messages; although security-enhancing technologies exist, there are no absolutely impenetrable systems (one might add, however, that the same is true for all other forms of communication). Also, messages tend to be relatively informal — which is also often a benefit — but insufficient sensitivity to wording or etiquette in the absence of physical cues can lead to misunderstandings in the quick give and take, for instance, of an electronic conference "conversation." And relatively few people are accessible through networks as yet, particularly in Africa, giving rise to concerns that, rather than enhancing democracy and empowering individuals by decentralizing information access, computer networks may be creating information elites. There are also other political, economic, social, and technical challenges

in networking that vary in relative importance depending upon the part of the world one is considering (many of these that are relevant to the African context are highlighted below).

Such concerns are a caution against promoting computer networks as a technological panacea, yet the essential benefit of electronic networking — that it provides a powerful, rapid, and inexpensive way for communication to occur and for information to flow — unquestionably makes it a medium with extraordinary potential. In some cases networking supplements or enhances other forms of communication and makes the transfer of information faster and more convenient, and in other cases it actually fosters new communication, creating and strengthening communities of common interests and making possible exchanges of information that otherwise simply would not take place. For scientists, among others, electronic networking can now truly be called an essential tool.

Thus electronic networking, already integral to the normal conduct of science in the developed world, holds great promise for reducing the isolation of African scientists and engineers. To date, however, this technology has been only tenuously established within the African scientific community. There has generally been little institutional support, equipment may be difficult to obtain, maintain, and repair, overall familiarity with computers is relatively low, the need for training of users and technicians is great, and, although operating costs compare favorably with such alternatives as faxing, it has nevertheless proven a challenge to make e-mail self-sustaining in Africa, free from dependency on donor support.

### *Current Status of African Networking*

The community of electronic networkers in Africa is still relatively quite small; indeed, a few dedicated individuals have had great impact by virtue of their active roles in helping to establish projects, collect and distribute mail, improve and disseminate software, and train users. It is because of the pioneering efforts of such people that electronic networking has gained a foothold in Africa.

This kind of personal commitment describes the character of networking in Africa, and has resulted in the realization of the handful of pilot projects that are currently making a go of it on the continent. Projects such as NGONET, ESANET, CGNET, Healthnet, PADISNET, RIONET, and others have blazed the trail, achieving varying levels of success, as detailed in the text of the workshop papers, included in the full report. Among their successes can be counted the rising interest in African networking, which has been demonstrated by the number of inquiries received by AAAS and AAS, sessions dedicated to African issues at the most recent international meeting of the Internet Society (iNET'92) and the establishment of developing country representation on the Internet Society Board, and the proliferation of Africa-related electronic bulletin boards, mailing lists, and conferences among Africanists in the United States and elsewhere. These projects have also laid important groundwork that large-scale projects, such as the RINAF (Regional Informatics Network for Africa) proposal, can build on. The AAS/AAAS workshop itself happened in recognition of the fact that electronic networking in Africa has reached a certain critical juncture.

The purpose of the August workshop, which was attended by some 40 participants who represented a majority of existing noncommercial electronic networking initiatives in Africa and included a mix of technical experts and system users, was to review both positive and negative experiences with African scientific/academic networking and to address significant policy issues. These issues include: human resource and training needs related to all levels of networking activity; costs and sustainability issues; and regulatory issues, including government-mandated equipment procurement and licensing procedures. Although many of the issues raised were relevant to electronic networking in general, the focus of the meeting was on formulating recommendations to guide future actions of African universities and research institutes with respect to all aspects of participating in such networks, expediting the rationalization, coordination, and expansion of the existing array of networking projects. The workshop was also designed to facilitate productive donor-recipient relationships in this area.

The workshop was supported by a grant to AAAS from the Carnegie Corporation of New York as part of its science and technology information (STI) initiatives, under the Program for Strengthening Human Resources in Developing Countries. A proceedings volume, including the text of the prepared papers, is being published jointly by AAS and AAAS.

## Workshop Themes and Recommendations

Through the presentation of case studies and the ensuing discussions during the workshop, certain key, instructive commonalities and differences among the various networking experiences began to emerge and coalesce into "themes." Here they have been organized into five categories: Human Resources Development and Training Issues; Costs, Marketing, and Sustainability; Leadership and Participation; Hardware and Software; and Next Steps. The lines between the categories often blur; for example, costs and sustainability are largely determined by the user base, which is itself variously determined by the quality and availability of training, satisfactory hardware and software, effective leadership, and so on. Nevertheless, the five categories represent coherent issue areas that lend themselves to policy solutions, at least in part.

### *I. Human Resources Development and Training Issues*

If any single issue at the workshop rose to the forefront as primary, it was the need to expand and improve training efforts to encourage use of electronic networks and enhance local human resource bases in Africa. A thriving user base was seen as essential in generating sustainability for a network, as was establishing and maintaining local technical expertise to wean a project from reliance on external benefactors. Thus the need for training at various levels was emphasized — training in planning, installing, promoting, using, managing, repairing, and maintaining an electronic network. It is also necessary to train trainers.

It is essential that relevant target groups and appropriate individuals be identified for training, after which they should be given training designed to suit their particular needs. Training of beginners should include a broad overview of the functionality of the technology before delving into its usage. Another aspect of training that was stressed at the workshop is that obligations on the part of computer communications users should be taught in addition to the rewards that the systems can offer.

Experience has shown that technical expertise is required at every host. However, experience has also shown that donors have often bypassed local expertise in implementing projects, and this oversight has subsequently created problems of maintenance and support services. Therefore local talent should be developed and utilized to the greatest extent possible. Indeed, a primary goal of on-site training should be the creation of a viable, regenerative supply of trained local personnel. While there is some basic expertise already in place on the continent, it needs upgrading and exposure to new and emerging technological trends.

Various training methods were identified at the workshop, including hands-on demonstrations during installation, and training workshops and seminars. It was noted that it is not sufficient to spend a week or so during installation training people how to use the system. It is extremely important to sustain the training over a period of at least several months, if not continually, then intermittently, perhaps by a full-time regional trainer or trainers who would make regular site visits for periods of weeks at a time. Without a capacity for "hand-holding" and troubleshooting, it is likely that the network site will fall into disuse.

There is a clear need for documentation in support of training, such as repair manuals and other illustrative materials, to supplement the training effort and facilitate the development of local expertise. Documentation to provide more "information on information" is also needed, such as a regularly updated network directory/user's guide with instructions on accessing each network, information on its software and hardware requirements, and specifics on system interconnectivity and available services.

It was expressed at the workshop that sub-Saharan African universities should expand opportunities for advanced work in the science and technology (S&T) of information and communication, as expertise in these areas is very much needed by the private sector, governments, research institutes, and the universities themselves. Addis Ababa University's School of Information Studies for Africa (SISA) may be considered a model for training in the information sciences at an advanced level, but there should be better communication and complementarity among emerging university programs in this field. A distinction can be made between training in information science, in the sense of library science, and training in information and communication technologies; it should be borne in mind that different programs may need to have different emphases to best serve the particular needs of the country or region.

These forms of training require funding, and the costs of training and technical support must be factored into electronic networking projects. In spite of the tremendous cost advantages of e-mail versus faxing, cabling, telephoning, telexing, express mailing, and so on, there are costs to be met, and inadequate budgeting can sabotage the computer communications effort. There must be on-the-ground commitment in order to achieve sustainability. This can mean full-time staff support, if necessary. These expenses should be considered normal operating costs, not extravagances. In this connection it should also be remembered that use of e-mail should replace and offset other, costlier forms of communication, rather than add on to existing costs.

### *II. Costs, Marketing, and Sustainability*

Just as the issue of training emerged as the most pressing action item, so sustainability was clearly defined as the bottom line for the survival of electronic networks in Africa. It cannot be expected that donor support will continue to maintain African networks *ad infinitum*. It is critical that economic factors be considered at each stage of network planning and implementation.

The relationship between training and sustainability is that sustainability will ultimately be a function of users paying for such network services as message delivery, mailbox maintenance, and off-line database searches; users will not be inclined to pay for services that are undependable or confusing. There was a consensus at the workshop that training users and technical people is the most fundamental and effective way to ensure that electronic networks are — and are perceived as being — reliable and easy to use, which is not to minimize the importance of making improvements in other policy and technical areas as well. The point is that reliability is an essential prerequisite for successfully promoting or marketing a network; a representative from Ghana's GHASTINET project pointedly noted that unreliability had resulted in its reluctance to seek more users, and that, as long as the situation continued that way, marketing, and hence sustainability, would remain an impossibility.

Once a reliable system has been established, the benefits of electronic networking provide ample selling points. The Nairobi-based Environment Liaison Centre International (ELCI), which, like most organizations involved in networking in Africa, uses Fidonet[1] software, has estimated that a base of 50 users, charged US$10.00 per month and 50 cents per message, will result in a self-sustaining system. This price structure makes e-mail considerably less expensive than the alternatives of long-distance faxing, telexing, or express mailing. ELCI, which now has approximately 35 users, also estimates that a base of 200 users would justify upgrading to UNIX[2] technology.

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[1]Fidonet is a widespread, decentralized network based on personal computers.

[2]UNIX is a computer operating system that, because of its multitasking capabilities, is the best system for handling many simultaneous electronic communications activities.

At the national level, the PTTs (Post, Telegraph, and Telecommunication authorities) can also play a role in supporting the sustainability of electronic networks for S&T. It is an appropriate role because these noncommercial networks represent key enabling mechanisms for the conduct of research that is fundamental to African development. PTTs can and should be encouraged to improve services and infrastructure and review their policies in such areas as pricing, control of equipment, and licensing procedures. The S&T community must therefore become more involved in explaining and promoting information services to policymakers.

### *III. Leadership and Participation*

Leadership and participation need to be considered at various levels and throughout all stages of networking, from planning through implementation. Yet electronic networking, especially the decentralized Fidonet network, which is predominant in Africa, has spread in an essentially grassroots, i.e., non-hierarchical, manner, from user to user. The "bottom up" approach has been central to the character of Fidonet, and periodic attempts to impose a "top down" organizational structure upon it have met with successful resistance. Caution was also expressed at the workshop about becoming unnecessarily entangled in bureaucracy before initiating networking activity. That said, leadership — or lack thereof — at the project level and the university level has proven to be a critical determining factor in the level of success achieved thus far, and national or regional-level participation and support could greatly facilitate the further expansion of electronic networking in Africa.

It was noted at the workshop that within any project there are key players who profoundly affect the likelihood of success. These key players might be project directors or enthusiastic users who master the system and encourage others to participate as well. In university networks, it has been noted that the active participation of Vice-Chancellors improves the network's chances for success. It is helpful, if not absolutely essential, if project directors and other involved administrators are also network *users*. In projects where this is the case, these people have tended to become champions of network utilization; in cases where they remain aloof, apathy often results, stalling the project or slowing it down. Thus, there is an integral link between participation and leadership. Likewise, it is helpful to have continuity in high-level administrative positions; changes in such positions have also been known to delay or sidetrack a project.

At the university, institutional, and project levels, then, network activity can be initiated and nurtured. Sooner or later, however, one needs to consider the question of electronic networking in the context of broader national information policies. In extreme cases during certain periods, computer technology has been banned outright in some countries. More commonly, PTTs may have short-term profitmaking goals, or there may be national trade policy or security concerns, any of which may hamper the ability of institutions to obtain and/or use telecommunications equipment. A concerted effort to enlist the support of key agencies may help smooth the way for the further progress of science and technology communication networks in Africa.

The issue of setting up national bodies, committees, focal points, or clearinghouses to coordinate electronic communication programs and projects was raised at the workshop. It was agreed that these committees should have clearly identifiable functions that address critical policy issues: ownership, access, training, pricing, regulations, and so on. PTTs and other government agencies, universities, research institutes, and the private sector all have roles to play in the process of setting up such national coordinating bodies, whose functions would also include marketing and sensitization programs directed at potential users and policymakers alike.

### *IV. Hardware and Software*

It is something of a challenge to discern appropriate choices among the morass of technologies that includes such arcane-sounding terms as UNIX, Fido, X.25, packet-switching, digital radio, TCP/IP, and V42 bis Worldport. Assuming that the need for a technology has been established, three general conditions should

be met before adopting it: 1) it exists; 2) it works with what else you have; and 3) it makes economic sense. In other words, system planners should not be wedded to particular technologies, but should proceed by making optimal use of what already exists and what is appropriate to the particular situation.

Equipment is sometimes under-utilized because of a lack of appreciation of its full potential. It is necessary to experiment and explore to the limit what is already in place. One reason some technologies are overlooked is because, too often, people believe that "high tech" is essential, when in truth a "lower tech" solution can sometimes achieve the same ends. Moving from the pc-based Fidonet to a UNIX-based network, for example, is a decision that should be justified on the basis of need and the number of users, not because it is perceived as more advanced or prestigious.

Some concern was expressed at the workshop that Fido software is a "third world software." Actually Fidonet is in wide use by individuals and small groups throughout the world, including North America. Internet, BITNET, EARN, and so forth, are found mainly among larger institutions, such as universities, major research centers, and government agencies. The main barrier to full Internet access in Africa is, predictably, cost. Although Fidonet cannot match all the services of the Internet, it is a cost effective and user-friendly method of meeting fundamental communication needs. Messages can be sent from one system to the other by means of "gateways." On-line Internet access is a goal that should not be abandoned, but should not prevent or delay the inception of electronic networking.

At many African networking sites, dealing with what exists means dealing with a poor telecommunications infrastructure. While this has certainly created difficulties, they are generally resolvable by obtaining a good quality modem. This may not be a simple task in some places, and often there is little local capacity to deal with repairs and configuration. Nevertheless, the infrastructure is not an insurmountable barrier. With error-correcting modems, messages and files are routinely sent successfully even over very noisy public phone lines, although transmission time may be slowed considerably, raising costs. Therefore it is not necessary to wait for the PTTs to install X.25[3] networks where they do not yet exist. Where they do exist, cost comparisons should be made prior to making a choice of medium.

Optimal use of what already exists also extends to the possibility of connecting to existing networking projects rather than building a new network. The Association of African Universities (AAU), for example, whose Vice-Chancellors meet on a regular basis, has decided not to form its own communications network, but instead to cooperate with the Pan African Development Information System (PADIS) of the United Nations Economic Commission for Africa, which is already involved in developing networking in Africa.

It is especially important for regional networking initiatives to take the variety of local conditions into account in planning a project. For example, in the RINAF project, which aims in part to coordinate, integrate, and upgrade African networks and their overseas connections, different approaches will be used in different countries, using X.25 lines where they are available, strengthening Fidonet links, or using satellite links where appropriate, and so on, with Internet connections made at regional nodes when and where feasible.

Compatibility of technologies is a related area requiring a careful assessment of existing local conditions. Several cases were reported at the workshop in which equipment was delivered that was defective or incompatible in some way. For instance, modems were sent that did not work or did not comply with voltage ratings, and other similar, and ostensibly avoidable, mishaps. Frequently there are also long delays — up to

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[3]X.25 is a protocol used on public data networks, designed for the transmission of computer communications.

12 months — in delivery or replacement of essential parts, placing even greater importance on "getting it right the first time" to minimize these crippling delays.

### *V. Next Steps*

There is a tremendous demand for pc-based network linkages at universities throughout Africa for administrative, research, and other purposes. The particular goals of the various institutions and regions are dependent upon their relative stage of network development. Where basic messaging capabilities have proven more or less reliable, one begins to think about further applications; in other places, this first step presents challenges enough.

West African universities, for example, are lagging significantly in terms of network progress; thus, there is a need for a special focus on that region's basic electronic communication needs for research and teaching. With the notable exception of a network built by the French research institute ORSTOM, called RIO (Réseau Informatique de l'ORSTOM), which links French researchers in Africa and elsewhere, communication networks in West Africa are virtually non-existent, a situation, reported on during the workshop, that stands in contrast to the progress that has been made in some Eastern and Southern African institutions.

Among the potential further applications and other issues in need of greater attention that were discussed at the workshop, in addition to those already discussed, are the following:

- noninteractive searching on networks at low cost. This includes CD-ROM applications, although CD-ROM is not necessarily an effective technology for multiple users in large numbers.
- further investigation of how to affordably access databases worldwide, including university twinning arrangements, or the possibility of developing software that might combine e-mail capability with automatic keyword searching, so that one could send a search request as a message and receive a reply without the need either for human intervention or for long-distance time on-line.
- spreading the word in the more developed world that e-mail capability does, in fact, exist in Africa. At least two positive results would thereby be encouraged: overseas colleagues of African scientists and engineers could send messages to Africa, encouraging greater communication and possibly collaboration, and raising morale by diminishing the sense of isolation; and institutions overseas, where telephoning is cheaper and more reliable, could initiate calls to African hosts for the purpose of exchanging volumes of mail, helping to get African networks off the ground during the difficult initial phases of development.
- documentation on usage patterns and costs and benefits to demonstrate empirically the advantages and potential of electronic networking. The International Centre for Insect Physiology and Ecology (ICIPE) has done some such documentation based on its experience with CGNET, analyzing the number of connections made over given periods compared to a suggested optimal scenario, and attempting to discern associated "true" and "excess" costs. It would be useful to have additional, similar studies, and, where possible, to include comparisons (cost, speed, reliability) to other methods of communication.
- promoting electronic conferencing for research and education. The advantages of conferencing include: teaching and seminars; scientific collaboration in research and writing; the concept of the "virtual student"; and reduction in time necessary for communication. The following drawbacks to conferencing were noted: the unmet need for interpersonal relationships (students/teachers); the lack of privacy in making comments (although most conferencing software includes provision for private messages akin to e-mail); the large volumes of information to digest; general lack of familiarity with electronic conferencing in Africa; and the varying complexity of hardware needs among target users.

## Conclusion

Electronic networking continues to hold great promise for the African scientific and technical community, with downstream potential to benefit the social and economic development process. Initial efforts to establish such networks in Africa have met with limited success and have served to identify key positive and negative elements that contribute to a project's relative success or failure.

Perhaps the most important condition for success and sustainability is to have a group of enthusiastic users. Even a small group of enthusiastic users — or one extremely enthusiastic user (a local "champion" of networking) — can be instrumental in attracting other users, resulting in a larger group of users who could, by the payment of affordable fees, sustain the network. Satisfaction of user needs thus becomes the paramount issue, which is why adequate training is the first priority. Training, in order to be adequate, must be targeted at all levels of networking, involve local expertise, and be ongoing so that competence can be solidly established, maintained, and then propagated. Documentation to guide users is also a critical, and heretofore largely lacking, element.

The costs of networking represent another significant issue that is related to the user base. Having more users lowers the marginal cost of messages and helps make the system more affordable to operate. At least until a sufficient user base is established, it may be helpful to have someone "poll" the system for mail from outside, where calling rates are cheaper and/or lines may be more reliable. There are also costs, as well as delays, associated with government regulations and policies, some of which can be targeted for reduction by policy change; likely candidates include tariffs on computer equipment, the requirement of government approval of type of equipment, time-consuming and often expensive licensing requirements, and telecommunications price structures for nonprofit organizations. There are also intransigent costs such as those associated with on-line remote database searching; these are likely to remain prohibitive for the foreseeable future, but cooperative arrangements can be made, via e-mail, with colleagues within Africa and overseas. It is possible, for example, to send a search request as a message to a colleague who would perform the search locally and send the results back by e-mail. Such cooperative arrangements should be encouraged, and there is also potential for the creation of software that could perform this operation automatically.

All one needs in order to participate in networking, technically, is a computer with communications software, a modem, and a transmission medium. Networking can be made more successful and affordable by such means as mentioned above, and these means can be facilitated by the support of institutions such as government agencies, universities, commercial organizations, and, at least during the initial phases, donors. The adoption by such institutions of policies that encourage networking would accelerate Africa's participation in the information age and enhance the contributions of African science and technology to development.

The African Academy of Sciences/
American Association for the Advancement of Science

# Workshop on Science and Technology Communication Networks in Africa

## Agenda

Thursday, August 27

**Panel I. National-Level Initiatives: Experiences and Prospects**

*General questions:*

What role can national committees, or other bodies, play in formulating networking plans and generally promoting telecommunications for scientific/academic uses?

How can networking efforts interact effectively with governmental entities, especially PTTs?

What training efforts can be organized at this level?

How best to strengthen and encourage local capacity?

What can be recommended vis à vis cost-sharing within locally based systems?

**Panel II. Human Resource Issues: Training, Usage, and Maintenance**

*General questions:*

What expertise, motivation, and control are required of users? of system operators? of system managers?

How can skills be retained and updated? Where to do this?

What resources can assist individuals involved in networking, such as manuals and reference materials, user conferences, and so on?

What relief can be offered to the pressured system operator?

How to "advertise" local capacity, versus relying on outside experts?

Friday, August 28

**Panel III. Regional Networking: Within-Africa Experiences and Prospects**

*General questions:*

What can scientific/academic institutions and their partners (including donors) do to enhance the free flow of information across borders?

What benefits, and shortcomings, are related to regional- versus national-level networking? Regional versus overseas?

What are the major technical and financial constraints to regional networking, and how to resolve them, in the short- to long-term?

How to harmonize and standardize systems for compatibility within larger arenas (regional and international)?

**Panel IV. Addressing STI Needs in Education and Research**

*General questions:*

How best to design systems to address users' needs? Where to place them?

How to increase awareness among potential users of utility, cost effectiveness, and technical requirements of networking electronically?

How to promote an "information culture" in the region?

How to increase appreciation of managers for the potentials of computer-mediated communication (its accessibility, reliability, etc.)?

In what ways can on-line communication be feasible in Africa?

**Panel V. International Connections: Experiences and Prospects**

*General questions:*

Essentially, how can Africa participate in the global scientific community?

What local adaptations and innovations make international connectivity work?

How to deal with costs (especially foreign exchange needs), particularly after pilot phases are completed?

What policy changes with PTTs are priorities? How to address?

What international partnerships should be engendered?

How to avoid problems of incompatibility?

Saturday, August 29

**Panel VI. Marketing Networks: Strategies for Success**

*General questions:*

With hindsight, what lessons have been learned about promoting networks among users, decisionmakers, funders, government authorities?

How best for donors/networks to work together, from pre-feasibility phases through project completion?

What are the routes to sustainability of networks, especially in the light of donor limitations and serious, ongoing national financial crises?

**Final Session. Recommendations for Action: Networking Needs and Policy Imperatives**

The African Academy of Sciences/
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# Workshop on Science and Technology Communication Networks in Africa

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The full proceedings volume from the Workshop on Science and Technology Communication Networks in Africa, which includes the prepared papers, is available at no charge from the Sub-Saharan Africa Program of the American Association for the Advancement of Science. Please send your request to:

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