Part II — Parallel Sessions[1]

Tuesday, 9 December 2003, 9.00 a.m. to 12.30 p.m.

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10 Contributions to Education

11 Contributions to Economic Development

12 Contributions to the Environment

13 Contributions to Health

14 Contributions to and Benefits from Enabling Technologie

The rapporteurs of the Parallel Sessions presented their summaries in the Plenary Sessions on Tuesday 9 December at 2.00 p.m.

Moderator: Dr Mohamed H. A. Hassan

1. An On-Line Forum on the RSIS Website had preceded the conference. The discussion groups on all five topics of the parallel sessions: education, economic development, environment, health and enabling technologies, were moderated and the ten participants considered to have made the most important contributions to the On-Line Forum were invited to the conference. Papers submitted by these participants are included in Annex II of these proceedings.

10 Contributions to Education

Chair	**Wei Yu**, Chinese Education Ministry
Rapporteur	**Mustafa El-Tayeb**, UNESCO
CERN Moderator	**Robert Eisenstein**
Speakers	**Robert Eisenstein**, Santa Fe Institute and CERN **H R H Princess Maha Chakri Sirindhorn**, Princess of Thailand **Atta-Ur Rahman**, Ministry of Science and Technology, Government of Pakistan **Mohammad Hassan**, Director-General of the Third World Academy of Sciences **Robert Martin**, Director of the Institute of Museum and Library Services **Wesley Shrum**, Louisiana State University
Website	http://rsis.web.cern.ch/rsis/

Session Summary (John Ellis, CERN)

Issues Raised

In preparing the parallel session on education, speakers were asked to address several key issues. These included:

– the role of Information and Computing Technology (ICT) in fostering education,
– the factors that make distance-learning initiatives successful,
– ways of bringing educators who work on various e-learning initiatives into contact with each other,
– ways of improving free access to scientific information,
– the roles of libraries and museums, and
– the roles of virtual universities and laboratories.

The session was presented in all forms of multimedia. The first speaker was in the USA while his computer was with us. The second lecture was a film shot in Asia and Africa. Other speakers made 'conventional' computer presentations, and our Chairman did not use ICT at all, but gave a classical lecture.

The speakers focused on the important roles that ICTs can play in facilitating education, and the specific necessity of education in science and technology. Various ways to bridge the digital divide were discussed. Particular emphasis was given to the need for free access to information, software and networks (while recognizing the importance of intellectual property rights), and the necessity for strategic collaborations that can increase the power of ICT applications in education.

Successful Examples

Several examples were given of successful educational initiatives based on ICT.

Many valuable educational and research materials are now available over the Internet. One good example is the OpenCourseWare made available by MIT, which includes materials such as syllabi, lecture notes, examinations and problem sets. Other universities also produce material suitable for distance learning: for example, Stanford University has an extensive range of courses available on video, and there are also initiatives from the University of California, the University of Illinois and the Open University in the U.K.

Another interesting application of ICT within the research community is the free but un-refereed `arXiv' digital archive of research papers in physics, mathematics, computing and quantitative biology, on arXiv.org . By contrast, the 'Public Library of Science' (PLOS) initiative makes refereed research papers available free to readers, but the authors must pay to publish, which is an obstacle to scientists in some countries.

Also mentioned in the session were several interesting structural initiatives based on ICT, including the African Virtual University, and we heard about exciting developments in a couple of individual countries.

Thailand has also been particularly active in developing distance-learning programmes using ICT. These include satellite-based training for some 3000 schools and the free offer, by a national Institute for the Promotion of Teaching Science and Technology, of Web-based learning material and CD-ROMs. There is also a central repository for websites of interest to educators in Thailand. However, the Thai experience emphasizes that, while digital education is good, mechanisms to promote the use of Web-based material are vital, as is the provision of material in the local language. Finally, hands-on experience and contact between educators and learners are also necessary.

The Pakistani government has recognized the importance of ICT for education, but also realizes the need for complementary infrastructure, trained human resources, an enabling environment, and universal access for the citizen. The government acts as a facilitator and enabler. Through its actions, Internet access has recently expanded dramatically — from 26% of the population in 2000 to 97% in 2003 — while the bandwidth available has soared — from 32Mb/s in 2000 to 600Mb/s in 2003 — and costs have plummeted, with a resultant increase in the number of Internet users from 120,000 in 2000 to 4,800,000 in 2003. The PAKSAT 1 satellite provides four free educational TV channels and all universities are now connected by an optical fibre backbone. In this way, the Pakistani government has been able to create a national Virtual University Network, which is a hybrid between distance and interactive learning. It is also seeking to help the Pakistani academic community in various ways, for example by providing online access to 31,600 research journals nationwide: more information is available on www.comstech.org.pk .

It was agreed that distance learning needs more than simply making material available online. Attention must also be paid to interface design, navigation and feedback. Also, assessment is crucial and programmes must be developed with clear outcomes in mind. Different programmes should share the results of these assessments to identify the most successful approaches, for example within South–South partnerships.

In the near future, the advent of distributed computing based on Grid technology, which is being driven by data-intensive sciences such as high-energy physics, will put enormous computational power at the disposal of the educational community. It will turn the World-Wide Web — invented at CERN to enable scientists from many different countries to work together — from a passive system into an active device, and will surely also have a profound effect on education.

Educational Roles of Museums and Libraries

These institutions are crucial for creating a 'learning society'. The Institute of Museum and Library Science (IMLS), an independent federal agency in the United States, provides grants and plays a national leadership role in helping the more than 15,000 museums and 122,000 libraries in the U.S. become more effective educational organizations through support of activities in areas such as capacity-building, lifelong learning, cultural preservation, and civic engagement. The IMLS mission is to create and sustain a nation of learners through supporting museum and library services. Libraries and museums play an important role in formal and informal education, including science education. A 2002 IMLS-funded survey found that, cumulatively, U.S. museums spent more than one billion dollars on K-12 educational programmes in 2000/2001 and provided millions of instructional hours.

ICT has led to a convergence of traditional museums, libraries and archival resources, in terms of their assets, their practices, their programmes, and their accessibility to learners of all ages. The International Children's Digital Library, for example, [www.icdlbooks.org] is an international public/private partnership that has created a digital collection of children's literature from around the globe, with topic headings and interface designed in concert with the children who comprise the project's audience. Field Trip Earth [www.fieldtripearth.org] is an online resource developed by the North Carolina Zoo that enables students, teachers, and the public to follow and interact with the daily work of wildlife researchers and conservation experts around the world. These library and museum-based projects are making new contributions to learning in and out of school.

Effective ICT practices require shared standards and frameworks and, in addition to supporting projects that use new digital technologies, IMLS supports efforts to identify best practices for the creation, management and preservation of digital resources — necessary components for a strong and vital learning infrastructure. In the U.S., this learning infrastructure has been enhanced by the creation of several online central repositories, including the National Science Digital Library, supported by the National Science Foundation, and GEM, the Gateway to Educational Materials (www.thegateway.org), funded by the U.S. Department of Education. These repositories are the product of multi-organizational collaborations, formed to address the educational needs of students and teachers more effectively through new technologies.

Also in this connection, ICTs now make possible the concept of a 'virtual laboratory', as exemplified by 'Bugscope', and telescopes or a microscopes that can be controlled from a distance. A public–private partnership has created 'Try Science' at www.tryscience.org , a gateway encouraging people to experience the excitement of contemporary science through on- and off-line interactivity with over 400 science and technology centres worldwide.

South–South Partnerships

The importance of South–South co-operation also emerged clearly from our discussions. This is important, not only in the ICT area, but also for training scientists and general capacity-building. Among the different modalities of South–South co-operation, one promising development has been the recent initiative by Brazil, Mexico, India and China to facilitate training in their respective countries by each offering 50 scholarships, some in ICTs.

Such South–South partnerships will be key tools for disseminating and sharing innovative experiences, as well as fostering a new generation of talented scientists. These are cheaper than sending students for postgraduate training in developed countries, which also entails the danger of a brain drain. However, in many cases, the necessary first step must be to build up the communication capacities of science academies.

Centres of excellence should establish networks to use ICTs to exchange information on specific issues affecting the South, such as safe drinking water and biodiversity. For this, however, access is required to basic communication facilities and infrastructure, and programmes are needed to provide that access, e.g., by purchasing computers, providing Internet connectivity, and designing websites.

Conclusions

There is general agreement that ICTs now play a key role in the learning process — including ongoing developments such as the Grid technology for distributed computing as well as established technologies — in both specialized educational institutions and organizations providing resources for learning throughout life. Projects that are on the 'new frontiers' of education focus on meeting the needs of the learner and providing a variety of pedagogical approaches that can accommodate different learning styles and situations.

There are many encouraging examples of ICT projects based at institutions of higher education, such as the OpenCourseWare provided by MIT and the video recordings from Stanford University, as well as virtual universities and laboratories. Other projects and programmes come from collaborations between libraries, museums, and other educational organizations. However, many issues remain, such as the need to negotiate electronic access to research journals, 'business model' incentives for different institutions to collaborate for shared educational and community goals, and the challenges of creating and adhering to common standards and frameworks. In addition, the developments made possible by ICTs do not alter the fact that libraries and museums must continue to play their traditional stewardship, exhibiting, and information-providing roles.

However, in order for developing countries to reap full benefit from ICTs, the world needs to develop the infrastructure for bridging the digital divide: one must not put the cart before the horse. Advanced laboratories, such as CERN, can play valuable roles through their expertise in ICTs, by their global network of collaborators, by making educational materials available on the Internet, and by validating sources of scientific information. However, it is also essential that developing countries help themselves and each other by expanding South–South cooperation. In this connection, the African Virtual University and a special initiative to connect African institutions are particularly welcome.

As the session moderator pointed out, the last 25 years of experience teach us that we have only just begun the revolution in the process of using ICTs to facilitate education, and it is clear that we must all work together to realize its full potential.

11 Contributions to Economic Development

Chair	**John Dryden**, OECD (Organization for Economic Cooperation and Development)
Rapporteur	**Dr Mohammad Nahavandian**, Institute for Humanities and Cultural Studies, Tehran, Iran
CERN Moderator	**Mike Doran**
Speakers	**Paul Rübig**, Member of the European Parliament **John Burley**, UNCTAD (United Nations Conference on Trade and Development) **Richard Dixon-Hughes**, ISO (International Standards Organization) **Feng-Chin Ling**, AFACT (Asia-Pacific Council for Trade Facilitation and Electronic Business) **Subbiah Arunachalam**, M S Swaminatham Research Foundation, India **Fidel Castro Diaz-Balart**, Cuban Academy of Science
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Introduction

The Information Society was made possible by scientific and technological advances, and many of its enabling technologies were developed in order to further scientific research and collaboration. For these reasons, the international scientific community has a key role to play in the WSIS. The aim of the RSIS conference in this session is to allow members of the scientific and governmental communities, the civil society and business, to discuss the critically important role of science and technology in pioneering and furthering the development of the Information Society, and the future contributions it can make world-wide to economic development.

- What can science do to help maximize the benefits of information and communication technologies?
- What benefits can developing economies gain from e-business?
- What e-strategies have been found to work best in developing countries?
- In what ways can knowledge and technology transfer help bridge the economic digital divide?

The Chairman suggested three themes for the session:

1. ICTs for economic growth
2. The role of ICTs as promoters of innovation and as contributors to development
3. Access to information, literacy, and the human factor in the attainment of economic development

1. ICTs for Economic Growth

The Chairman stated that despite overinvestment in ICTs in the late 1990s and economic downturn since 2001 (during which productivity had held up well), there is increasing optimism that science and innovation-driven ICT development (Moore's Law) is steadily enhancing economic development. Wider use of broadband is spreading adoption of ICTs.

Paul Rübig

SMEs (in Europe: 75% of all new jobs, employing two thirds of all employees, 80% of all tax paid by SMEs) are the key to economic progress and it is important to have the right framework for their development.

ICTs and access to financing are the bases of SME success. Three levels of business are recognized: customer to customer (C2C), business to customer (B2C) and business to business (B2B). The main priority must be the latter. Trade facilitation for SMEs depends on a multilateral approach (Basel 2 Agreement); big business has strong lobbying possibilities at the WTO level. Access to financing is crucial for SMEs. The principle for economic development should be 'think small first'. The EU is fostering partnerships with SMEs in the developing world.

Issues: improved use of ICTs for economic growth; support for renewable energies and sustainable growth (Kyoto Conference); new investment flows; international treaty for SMEs.

John Burley

The impact of technological development on economic development has long been recognized. ICTs have a potential for increasing efficiency and have had an impact on growth, through the positive contribution of ICT investment to productivity. ICT use requires a supportive environment and improvements in other factors to maximize return on investment in them. ICTs have a sustained impact provided that the policy mix is correct. ICTs have fostered outsourcing, which is increasingly important for countries like India which can offer outsourcing services that boost the local economy. Free and open-source software is opening new prospects for developing countries in access to and participation in key software developments. However, the digital divide is a matter of serious concern (95% of e-commerce is in the developed world) and while Internet use is expanding rapidly (32% of users in developing countries in 2002, 50% by 2008), there is no direct linkage between Internet penetration into the developing world and levels of commercial use and thus impact on economic development.

Some reasons for this are:

1. lack of awareness of ICT benefits;
2. weak Internet connectivity and broadband networks;
3. high cost;
4. inadequate legal and regulatory framework;
5. failure to use local content, language;
6. social inequalities.

ICTs must not be seen as a panacea for development and cannot compensate for flaws and deficiencies in economic and governmental structures.

Some Conclusions

1. The need for a balanced approach
2. Each country must define its e-strategy
3. Training and education are of paramount importance
4. Free Open-Source Software (FOSS) is essential
5. A serious effort must be concentrated on standardization and inter-operability
6. More public and private investment is needed
7. Connectivity and telecommunications infrastructure are critical prerequisites.

2. ICTs — Innovation and Development

Introducing ICTs as promoters of innovation and development, the Chairman stated that scientific research had contributed to e-development (WWW), which feeds back to innovation since researchers use developments to create further innovations. There is a clear link between scientific and technological developments and further technological and economic development.

Richard Dixon-Hughes (ISO): Global Standards for the Information Society

Developments in ICTs are accelerating and major segments of the international economy are now totally dependent on these technologies which bring benefits in many fields. Nevertheless, overcoming the digital divide to enable all peoples to share these benefits is a major challenge. Research offers seemingly endless possibilities for improved technologies but the ICT industry can only adopt the fruits of scientific creativity when they deliver commercial benefits. International standardization facilitates adoption of technology by balancing commercial, technical and community interests through open, participative processes and is well suited to ensuring that our goals for the Information Society are met.

International standards have been and will continue to be essential as a foundation of the Information Revolution (e.g. information coding for use by processing systems; standards for defining and using databases, messages, and documents; standards for programming languages, systems modelling and processing platform interfaces; applications standards in health care, trade and commerce, finance, transport and mapping; standards defining best practice for the management and use of technology).

Many different organizations are now developing global standards to support the Information Society (e.g. ISO, IEC and ITU-T, W3C, IETF, IEEE, UN/CEFACT and OASIS, etc.).

Examples of major contributions of international standards to extending the Information Society include electronic multimedia (e.g. JPEG and MPEG) e-business collaboration (EDIFACT standards for international trade, transport, etc., and recent agreements sponsored by ISO, IEC, ITU, UN/ECE).

The cost of setting up an e-business solution needs to be lower than the benefit incurred. For many SMEs, high set-up costs can preclude participation in e-business. Being locked in to customized integration products inhibits e-commerce, the growth of standards-based approaches makes B2B connectivity affordable for SMEs.

Conclusions: On-going development of the Information Society requires a broadly-based, responsive, global programme of continual standards development based on active co-operation of standards bodies and on three principles: inclusiveness (accepting work of other organizations into the international standards framework); global market relevance (standards must address industry's needs); faster adoption through lower-consensus documents (that can be later refined into full standards following implementation experience).

Feng-Chin Lin (Asia Pacific Council for Trade Facilitation and Electronic Business, AFACT) then presented the HUB Model for SME B2B (Business-to-Business) Applications. He traced the major problems in supply chain management in the IT industry: many incompatible IT platforms, redundant investment in information systems and applications and multi-layered architectures which slow down information transmission in the supply chain.

The IT industry in Taiwan has 3–4000 SMEs, both suppliers and customers who trade on a global basis. The HUB model has evolved from a multi-tier linear activity model to a new framework based on a trading partner network. The HUB system services include, e-Procurement, e-Logistics, e-Design and e-Cash.

Currently 1200 trading partners, including 100 logistics service providers, are connected to the HUB and the services will be extended to China, Japan, Europe and the US through inter-network integration.

The single window for B2B information flow using the HUB concept could be implemented by SMEs in many industries in both developed and developing countries alike.

3. Access, Literacy and Diffusion to a Wider Population

Subbiah Arunachalam, M. S. Swaminatham Research Foundation, India

(**Film** of hub project in South India (Pondicherry) where local farmers and fishermen obtain essential information on weather, crop pests, etc. from a rural internet office.)

Partnerships and such broader educational possibilities as virtual universities and academies may help to bridge the digital divide, but in the case of rural communities, economic development and improvements in information (education, health, agriculture, safety, hygiene, etc.) require the expansion of knowledge centres manned by experts who are prepared to listen to needs and respond to them in a targeted way and on the basis of a two-way communication.

It is essential in such poor regions of LDCs not to put the technological cart before the horse: in areas where literacy is low, Internet access may be irrelevant, as well as being unattainable both in financial and practical terms. The number of users of such centres is a better benchmark of ICT impact for developing countries than the abstract percentage of Internet users. The prevailing principles are those of John Ruskin's *"Unto this Last"* as advocated by Mahatma Ghandi. Women in particular are seen as essential vectors of information to the family unit and thus to a small village community.

General Conclusion: IT alone is useless in promoting economic development; it is only useful in combination with other factors. A holistic approach and programme are therefore essential for rural communities in the LDCs.

Fidel Castro Diaz-Balart, Cuban Academy of Science

The Role of New Technologies in National Economic Development — The Cuban Experience

The speaker presented an overview of key research institutions in Cuba, stressing the importance of intensive education as a prime prerequisite for economic development, the impact of science and technology on industrial and economic development as well as the need for a critical mass of a core of universities and research centres.

Three basic strategies have been implemented to ensure that biotechnological research has an impact on the Cuban economy: a) closed-loop organizations with responsibility and resources for research, product development and manufacturing; b) global-market orientation to ensure cost-effectiveness of investment; and c) the filing of patents, demanding a tight relationship between fundamental research and industrial strategy.

Conclusions

The polarization of scientific activity between North and South is a global problem. Use of knowledge requires abundant and competent human resources, access to information channels, organizational resources, functional links between academia and industry, legal support infrastructure, negotiation capacity, etc. Scarcity of these commodities in the South is a formidable barrier to development. The capacity to use knowledge is increasingly linked to the capacity to generate it. Knowledge and technology transfer models are no longer functional. Scientific capacity has to be established. Co-operation between North and South should be established on the basis of: 1) joint research projects and research teams for the sharing and pooling of information with an industrial as well as an academic component as a mechanism for influencing technological and economic development; 2) co-operation structures focusing on frontier research projects of universal interest.

4. Questions & Answers

Q: How sustainable are the grass-roots information centres in India and can they be widely replicated?

A: (Arunachalam): Nothing is stable in the developing world. However, such centres foster social empowerment at the micro-social level. We are planning to extend the scheme into other rural areas, although we are finding that populations in some provinces, with lower receptivity to the value of technological development and education, are proving more resistant to such schemes.

Q: Are you not concerned by the fact that ICTs have generated a brain-drain from India?

A: (Arunchalam): India has a huge population with an untapped potential and inexhaustible pool of talent. Indians working in Silicon Valley assist families in rural communities financially and their experience serves as an impetus to others to reap the benefits of education.

Q: (Rubio, CERN): The disparity between the advances linked to the rapid rate of IT development in the developed countries and in centres like CERN (e.g. the Grid) is widening the digital divide with the LDCs. How should research institutions like CERN address this divide?

A: (Dryden): Partnerships between all the stakeholders (i.e. NGOs, centres of excellence, international organizations, EU, standards organizations) are the key as well as open access to publicly-funded research data. The availability of such data will further push back the frontiers of technological achievement. One of the key issues is the mechanism by which the partners can be brought together to create the information society. The research field has demonstrated the advantages of access to publicly-funded research data in the promotion of a given discipline or field of technology.

A: (Burley): The three key issues are 1) awareness at difference levels (e.g. political commitment, individuals with vision); 2) the magic of the market place and 3) training, exposure, education.

Comment: (Eliot, ICSU): Science is the basis of economic development because it is incremental by its very nature ("I stood on the shoulders of giants"), but requires investment and the right climate and legal framework. A major threat to such development is the tightening of EU intellectual property legislation.

Comment: (Barone, Greece): The Internet is still used by only a minority of the world's population. That should be taken into account when assessing the impact of ICTs in the least developed countries.

A: (Burley): The degree of Internet use is clearly and inevitably highest in countries with a large educated middle class.

Summing up by Mohammad Nahavandian

General statement of principle: "Grey matter is the most evenly distributed commodity."

Of the six speakers, three examined the policy aspect of ICTs and three gave examples of how these policies can be implemented.

The following main issues have emerged from the session:

1. Global policies are needed for global economic development: globalization cannot proceed unchecked or unregulated.
2. Unilateralism is no longer acceptable as an economic principle in the global market: the WTO development negotiations are still imbued with a sense of national priorities.
3. the need to think globally and multilaterally rather than in terms of the requirements of governments or non-democratic institutions (e.g. standardization, the domain names issue);
4. Localization of technical policies (application and adaptation to meet local needs).
5. The scientific community, international research organizations and centres of excellence must play a pioneering role; the intellectual property system has to be engineered to foster global development; however, the contribution of traditional knowledge to community life in the LDCs has to be respected and protected.
6. Attention must be paid to a sustainable relationship between economic development and the environment.
7. The beneficial impact of ICTs on economic development requires a fertile economic, educational, social, legal and political environment; the scientific community can act as a pioneer in creating the right environment for scientific and technological development and information exchange which are the motors of economic development.
8. National borders are of decreasing importance in the global economy and interrelationship of markets; the global good and universal moral values increasingly exercise the public imagination and emotions rather than purely national concerns; here too scientific society has played and must continue to play a pioneering role.

12 Contributions to the Environment

Chair	**Walter Erdelen**, UNESCO
Rapporteur	**Luigi Fusco**, ESA
CERN Moderator	**Hans Falk Hoffmann**
Speakers	**David Williams**, EUMETSAT **Peter Bernal**, IOC/UNESCO **Josef Aschbacher**, ESA **Stuart Marsh**, BGS **Stuart Salter**, IUCN **Luigi Fusco**, ESA
Website	http://rsis.web.cern.ch/rsis/

Session Summary

The chair, W. Erdelen (UNESCO) introduced the main goal of the session, namely to debate how sustainable development is linked to, and can benefit from, the present information management evolving towards global environmental knowledge management, accessible to all.

In the following the contributions of the speakers to the session are summarized:

D. Williams (EUMETSAT) introduced the Meteorological Community's vision

Meteorology is a mature, global community that endeavours successfully to get away from 'a world full of data and short of information'. Thus it could be a reference for other communities.

The international meteorological community is organized around an operational system handling and integrating space mission data and forecasting models for the generation of routine global and regional products (e.g. SST maps).

The strategy of sharing of resources and concerted efforts by global partners represents an important political and pragmatic step that has allowed the present maturity to be reached.

This approach was further promoted at the last Earth Observation Summit in January 2003.

The results of these efforts should become available also to those countries and their citizens with less developed communication infrastructures.

P. Bernal (IOC/UNESCO) spoke representing the Ocean Community

The international Global Ocean Observing System (GOOS) was created as a response to the Rio Conference in 1992. GOOS, as a single, permanent, global, public-oriented service, is being achieved with the active contribution of different segments of society.

At present Space missions are extensively used to generate large amounts of data while the community is mainly organized by geographic region.

Efforts to get better coverage are ongoing and to obtain access to *in situ* measurements. It was noted that improved marine observation and derived environmental information serve other large potential user communities such as energy, transportation, health, finance, etc. The reduction of environmental forecast uncertainty (i.e. improved medium-term weather forecasting, achieved by improving access to quality information) has substantially helped the tourism industry.

One issue, considered to be relevant across the environmental community, is related to the adoption of international standards in the area of data and information exchange and sharing.

J. Aschbacher (ESA) provided the European Space Community' perspective

He introduced the Global Monitoring for Environment and Security (GMES) results achieved at the last Baveno meeting in November. GMES is a joint EU/ESA initiative to develop operational monitoring systems comprising space, *in situ* and forecast models to support Europe's environment and security policies. The European environmental community is driving the GMES initiative in the various thematic applications on the global (e.g. verification of environmental treaties), regional (e.g. environmental indicators), and local scale (e.g. sea pollution monitoring).

Furthermore, ESA and the EU have approved a 'White paper on Space', which addresses topics such as Galileo, GMES, the digital divide, technology and science. The paper addresses the issues of sustainability, integration of technologies, user involvement and operational services for the institution and the community.

It was recognized that the need for a shared infrastructure and for a well co-ordinated information management tool across environmental users is a key element for environment information management.

S. Marsh (BGS) highlighted the Geo-Hazard Community's position

For the purposes of this presentation, geo-hazards address earthquakes, volcanoes, landslides, and subsidence. These disasters all hinder sustainable development, costing lives and livelihoods and damaging infrastructure.

The international response to geo-hazards involves the political sector at various levels, the United Nations, and all sorts of operational communities and science and technology. It requires access to integrated *in situ* and remote observations. Common user requirements include baseline hazard inventories and rapid information access, which imply more accurate observations in time and in space. Equally important is the process of transforming data into useful information and knowledge. This involves data management, integration and hazard modelling. But the biggest challenge is to create an integrated, global geo-hazards community capable of doing these things via capacity-building efforts.

S. Salter (IUCN) discussed the Biodiversity Community vision

Experience shows that when ecosystems collapse they do so in a very fast way. Furthermore, environmental stress translates quickly into social stress.

There is an urgent demand for an authoritative and accessible biodiversity and environmental decision-support tool.

The World Conservation Union (IUCN) is responding to the need. Using the network of 7,800 volunteer experts in the IUCN Species Survival Commission (SSC), up-to-date information is collected on a wide variety of species. This is then peer-reviewed and made available to decision makers worldwide. One product is the IUCN Red List of Endangered Species.

The issue of alleviation of poverty linked to environmental issues was also discussed. There is clear evidence that current development strategies often have unintended detrimental effects on the environment that ultimately may end up making the overall poverty situation worse. It is well recognized that development strategies need to have environmental stewardship as a core pillar. A clear, multidisciplinary approach will be needed to support this goal.

L. Fusco (ESA) complemented the vision on the role that Information Systems Technologies play in environmental monitoring

Environmental monitoring for sustainable development needs integration of all available mature technical resources, including space and other technologies, which can respond to the appropriate time and spacial scale (local, regional and global).

Close co-operation and data/information-sharing with all concerned parties and communities is an essential factor in achieving success. An effective demonstration of this approach is the International Charter for Disaster Management in which all participant Space Agencies respond in the most efficient way to the call made by Civil Protection bodies and other users, providing free data and information.

One of the always discussed, but never solved, issues related to data access is an unified and supportive data policy.

Comments

The workshop was further animated with contributions from the audience (e.g. Udo Herbert, Dep. Animal Science and Technology, Fed. Univ. of Technology, Owerri, Nigeria; Sandra Mejia, Rural Development/GIS Specialist, Managua, Nicaragua), who reported on "Environmental Information Management in Developing Countries" and on "Bridging the Digital Divide in Environmental Information Management").

Summary Statement

It was agreed that the following statement be reported to the Plenary Meeting as a goal for the future:

> **"Every citizen shall be able to easily monitor the state of his environment, from his planet to his country, to his village, to his street, to his house."**

Recommendations

The concrete recommendations made by the Environmental Session can be summarized as follows:

- The task of monitoring the Earth's status is a global issue. Earth science research should be encouraged on a global scale. Earth science is of concern for every citizen's immediate environment and condition of life and thus different from other sciences. Earth science should involve international bodies, institutes and single scientists from all countries, ultimately aimed at serving every citizen.
- Life on Earth depends on biodiversity and the living environment. Biodiversity is not properly funded and organized in terms of science.
- There is a fundamental communication gap between data providers, scientists and users/citizens. For example, the World Bank and other funding agencies are not using environmental information as they should.
- An improved technical and political link between data providers and data users is needed to improve access and share environmental information.
- Education and capacity-building need to be supported throughout with all possible resources and opportunities at all levels.

13 Contributions to Health

Chair	**Jim Kim**, World Health Organization
Rapporteur	**Harry McConnell**, Interactive Health Network, International e-Health Association
CERN moderator	**Manjit Dosanjh**
Speakers	**Luis Gabriel Cuervo**, The Cochrane Collaboration and BMJ Knowledge's Clinical Evidence **Dialo Diop**, Université Cheikh Anta Diop in Dakar, Senegal **and** Université Pierre et Marie Curie, Paris **David Dickson**, Science and Development Network **Mary Ann Lansang**, INCLEN Trust and University of the Philippines **Salah Mandil**, International e-Health Association **S. Yunkap Kwankam**, World Health Organization
Website	http://rsis.web.cern.ch/rsis/

Introduction

This session focused on the practical application of science to health with implementation of information and communications technologies seen as critical tools in health and development. Access to essential health information and the infrastructure necessary to attain this were seen as important for implementation globally. It was emphasized that information must be relevant to the user, include local knowledge and experience, be in appropriate languages for the population as well as use accessible media. The exchange should be a two-way process and the level of evidence of information be specified and quality maintained through peer review and open communication. Telemedicine, e-Learning and scientific applications were also emphasized and inclusion of developing countries in global efforts such as the Human Genome Project and disease surveillance was seen as essential. Nutrition, safe water and basic human needs were stressed as a major priority above technology; IT was discussed as an essential tool to assist in making these basic needs more accessible and to integrate health systems in developing countries. Appropriate measures of health care impact for e-Health were viewed as critical and technological measures, for example, 'hits' on web sites were not seen as sufficient indicators for assessing the effectiveness of IT in improving health and health care. Clear measures of outcome showing benefits to the health of individuals and populations must be integrated into programmes using ICTs in healthcare.

For information to be effective, it needs to be delivered at the right time, to the right people, and in the most appropriate format. New technologies and knowledge reduce the time between knowledge output and its dissemination to the end user; behaviour change and empowerment are among the new challenges required to influence healthcare providers and information providers.

General Summary

This session was preceded by an active online discussion group moderated by Dr Manjit Dosanjh, CERN. Many of the issues discussed online were further clarified at this lively session with much discussion generated.

All the talks can be accessed via www.cern.ch/rsis/health/

Topics discussed included:

- How can remote consultations benefit communities in remote and developing areas?
- What promise do information and communication technologies hold for the health field?
- What are the best ways to achieve greater equitable access to health related information so that the society as a whole can benefit from the latest research and breakthroughs?

The role of health in the information society was discussed from several different perspectives: that of the World Health Organization, the international community, non-governmental organizations, publishers, media, scientists, policy-makers, epidemiologists, medical practitioners, health educators, patients and society at large. Health is seen as part of the information society that involves everyone as stakeholders, the recent history of ICTs already making significant changes in the way that scientists, clinicians and patients access and use data was reviewed. Controversies over free vs. controlled access to information were discussed as well as the importance of security of data. The World Health Organization was described as playing a role as convenor or steward for e-Health and as a catalyst for action. The leadership role of NGOs was recognized in this area and the landmark agreement between commercial publishers was described as a critical first step to health entering the information society. It was pointed out, however, that the flow of information was inappropriately oriented towards industrialized countries while little emphasis has been given to data on health communication between developing countries. The paucity of South–South and South–North information flow was highlighted.

Capacity-building was seen as essential for maximizing the vast information and experience in developing countries. The lack of involvement of any Southern organization in the human genome project was given as one example as well as the lack of data collected in Africa on SARS, hepatitis C, and many other diseases and the unavailability of African publications in medicine. In order to overcome the infrastructure problems and lack of services in developing countries, market globalization was described as one factor holding back the South as well as the lack of recognition of health as a human right in many parts of the world. Publications in medicine need to involve more actively research from the South and data generated in developing countries must be given more priority. Evidence in industrialized countries cannot always be generalized to be relevant to the South. There was considerable discussion about the merits of this and the role of commercial publishers from a global perspective as well as health scientists and clinicians. The divide between rural and urban information as well as between different economic sectors within a given society was also discussed as another example of the digital divide in healthcare.

In this discussion, development was seen as the practical application of science to society's needs, with health viewed as one aspect of science applications that touches us all directly. Successful telemedicine projects were described such as the River Blindness campaign in Africa and a model of e-Health in Mexico working between urban and rural areas. e-Learning projects were reviewed globally and the critical issues surrounding sharing of information and appropriateness of information explored. The role of evidence and the importance of quality of medical information were emphasized. Examples were given (e.g. thrombolytic therapy) where solid evidence was ignored for many years because of a lack of sharing of information in the medical community and lack of capacity for systematic reviews leading to unnecessary redundancy of efforts and lack of appropriate treatment.

For health professionals, the gap could be filled in the short- to mid-term, provided priority is given to investment in ICT infrastructure (power supply, telephone, high-speed network etc.) which is a prerequisite for telemedicine, distance learning and training, and virtual libraries. For people at the grass-roots level, the challenge is a long-term and daunting one because, beyond access issues, they also face cultural obstacles such as illiteracy. Therefore, sound and image are the most appropriate means for disseminating health-related information (mainly frequency modulation broadcasting in local languages). Thus in order to overcome the shortcomings of ICT infrastructure and services in the South as well as imbalances inside individual countries (urban versus rural areas), the issues of market-led globalization and of basic human rights for the population (i.e. health and information) should be considered.

Throughout the discussion, the content, quality, and appropriateness of information itself were stressed. Accessibility of information as well as of the necessary hardware and software and connectivity to achieve effective health communications was discussed. Libraries and the media were seen as important aspects to be included in capacity-building, in addition to the medical and scientific communities talking to the general public and patients. Security and privacy were brought up as concerns in the context of human rights, mental health, and confidentiality issues. Use of local languages and incorporation of local knowledge were also seen as key factors that have been neglected in many efforts to involve healthcare in the information society to date. Two-way communication with developing countries was stressed and emphasis on integration of IT with essential health and human needs was considered a main priority.

Surprising Issues

Many examples were given of the South being left out in the global biomedical scientific enterprise. There were some criticisms of the current emphasis on making Northern-generated data and publications available to the South, with less emphasis on information generated from the South. The discussions strongly emphasized that basic health needs should be a priority in planning and implementation. There was little discussion of technological issues, for example of security, interoperability, or standardization.

Particularly Interesting Issues

The distinction between information vs. knowledge and how evidence-based information can be translated into action and behavioural change were discussed. It was considered important to better understand how evidence and information could be translated into better healthcare policy and improved quality of health care. The problems facing health with respect to the information society are not so much technological in nature as human. The divide is more in the quality and nature of the information itself and accessibility of information must include consideration of language, culture, and appropriateness. The importance of valid, reliable, evidence-based information relevant to health-care professionals at the point of care and available to patients was stressed. The promotion of learner-centred e-Learning and respect for local needs in medical and health professional education was also seen as a priority. Creating enabling environments and capacity-building were put forward as mechanisms to achieve this. Effective policy using e-Health principles, such as seen in the River Blindness experience, can have a major impact on health and healthcare, medical research, and education as well as disease prevention.

Conclusions

1. Capacity-building is seen as an essential tool.
2. Information and knowledge shared must be locally relevant, reliable, and accessible.
3. Though great progress has been made, we face new challenges and must work collaboratively to achieve the next stage of health information development.
4. More emphasis needs to be placed on human factors and behavioural change.
5. Facilitation and communication are keys to success.
6. Evidence and learner-centred e-Learning will further professional development and patient care.
7. Research collaboration can be greatly enhanced by IT strategies, and involvement of researchers from developing countries is important to harness this knowledge.

Recommendations

1. That we prioritize basic health needs, e.g. safe water, food, nutrition, sanitation as the most critical requirement in global health and that we integrate these essential needs with technology such that healthcare can be made more effective.
2. That we maximize the use of indigenous knowledge of information technology and medical-related issues. Both lessons learned and best practices should be shared and feedback mechanisms from all stakeholders should be in place.
3. Capacity-building is essential for e-Health applications and should include all stakeholders and involve the individual, institution, and health systems. Training for health professionals, patients, researchers, teachers and the media should be incorporated in e-Health programmes.
4. That communication be a priority — two-way communication with developing countries is especially important. Sharing of medical knowledge, experience of ICT use, and experience between developing countries and industrialized regions and between developing regions should be incorporated in implementation.

5. That we strive to understand the impact of e-Health application and actively develop and apply appropriate outcome measures relating to healthcare measures.
6. That we promote and cultivate learner-centred e-Learning and empowerment.
7. That we respect local needs, values, appropriateness of information and priorities.
8. That greater investment be made by governments and international aid agencies in the information and communication technologies needed to access essential information, and in training individuals in the use of ICTs for such purposes, especially in the developing world. Long-term and substantial financing should be available for initiatives focused on and driven by developing countries.
9. That we strive to maximize the use of existing knowledge through effective communication and dissemination.
10. That empowerment and support to partners in developing countries be a priority and that we maximize the use of partnerships in different regions, different disciplines and areas of knowledge.
11. That we strive for better integration of evidence and further efforts for effective evidence-based behaviour change for health policy, public health and clinical care.
12. That fundamental scientific information, especially related to health be made readily available on the World-Wide Web, especially that relating to the diseases whose main impact is in the developing world.
13. That the software tools for disseminating this information be made as widely accessible as possible.
14. That world-wide networking infrastructure for distributing this information be strengthened.
15. We request WHO and other UN agencies to act as catalysts for government, civil society and the scientific community, to convene all stakeholders and facilitate implementation of these recommendations.
16. National aid agencies in the information and communication technologies are needed to access essential information, and to train individuals in the use of ICTs for such purposes, especially in the developing world. Long-term and substantial financing should be available for initiatives focused on and driven by developing countries.

14 Contributions to and Benefits from Enabling Technologies

Chair	**Robert Kahn**, President of the Corporation for National Research Initiatives (CNRI)
Rapporteur	**David Williams**, CERN and TERENA
CERN Moderator	**François Fluckiger**
Speakers	**Robert Kahn**, CNRI, USA **Anthony Hey**, UK's e-Science Programme, University of Southampton, UK **Harvey Newman**, California Institute of Technology, USA **Francis Tusubira**, University of Makerere, Uganda **Katepalli Sreenivasan**, Director of the International Centre for Theoretical Physics, Trieste, Italy
Website	http://rsis.web.cern.ch/rsis/

Session Summary

This report starts with a brief summary of the talks, and then provides a synthesis of the themes and outcome of the discussion.

Managing Digital Objects on the Internet

Robert E. Kahn is President of the Corporation for National Research Initiatives (CNRI) in Washington D.C. and was one of the real fathers of the Internet.

Kahn predicts that infrastructure for managing information over indefinite periods will fundamentally alter our use of the Internet and greatly impact both business and society. He feels that 'digital objects' are the key insight (see the presentation for an explanation and example of a 'digital object') and that we essentially have many of the building blocks needed to create interoperable 'digital objects' already to hand.

e-Science and Global Grids in the Information Society

Anthony Hey heads the UK's e-Science Programme. He is at the Engineering and Physical Sciences Research Council, on leave from the Department of Electronics and Computer Science at the University of Southampton.

Hey covered many topics, starting from the perspective of the UK's e-Science Programme. He gave some examples of possible 'collection-based' science which could be enabled by e-Science tools, and suggested that publicly funded research results should not be restricted to the 'primary scientists' who had been responsible for generating the data.

He also described the recently founded Open Middleware Infrastructure Institute (OMII), which is tasked to develop robust Open Source versions of Open Grid Standards, which he feels will help to unlock global creativity. He finished with a 2002 quote from Tony Blair that "[The Grid] intends to make access to computing power, scientific data repositories and experimental facilities as easy as the Web makes access to information."

Networks and Grids for Science and Global Virtual Organizations

Harvey Newman is in the Department of Physics at the California Institute of Technology (Caltech). He has been responsible for many projects using advanced networking for particle physics over the past 25 years. He also heads the Standing Committee on Inter-regional Connectivity (SCIC) of the International Committee for Future Accelerators — the body which coordinates global particle physics.

Newman drew on particle physics to demonstrate the essential role which computer networking plays in sustaining the global virtual organization (GVO) which is constituted by the worldwide particle physics community, but he also emphasized the many different fields of research that have fundamentally similar requirements. The underlying challenge comes from the rapid growth in the volume of scientific data which is being generated by many disciplines, leading to a continually increasing requirement for network capacity to sustain each discipline's GVO. A broad deployment of fibre optic networks and a better understanding of the software needed to sustain high-throughput long-distance file transfers are key elements in the response to that challenge.

In the context of the work of SCIC, and the end-to-end monitoring activity led by Les Cottrell at the Stanford Linear Accelerator Center (SLAC), Newman provided several illustrations of the reality of the 'digital divide' inside the worldwide research community.

Operating at the 8th and 9th OSI Layers to Promote the Spread of the Internet in Africa

Francis Tusubira is the Acting Director of the Directorate for ICT Support at the University of Makerere, Uganda. His ~5 page discussion paper can be accessed at http://rsis.web.cern.ch/rsis/ and your rapporteur strongly encourages you to read that very interesting document.

Tusubira starts by noting that, despite ~15 years of efforts, the Internet has not yet really been deployed in Africa. Even in South Africa, which is in the leading position in sub-Saharan Africa, less than 5% of the population use the Internet, and in most other sub-Saharan African countries the number of users is less than 1% of the population (2002 data).

He believes that one of the main problems is that ICT is not perceived by African politicians and governments as having an important and beneficial impact on economic growth, when compared, for example, to transport infrastructures such as roads. He also comments that there is a major communication gap between ICT and development professionals in Africa. An effective interface could bridge that gap and translate ICT opportunities into real development benefits. He calls for scientists to step into the ring and become direct players in the development forum, rather than being satisfied with a marginal role as precursors or catalysts.

How ICTP Might Provide Concrete Help

Katepalli Sreenivasan is the Director of the International Centre for Theoretical Physics (ICTP) in Trieste, Italy. He started with a short overview of ICTP, which welcomed some 4,000 visiting scientists from about 170 countries in 2002. It also hosted some 40 conferences, schools and workshops.

ICTP has placed considerable emphasis on the issue of providing affordable and usable access for researchers in developing countries to up-to-date research results through eJDS, its Electronic Journals Delivery Service. eJDS addresses both the high cost of standard online access to journals, and the limited bandwidth which is available in many developing countries.

Sreenivasan showed plots of relative Internet performance for different areas of the world, confirming that developing countries, although making progress in absolute terms, show a rather constant time-lag (about one decade) with respect to most developed regions. He emphasized that this is making it extremely difficult for world-class scientists in developing countries to participate effectively in global research teams.

He explained that discussions among many organizations, including ICTP, UNESCO, WHO, FAO, IUPAP, ICSU and others, have led to a strategy where UNESCO will concentrate on the provision of infrastructure and ICTP will emphasize appropriate training and access to scientific literature.

Overall Themes from the Session

One preliminary remark is in order. Technology is important, and the impact which Internet technology might have in driving economic progress in the developing world can easily be underestimated. However, we must not be blind to the fact that many of the developing world's challenges are of a more fundamental nature — such as providing sufficient food, clean water, basic healthcare, protection from strife, universal education, etc. While Internet technology can provide significant help in many of those fields, the non-Internet challenges are already huge.

A first point of note was that, despite the title of the session being 'Enabling Technologies' we spent little time discussing technologies as such. The discussion was much more about issues related to the 'digital divide' and concerning the infrastructure needed to provide for truly global access to the advanced Internet infrastructure now required for participation in most fields of research.

The true 'technology' issues in the session were the presentation by the chair on 'digital objects', and a discussion about 'micro-payments' and the extent to which they might be an enabling technology. The claim was that information providers in developed countries might be more willing to forgo micro-payments to individual researchers from developing countries, rather than to have to negotiate rather complex agreements with the (groups of) universities where those researchers were working.

The Digital Divide: It Exists and it is Deep

Francis Tsusbira told us that Makerere University pays roughly $28,000 per month for its 2.5 Mb/s of satellite connectivity to the Internet. Your rapporteur can confirm that that is a rather standard price for such connectivity. On the other hand, the price that European networks have to pay for a corresponding amount of raw bandwidth, provided via a terrestrial fibre optic cable, can be as low as 5 euros per month. Furthermore, American prices are at least a factor two lower than those in Europe.

Looked at in another way, it is now becoming rather usual that European and American universities are connected to the Internet at 1 Gb/s, or 400 times more than is possible at Makerere. And we should not forget that, by African standards, Makerere is very well connected. Experience gathered in Europe over the past twenty years (during which period enormous progress was made in introducing competition into a telecoms market which was initially dominated by national monopolies) also points out that there is an inherent cost of acquiring bandwidth in (very) small volumes. That effect can be estimated as a factor 5 as one moves from kb/s to Mb/s, and a further factor 5 when moving from Mb/s to Gb/s, leading to an overall penalty of ~25 times if you are forced to buy capacity in kb/s chunks.

The GDP per inhabitant, measured using purchasing power parity, is some 20 times lower in Uganda than in Europe or the USA. [Specifically the Uganda estimate in 2002 was $1,200, compared to about $25,000 in the UK and about $36,000 in the USA].

Accordingly the relative cost of obtaining sensible Internet bandwidth to many African universities is up to 20,000 times that of obtaining similar connectivity in Europe.

Fixing it Requires Political Engagement Rather Than Technological Progress

Making any significant impact on the 'digital divide' requires not so much technological progress as political engagement by the research community.

The first thing that they need to do is to understand the national regulatory regime for telecoms, and the real level of telecoms pricing in the country. What is available and what is the price being charged relative to competitive prices elsewhere? It is also important to understand what technology will be appropriate for local circumstances. With enough understanding of the local market and regulatory situation, and backed up by international comparisons, it is possible to explain to fellow researchers, to students, to university administrators, to telecoms vendors, to politicians, and to normal citizens how excessively high pricing can act as a road-block to economic progress.

The research community must not be inhibited about 'selling' the extremely important role that advanced research plays in driving national economic progress, and also in highlighting the vital role that advanced Internet access now plays in participating in the global research community. The message needs to be that good roads and good Internet access are equally important requirements for successful economic development.

In terms of practical things that need to be done, the summary is that the research community needs to build alliances, and the experience from Europe is that one of the best alliances is to build campus-wide networks and to create a National Research and Education Network (NREN). The point is that driving telecoms costs depends a lot on buying in bulk. You do not need independent Internet connections to faculties, you need one Internet connection to the campus, and an efficient on-campus Local Area Network. And then you need all university campuses in a country to join together, and also the research centres, and buy their Internet access in bulk, and also to create an inter-campus national network (operated by the NREN).

And in all of that 'alliance building' it is vital that the network engineers, the campus ICT staff, and the real end-users are all working together. It takes time to build confidence in this approach, but it is the only way to drive down costs. And, as part of the process, you will find that it is even possible to create alliances with the telecoms vendors, who will start to recognize that the research and education community represents many of their most advanced users, who can help to lead the overall population forward.

It Will Probably Get Worse Before it Gets Better

The use of the Internet by the research community in the developed world is in a phase of extremely rapid growth. That is driven both by 'demand pull' — the fact that the volume of scientific data, information and knowledge is exploding — and by 'technology push' — the fact that advances in lasers, receivers, coding, fibres and interfacing is driving the cost of the bandwidth down. Even to avoid falling further behind with respect to the developed world, the developing countries will need to make very rapid progress in attacking the organizational and economic issues created by dominant, often monopoly, telecoms vendors and lack of modern infrastructure.

In the personal opinion of the rapporteur, the relative situation is likely to get worse over the next 5–10 years before it gets better. However, there are opportunities, which, if bold action is taken, could invalidate this pessimistic scenario. The important point is that the provision of a national optical fibre infrastructure has been shown, in various countries in Europe, to offer an opportunity to 'leap-frog' and for a country to make very rapid progress. The Czech Republic, Poland, and the Slovak Republic, all provide excellent examples — the Slovak national network moved from a Mb/s backbone to a Gb/s backbone over a two-year period without requiring additional funding.

In terms of organizations which can help organize the various national research communities to make progress, the rapporteur feels that ICTP in Trieste could play a very special role, since it brings together an understanding of the aspirations of world-class researchers with a strong sensitivity to, and interest in the needs of, the developing world.

Security

Many people in the audience and on the panel commented that much more investment in security was needed. As we move towards a very pervasive use of ICT in general and the Internet in particular, there is a huge need to ensure that the people accessing services, and offering to pay for goods, are indeed who they claim to be. In return the people need to be assured that their identity is well protected when they engage themselves online. The protection has to cover both technological issues — it should be impossible to intercept such information — and regulatory aspects — to what extent can someone who gets to know your online identity use that information for other purposes?

Publishing and Copyright

In the discussions many people made it clear that the high cost of accessing scientific information, whether online or offline, was a major source of concern in developing countries. There is a general feeling that the present model of scientific publishing is not sustainable, though most people are much less clear about what could form a viable alternative model.

In October 2003, the Second Open Round Table on Developing Countries Access to Scientific Knowledge (Quantifying the Digital Divide) was held at ICTP, Trieste, and the meeting website (www.ejds.org/meeting2003) contains a wealth of excellent information on these issues.

Many of the same issues were also due to be addressed, albeit in the narrower context of global particle physics research, at the HEPgrid and Digital Divide Workshop in Rio de Janiero, Brazil, on 16–20 February 2004. For more information see www.uerj.br/lishep2004 .

Open Access, Open Standards and Open Source

The panel had a discussion about the potential benefits of extensive use of open-source software for developing countries. Tony Hey had made the point that we should aim for at least one high-quality implementation of all open standards to be available in open source form. Hilda Cerdeira had challenged Hey as to where the resources for that high-quality implementation would come from. Hey's answer was that, at least for the areas of Grid middleware for which he

was responsible, the intention was that the Open Middleware Infrastructure Institute (OMII — see www.omii.ac.uk) would provide those resources, and he felt that there was a good chance that the Institute, which was just being set up, would be able to develop a sustainable model for its long-term funding.

Data Management

There had also been many comments from the audience and from the panel about the fact that users needed access to well managed and organized data, and not simply to a random collection of incoherent data.

While not underestimating the challenges which that poses, the panels feel that, over the medium-term, grids will enable broad access to tools which will help disciplines (and a multitude of sub-disciplines) to adopt uniform metadata standards, and widely-accepted ontologies.

Next Steps

1. As a first step we need to encourage researchers in the developing countries to recognize the reality of the present situation — that there is a 'digital divide' and that it is serious and likely to have a very negative impact on research and also on national economic growth.
2. We also need to encourage these same researchers to combine their forces in order to make progress. One point which might seem obvious, but is nevertheless important, is to ensure that universities and research centres in developing countries invest sufficient resources in their campus LANs. European experience has certainly been that the expertise acquired by staff working to support campus LANs proved to be extremely valuable for the development of many other areas of networking. Campus LANs also encourage faculties to work together, to learn from each other, and to pool their demands for wide-area Internet connectivity.
3. At the national level we believe that the creation of a National Research and Education Network (NREN) organization is an important step forward, allowing the country to build up a critical store of expertise. A more general discussion of the NREN issues can be found at http://www.terena.nl/conferences/nato-anw2003/Varna-statement.pdf , which is a document written in response to the complex situation in South East Europe. The NREN should be the place where an analysis is made of the wide-area technologies which are available locally, and of their cost, and where a national strategy is defined.
4. Similarly, a coherent national approach is needed from the research community to issues of open access, open standards, and open source.

Conclusion

There are few simple solutions in the field of Enabling Technologies for RSIS. The technologies themselves are changing very rapidly, and the economic factors are also volatile. In developing countries the resolution of the immediate problems depends at least as much on societal factors as scientific ones, and the research community must engage with the world of politics and national communications regulations. In that field, as in many others, unity is strength, and the creation of NREN organizations can help considerably in making significant progress.

Comments From the Floor

– The path to ICT-driven success in the developing countries must be a multi-step process involving many factors. Major progress cannot be achieved without formulating a clear vision of such a multi-step process. The first step is to introduce facilitating policies at national level. Secondly, programmes must be created that are modelled on successful programmes in better-off regions of the world but which take account of local needs and resources. Thirdly, ways must be found of improving education in rural areas as a support for more advanced development.

- For the future, teachers must be included in thinking about the use of ICTs in the health, medicine and enabling technologies fields. Educators at all levels and those who teach educators must be taught how to use available ICT technologies, must be included in the knowledge network, and must be involved in shaping ICT-based education and learning tools.
- The scientific community needs to address gender as an underlying issue at all levels.
- Developing countries cannot afford the increasing cost of journals. If scientists in developing countries published their results openly, they could run the risk of them being plagiarized. People in developing countries who publish their results on the Internet must therefore be protected. Moreover, free access to all published work might not be compatible with peer review conditions.
- Open publication of journals on the Web is a separate issue from the peer review process. Open publishing in fact implies an even more rigorous peer review process because arguments and reasons for rejecting or accepting a paper come under much wider scrutiny.
- Closing the digital divide and the development gap is a long-term task. Input on how to resolve the digital divide usually comes from governmental bodies or international institutions. In the long run, the scientific community's contribution to this issue will be essential on this since science operates on the premise that, in time, investment in science research brings technological innovation. Scientific communities must therefore contribute to policy-making in this field. The RSIS conference should be part of an on-going effort by the world-wide scientific community and in particular by organizations such as CERN and UNESCO.
- The measure of whether you have knowledge is whether you can create new knowledge. As available resources to resolve the digital divide are limited everywhere, creating a sustainable process of innovation must be the key approach.
- While access to and ICTs and ICT-based technologies is essential for developing countries, an equally critical issue is the need to identify and apply technologies that are *appropriate* to the environment in which they are to be used. The technology push is thus not appropriate in all contexts. The user needs to be in the driving position, communicating priorities and requirements. Good environmentalism, which in this context implies an appreciation of local conditions, is also good economics.

D. Williams, replying to a question on the underlying causes of the immense difference in pricing for Internet connectivity between Africa on the one hand and Europe and the USA on the other hand, added the following remarks:

> "The discrepancy is mainly due to a difference in the technologies used. Within much of Europe there are sufficient companies (studies show that at least four are required) competing to provide fibre-optic access, which is an inherently cheap technology. In Africa the potential heavy Internet users are much more widely spread and there has not been enough perceived interest to sustain the up-front investment needed to deploy fibre-optic infrastructure. The present technology of choice in Africa (satellite) is inherently expensive compared to optical fibres. In addition, the high price of bandwidth and, in many countries, regulatory rules which severely limit the deployment of ground stations, stifles demand. As a result the overall market is not very vibrant, and the economy of scale which comes from purchasing big chunks of bandwidth cannot come into play. The situation in Europe some 15–20 years ago was very similar to what we now see in Africa, but over time it evolved to the present rather satisfactory position. The fundamental role of the research community has to be: to understand which technologies are inherently cheap, to encourage their governments to support competitive investment in infrastructure, and a regulatory environment which allows essentially everyone to deploy their own infrastructure, and to work together to provide common shared technical solutions around each campus and around each country."