The Amateur Computerist

Spring 2004 Netizen Empowerment and the 30th Anniversary of TCP/IP Volume 12 No 2

Netizen Empowerment and the 30th Anniversary of TCP/IP

This issue of the *Amateur Computerist* celebrates a little known but important anniversary in Internet development. In May 1974 an article appeared in the technical journal, *IEEE Transactions on Communication,* which would have an important impact on the world.[1] This article titled "A Protocol for Packet Network Intercommunication" was written by Robert E. Kahn and Vinton Cerf.[2]

The article sets out the design and philosophy for the creation of a protocol. The protocol, was to make possible communication and interaction between many different computer networks, networks under different ownership, control, and often in different countries. Thus users in different countries and on different computer networks would be able to communicate. This is the basis for the birth of the Internet. It is also the basis for the birth of the netizen.

A common myth is that the Internet resulted from development by the U.S. government and its packet switching research on the ARPANET. The ARPANET, however, is but one network of a number of different networks being built by May 1974, when the Kahn-Cerf protocol, as it was commonly known at the time, was officially proposed. The article, "The Internet: On the International Origin and Collaborative Vision", which is featured in this issue of the *Amateur Computerist* documents what is largely an unknown history of the early development of TCP/IP by collaboration among an international group of researchers.

This issue also includes two articles by Izumi Aizu. One is on the role of netizens in Japan. The other was presented at a recent workshop of the United Nation's World Summit on Information Society (WSIS) held on February 27, 2004, in Geneva Switzerland.

WSIS is currently debating the issue of Internet governance and a number of people from different organizations have been invited into the process. The particular task set for the Feb. 27, 2004 workshop was to propose the areas needing consideration to determine a form for Internet governance. During the summary meeting of the workshop, Robert Kahn, who had chaired one of the sessions, indicated that he was surprised when netizen empowerment was raised as a policy consideration for Internet governance.

Kahn wondered whether netizen empowerment is an appropriate concept when considering policy for Internet governance. It helps to raise the question: Is it possible to create a governing structure for the Internet which leaves out the input and participation of users, of netizens? I want to propose that this is a critical question for anyone who claims to be considering issues related to Internet governance.

Very little input from netizens is currently possible into the WSIS process. There are a few online forums that are difficult to join and contribute to, and which do not encourage netizen participation.

These forums can be viewed at:
http://www.onlinewsis.org/

There is no way provided to send an email to anyone who has posted on these forums. Nor is there anyone who is part of the WSIS process who appears to be participating in the forums and considering how to present the issues raised to those who are invited to the UN meetings.

For example, one post on the forum helps to raise critical issues for Internet governance – public access for all, and participation in the decisions

Table of Contents

affecting the future development of the Internet. The person posting on March 27, 2004 writes: "Internet Governance covers different dimensions and wide-ranging issues, hence daunting challenges in implementation. I would like to underline, in this respect, the issue of public access and widening the scope of public engagement in decision-making processes..... Best Regards, Safaa Moussa, EGYPT"[3]

Yet this post was largely ignored on the online forum, and in the continuing deliberations for WSIS as well. Just as the research developing the Internet relied on the interactive participation and discussion among those doing the research work, so the continuing governance of the Internet requires the participation of netizens. A proposal to this effect was submitted to the U.S. government in 1998 and was presented in an English and French version in the *Amateur Computerist*.[4]

On the 30th anniversary of the official publication of the paper that proposed the protocol for the development of the Internet, this issue of the *Amateur Computerist* is dedicated to opening up this discussion online among the users of the Internet, among the netizens, rather than allowing it to be hidden behind the closed doors of the U.N. or of the U.S. government's ICANN.[5]

Notes:

1) V. Cerf and R. Kahn, "A Protocol for Packet Network Intercommunication," IEEE Transactions on Communications, Vol. COM-22, pp. 637-648, May 1974
http://cs.mills.edu/180/reading/CK74.pdf

2) The authors also give credit to an international group of researchers including L. Pouzin, R. Scantlebury, H. Zimmerman, D. Davies, R. Metcalfe, S. Crocker and D. Walden. at the end of their article.

3) The rest of the post reads: "It should be noted that ICT has become indispensable for quick access to information from all over the world and from different sources. It is also a tool for fostering decision-making processes and open dialogue, which makes it imperative to improve public accessibility at the lowest cost possible throughout the world and come up with practical means for bridging the digital divide."

Further public engagement, democracy and expression of views can be promoted through public accessibility to the Internet, to information, government services, policy documents, and civil society activities. http://www.wsis-online.net/igov-forum/forums/message-email?message_id=366112

4) The URL for the proposal "The Internet: An International Public Treasure: is http://www.ais.org/~jrh/acn/text/acn9-1.articles/acn9-1.06.txt. Also the proposal is online at the Dept of Commerce web site. The URL is: http://www.ntia.doc.gov/ntiahome/domainname/proposals/hauben/hauben.html

5) See for example:
http://www.circleid.com/article/ 91_0_1_0_C/

[Editor's Note: On February 27, 2004, the International Telecommunications Union held an experts workshop to address the question of Internet governance. The following was presented as part of a panel chaired by Robert Kahn.]

Netizen Participation in Internet Governance
ITU Workshop on Internet Governance
Geneva, February 27, 2004

Izumi Aizu
Deputy Directory,
Institute for HyperNetwork Society
izumi@anr.org

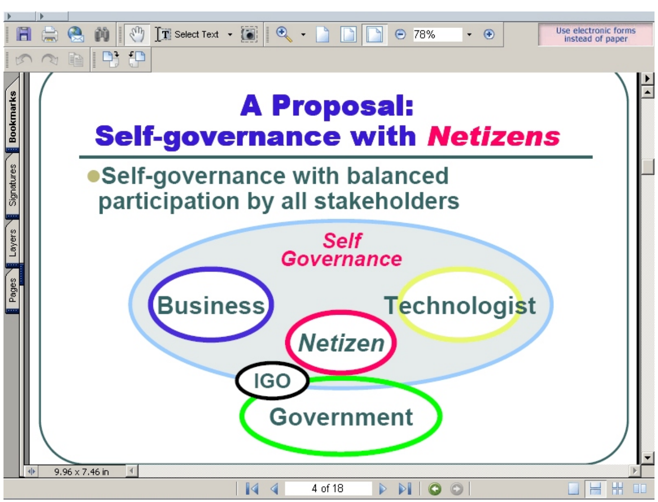
I have been involved with "Internet Governance", or areas of global Domain Name system management since around 1996. I was the Secretary General of the Asia and Pacific Association, which became a formal member of the Steering Committee of the so-called IFWP, International Forum on the White Paper. The IFWP process was a global effort to setup a new body to manage the DNS, upon receiving the call by the United States Government to "privatize" and "internationalize" the DNS management in an open and inclusive approach. We advocated the equal participation in the process and the body, eventually setup as ICANN, from Asia and Pacific regional viewpoints. Today, I would like to provide my proposal of putting the "Netizens" into the global governing framework of the Internet as we are tasked by the WSIS process to do.

There is the WSIS Civil Society Internet Governance Caucus. It has more than 60 individuals from most of the regions of the world and worked very hard to contribute to the Civil Society Declaration for the WSIS in its Internet Governance section. I suggest to you to take the principles proposed there into serious consideration for the coming debate. It would be more appreciated if this group gets formal recognition and is invited as a group to the next phase of the discussion including the Working Group under the Secretary General Koffi Anan.

As we are all aware, we are facing a new kind of challenge for this Internet Governance.

The Internet made it possible to send and receive information from anyone's desktop, laptop, or even from mobile phones on the go, with minimal cost, very easily and instantly, to anywhere in the world, ignoring the geographic and institutional borders including that of nation states. This fact poses trans-national challenges that are difficult to solve by applying the traditional "nation" based approaches.

Frankly, most of the current International or intergovernmental organizations were designed in the industrial age and not ready to deal with these national or global issues as efficiently and effectively as we want. They are slow to identify the issues, slow to come up with solutions, slow to agree with each other, often constrained by national and bureaucratic borders, and too rigid to respond to the rapid, ever-changing technologies and their applications. When they come up with a legal framework against certain types of spams, the spammers are already well ahead of the game creating new methods which are hard to trace and enforce. And this is just a small example of the large iceberg.



Here is a diagram in which "self-governance" will take place.

Therefore, there is a clear need to establish a new governance model in which, I think, the Netizens from Civil society will play a vital role, in cooperation with the government, International organizations, business sector and technical community.

First and foremost, the Internet is becoming an everyday tool, or commodity, for most of us. In Japan over 60% of the population or 70 million people are now using the Internet in one way or other, and 70% of the subscribers are now enjoying a highspeed broadband connection, which gives an "always on" feature. Korea as you know has the highest penetration of broadband, with 80% penetration to the household and the usage is very high. China, now is number 2 in terms of the number of users after the United States with 80 million people. The development of I-mode in Japan gave rise to the use of mobile phones to access the Internet, opening up the age of ubiquitous, or pervasive networking. As pointed out by many previous speakers, the Internet empowers the ordinary citizen with tremendous power – sending thousands of e-mails to millions of people at a cost of a few dollars, sending both positive messages as well as destructive viruses.

With this potential, millions of users are facing, or creating societal challenges. In Japan, victims of online dating services or mobile or ordinary Internet, is on the rise, targeting young women in schools, with more than 100 serious crimes a year. P2P file exchange is posing a threat to copyright holders, but it also is opening up new and creative ways of sharing works among citizens. Compared with these, Domain Names and IP address management is a far less serious problem , but we may face more challenges.

For any Internet governance model to work, it should fit in with the reality of the local and regional situation. As one of the few speakers from the Asian Pacific region, I would like to bring your attention to the very diverse situation of Internet development in our region, from highly developed places like Japan or Korea, to where it is just in its infancy in Afghanistan, East Timor and Iraq, suffering from wars and conflicts, or the tiny economy of Bhutan and many other LDCs. Though the Internet has been mostly developed by the so-called "Internet community" in many Asian countries, similar to that of developed countries, I could say that governments play a greater role in supporting the Internet in infrastructure and capacity building activities.

In the case of Asia and the Pacific, there has been a very strong tradition of voluntary coordination and cooperation among the Internet community. Here are all the "AP" organizations working on different areas of Internet management, from address and Domain Name management to infrastructure development or spam or security matters. We have an annual summit, just taking place right now in Kuala Lumpur, Malaysia, called APRICOT. This voluntary coordination is appreciated by governments but receives no control, nor financial support from government at all. It is working just fine.

As many speakers have already mentioned, we should try to follow the governance model of the architecture of the Internet which is based on a layered structure. Functions of each layer are different, so too the governance models should be. It is also necessary, however, to bring about coordination among different actors at different layers.

The word "Netizen" was first coined by a 20-year old student, the late Michael Hauben, in New York, in 1993. He was trying to identify the new residents of the network community, from Net Citizen to Netizen. These active users were originally found in the technical community, but now they have spread into civil society at large. They are the main actors of the Information Society, as Prof. Shumpei Kumon of GLOCOM offered in his theoretical analysis, that in the Information Society, the social games are played around intellectual values, not economic values, as in industrial society.

We see very active groups affecting the society, like slash-dot in the U.S. or 2-channel, its equivalent in Japan. We know many active political activities are generated from online forums in Korea, where Netizen has already become a common Korean term, affecting the outcome of the Presidential campaign, or in China where people are now starting to use online forums to criticize the government (sometime). The rise of Smart Mobs is illustrated by my friend Howard Rheingold in his book, showing the positive and negative potential impact of using these cheap, open, mobile technologies.

Why then should we let Netizens participate in this global governance? First, for any democratic governance it is necessary to establish the Consent of the Governed as a basic principle of governance. But we should go even further. The Netizen is the main actor in Internet development. Netizens are the great inventors and innovators of such tools as WWW, Mosaic or Netscape browsers, Yahoo by David Filo and Jerry Yang, students at Stanford University, or ICQ or Amazon which were also developed mainly by users. Missing them is like playing football without any top-notch players. Third, decisions around Internet governance will affect so many end-users directly. You need to listen to those who are affected by the decisions.

Netizens will act as a watchdog, or function to provide an appropriate Checks and Balances system, to counter other interests. By involving them they will have more of a sense of responsibility too.

I also want to try to list some merits of having Netizens participate.

First, Netizens have direct knowledge and rich experience on most issues caused by the use of the Internet. If you are the parents, quite often your children know much more about using the Net than you do.

Second, Netizens are flexible, and work more efficiently than many incumbent institutions where protocols and procedures take up too much time and act as barriers for timely decisions.

Third, Netizens are global citizens, not constrained by national boundaries. There are many communities of interest, spread globally, irrespective of geographic or other existing social boundaries.

Netizen participation will increase diversity. By making regional balance compulsory, Netizens from all regions of the globe will participate in governance activities.

Netizens will provide a counter economic balance, not dominated by large corporate interests, but adding non-profit, non-governmental forces. It will also provide cultural diversity, with a multilingual environment. It will reduce the marginalization of the minority, too. By encouraging Netizens to participate, affirmative efforts to listen to minority groups, persons with disabilities, women in vulnerable situations, linguistic minorities, all will have more opportunities for their voices to be heard.

Netizens share the view with the technical community that freedom at the edge of the network is the core value of the Internet. Traditional telecom operators, or mobile phone operators, on the other hand, may not necessarily share this vision and tend to "close" the network by inserting their central control that is convenient for the operators as well as the many "passive" consumers. We are concerned that this may stifle the innovation and development of the Internet we have enjoyed so far.

There are risks of excluding Netizens from the global governance mechanism. If we only rely on technologists, they may lack the human viewpoint. If we rely too much on corporations, aspects of human rights might be compromised in the name of profit-making, e.g. in the case of privacy protection. And if we rely too much on government or bureaucratic mechanisms, then we may face narrow "top-down" approaches or closed decisions.

In conclusion, we need to include Netizens for the self-governance mechanisms to work. This will help solve the dichotomy of private-sector only approach vs strong government involvement. It will create an appropriate, more balanced structure. There are active Netizens in the developing parts of the world who will also enhance the balanced participation. In order to make effective participation of the Netizens possible, it is necessary that their autonomous, distributed and collaborative network of networks exist. Efforts at ICANN At Large is one such example, trying to be bottom-up, coordinated globally, based on the subsidiary principle, that addresses that local issues be solved locally first, and seek for global solutions for only globally challenging issues. We also need self-certification mechanisms in place that work.

I have some suggestions and information for the upcoming process. We should be really open and inclusive: We need to involve more stakeholders from the developing parts of the world, and people in non-Western regions. We should also consider reaching out to people with different backgrounds; people with disabilities, for example, to bring them into the main stream of the debate. For effective outreach, regional meetings are essential to be able to listen to these diverse voices, ones you may not hear here in Geneva or in New York. To show our commitment, we, ICANN ALAC with other constituencies are hosting a WSIS Workshop at the coming ICANN Rome meeting next week. It will be on Mar 4, 2004, 11:00 am to12:30 pm and it is open to everyone. I hope many events like this will be organized to produce fruitful dialogue among us.

[Editor's Note: In honor of the 30th Anniversary of TCP/IP we print the following history of the international collaboration that make TCP/IP possible.]

The Internet: On its International Origins and Collaborative Vision
(A Work In Progress)

by Ronda Hauben
rh120@columbia.edu

"[T]he effort at developing the Internet Protocols was international from the beginning."
Vinton Cerf, "How the Internet Came to Be"

ABSTRACT

The process of the Internet's development offers an important prototype to understand the creation of a multinational collaborative research project which depends on and fosters communication across the boundaries of diverse administrative structures, political entities, and technical designs.

The mythology surrounding the origins of the Internet is that it began in 1969 in the U.S. That is the date marking the origins of the ARPANET (a U.S. packet switching network), but not the birth of the Internet. The origins of the Internet date from 1973. The goal of the researchers creating the Internet was to create a network of networks, a means for networks from diverse countries to intercommunicate. Originally the design was to link up several national but diverse packet switching networks including the ARPANET (U.S.), Cyclades (France), and NPL (Great Britain). When that was not politically feasible, the research project involved Norwegian, British and American research groups, and researchers from other countries, especially France, at various junctures. These research groups did the early development work. The Internet was international from its very beginnings.

Preface

The following work in progress begins the investigation of the collaboration between researchers from the U.S. and several European countries in the early development of the Internet. Both Bob Kahn and Vint Cerf, Internet researchers who are credited with the invention of the TCP/IP protocol, have noted that the Internet was international from its very origins. Yet the common understanding of the development of the TCP/IP protocol, the protocol that made it possible to build the Internet, has been that it was an American development. This misconception prevents the development of an accurate public understanding of the origins of the Internet, and of the lessons that this early history can provide for the future. It is impossible to have achieved the development of an international network of networks, of the Internet, without the international participation and collaboration to build the prototype and the functioning implementations of the needed technology.

This hidden history involved researchers from Great Britain, France, Norway, Germany and Italy, and the U.S. Recently I have also learned of the knowledge and interest in computer networking of researchers in Eastern European countries including Hungary, Russia and German Democratic Republic. How the actual historical development unfolded cannot be known unless there is serious attention to this research while pioneers of these achievements are alive and can be interviewed and encouraged to provide the help they can give. In the following working draft I begin to document some of the links and events that have come to the fore. I hope this working draft will begin the discussion needed to raise some of the research questions involving the Internet's origins that need scholarly collaborative attention, especially while the Internet pioneers are still alive.

I - Introduction: How Will the History of the Internet Be Told?

In a review essay in the December 1998 issue of the *American Historical Review*, the author, Roy Rosenzweig, points to how rarely most histories of the 20th century mention either computers or the Internet. Rosenzweig, however, predicts that this will soon change. He writes: "It is a fair guess that textbooks of the next century will devote considerable attention to the Internet and larger changes in information and communication technologies that have emerged so dramatically in recent years." Then he asks the question, "How will the history be written?"

Discussing several recent books about the history and development of the Internet, Rosenzweig suggests that no one single account is sufficient; that there will need to be a more adequate history written which will include aspects of all the books.

The review raises the question of what is needed to write the history of the Internet. It also considers whether the books already written meet the challenge or if there are essentials left out that can be investigated and documented.

Several of the books that have been written thus far focus mainly on the development of the ARPANET.[1] The ARPANET was an important predecessor to the Internet. It is the network that demonstrated to the world that large scale packet switching would be a feasible form of computer communications technology. Describing the ARPANET's contribution to the development of the Internet, Robert Kahn, co-inventor of the TCP/IP protocol explains: "The ARPANET was helpful in that it demonstrated the power of networking even though for a single network and community. The kinds of things that happened there, happen in all kinds of networks and communities. It also showed the importance of protocols and introduced an example of protocol layering (e.g. FTP on top of NCP on top of the communication subnet.)" (Kahn, E-mail, September 15, 2002.) This new technology made possible the resource sharing of human and computer resources.[2] This background helps to understand the origins of the Internet.

The history of the ARPANET and of packet switching, however, is not the history of the Internet. The ARPANET was a single network that linked heterogeneous computer systems into a resource sharing network, first within the U.S., and eventually it had tentacles to computer systems in other countries.[3] The ARPANET also supported the sharing of human resources and enabled people to interact. But the computer systems had to meet certain requirements, including permission from the U.S. government to connect to the ARPANET. The history of the ARPANET is the history of some of the foundations for the Internet. But it is not the history of the Internet. "What the ARPANET didn't address," Kahn clarifies, "was the issue of interconnecting multiple networks and all the attendant issues that raised." (Kahn, E-mail, September 15, 2002)[4]

II - Purpose

This paper is a beginning study of the origins, international in scope, of the Internet, and of the technology that made the Internet possible. This was the development of the TCP/IP protocol. The purpose of the paper is three fold. The first is to distinguish between the ARPANET and the Internet. In order to look at the origins and development of the Internet, it is important to recognize that the Internet is the solution to the multiple network problem, whereas the ARPANET and other packet switching networks were the solution to an earlier problem: the problem of communication among dissimilar computers and operating systems.[5]

Second, this paper documents the international collaboration and participation to create and develop the Internet that could span national borders and interconnect the computer communications networks of different countries. This collaboration involved the U.S., Norway and the U.K. and researchers from France and then Germany and Italy, at different stages in the process. Creating an Internet was a difficult problem to solve, not only theoretically, but practically as well. To understand the nature of the Internet, it is necessary to understand the multiple network problem and how it was solved. The difficulties were not only technical. Describing some of the difficulty he encountered, a British Internet pioneer, Peter Kirstein writes, “I was certainly ordered, in 1976, to stop work on the Internet Protocol but to concentrate only on European developments. I refused, and pursued several alternate paths for at least another decade.” (Kirstein, E-mail, October 4, 2002.)

Third, a central aspect in the development of the Internet is the vision that inspired and provided the glue for the international collaborative research efforts. To explore the nature and origin of this vision helps to understand the research processes creating the TCP/IP protocol.

III - Packet Switching Networks

Early research efforts to develop a way of transporting computer data led to the development of what is called “packet switching”. Packet switching technology breaks a message into small sections of data, gives each of these addressing information called a header, which together with the data are called “packets”. It then routes and delivers the packets, interspersed with other packets from other messages. After the packets reach their destination, the message is reconstructed. Paul Baran in the U.S. and a few years later, and unaware of Baran's work, Donald Davies in the U.K., developed similar concepts. In 1966 Davies implemented a packet switch connecting a set of host computers. Paal Spilling, a Norwegian Internet pioneer, refers to the resulting National Physical Laboratory (NPL) network as the first packet switching local area hub network. (Spilling, E-mail, August 2002)

In the U.S., there was interest in exploring the feasibility of packet switching for resource sharing computer networks. This interest led the Advanced Research Projects Agency (ARPA) to recruit Larry Roberts, a researcher at MIT's Lincoln Laboratories to join the Information Processing Techniques Office (IPTO). IPTO was planning to establish a packet switching network interconnecting a number of geographically dispersed dissimilar computers.

Networking technology was also of interest to other researchers around the world. In the early 1970s in France, Louis Pouzin was developing a French packet switching network, building on the lessons learned from previous packet switching research. He studied the research developments in the U.S. and Great Britain, and along with his research group, created the Cyclades/Cigale network. In the U.K., the NPL network was being developed by a research group headed by Donald Davies. In the U.S., there was the ARPANET development. The question became how could these networks be interconnected, i.e. how would communication be possible across the boundaries of these dissimilar networks. (Ronda Hauben, “The Birth of the Internet”)

A plan at the time was to connect the ARPANET in the U.S., CYCLADES, in France and NPL in Great Britain. A memo written in 1973 describing early technical plans for this interconnection, included a diagram of these three networks linked by gateways. These gateways would make it possible to transmit messages across the boundaries of different constituent networks. Following is a replica of the diagram (Cerf, *Memo*, p. 5. See Also Graphic I):

```
                                                          (Host)
                                                             /
                                                            /
        (        )                (         )            (     )
       (          )              (           )          (       )
(Host)--(CYCLADES)--(gateway)--(    ARPA     )--(gateway)--(  NPL  )
       (          )              (           )          (       )
        (        )                (         )            (     )
                                       \
                                        \
                                       (Host)
```

Also there was a diagram of data going from a host computer on one computer network to a gateway and then to a host on another computer network.

```
(H)----(G)----(G)---(H)
          \      /
           \    /
            (H)
```

Another description of the goal of connecting these 3 different networks, is presented at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, in 1974. In a paper for a conference there, British researcher, Donald Davies writes: "To achieve... the interconnection of packet switching systems we have to decide at what level they will interwork. The levels chosen could be character stream, packet transport or the virtual circuit. After some discussion, a group including ARPA, NPL, and CYCLADES is trying out a scheme of interconnection based on a packet transport network with an agreed protocol for message transport...." (Davies, "The Future of Computer Networks", *IIASA Conference on Computer Communications Networks*, October 21-25, 1974, p. 36)

Davies' paper is helpful in documenting the interest in creating a meta-network of other networks including the ARPANET, NPL and CYCLADES. Also, however, the occasion of the paper is significant. The IIASA is a research institute which supported collaboration among researchers from the Soviet Union and Eastern European countries and from the U.S., Western Europe and Japan. The conference in 1974 at which Davies spoke was a conference where researchers from these different countries were all introduced to networking technologies and developments of the time, including the ARPANET, NPL and CYCLADES developments.

At a workshop the following year in Laxenburg, in 1975, sponsored jointly by the IIASA and also the International Federation of Information Processing Organizations (IFIP), another British researcher, Peter Kirstein presented a paper that described the collaboration between the U.K. and the U.S. in networking. The paper included a diagram of the satellite and ground connectivity between the ARPANET in the U.S. and the University College London, (UCL) computers in U.K. The diagram also showed the Norwegian connection to the U.S. and U.K. networks. Kirstein's paper, "The Uses of the ARPA Network via the University College London Node" was reported to have been exciting to those present and plans for a network connecting the researchers of the IIASA were developed. The list of those at this workshop included researchers from Austria, Belgium, France, the Federal Republic of Germany, the German Democratic Republic, Hungary, Italy, Netherlands, Poland, Switzerland, the Soviet Union, the U.K., and the U.S. Davies and Kirstein were there from the U.K., Cerf from the U.S., Lazzori from Italy. Kopetz from Austria, K. Fuchs-Kittowski from the Germany Democratic Republic. Also there was discussion at the workshop about what kind of network researchers the IIASA would develop to support their collaboration.

The IIASA conference in 1974 and the workshop in 1975 include reports on the networking research being done to create the Internet and other networks like the European Informatics Network (EIN). It is significant that at a group including researchers from both Eastern Europe, the U.S. and Western Europe, the details of the internetworking developments were presented and discussed. Fuchs-Kittowski, a researcher from the GDR present at the 1975 workshop, remembers discussing possible participation in the UCL network in the U.K. by those from the German Democratic Republic. (See for example, Graphic III) There is at least one discussion in 1976 about whether or not to have an IIASA connection to the ARPANET or to the EIN. There was also international collaboration as part of the IFIP 6.1 working group toward the development of the Internet.

There are various streams of research that made contributions to the development of the Internet. The researchers in France developing Cyclades/Cigale contributed the important concept of the datagram as a means of transporting data. Pouzin also is credited with the creation of the sliding window as a flow control mechanism.[6] There were discussions among those participating in the INWG, later called IFIP, WG 6.1, where decisions were considered about what the standards should be to create the protocol for an Internet. For example, Pouzin describes some of the meetings: "Within INWG, which joined IFIP as WG 6.1, we had lengthy discussions about which level of protocol should be agreed first. It must have been during an INWG meeting on a boat (Stockholm-Turku and return) that a consensus developed on the principle of a common packet format. I don't have a record of this meeting in my diary, but I gather it was in August 1974, at the time of an IFIP Congress." (Pouzin, E-mail, April 28, 2003) Pouzin was also at the INWG 1974 conference and describes some of the discussion there. He writes: "Yes, this was 21-24 October 1974. We kept refining a common packet format. I had cranked up a proposal overnight during the workshop, and I remember Peter Kirstein made some objections after a call to Vint Cerf in the U.S. I don't know if this paper was recorded in history, perhaps as an INWG note." (Pouzin, E-mail, April 28, 2003) Describing the efforts that were made to link Cyclades and NPL, Pouzin explains: "In the end, there never was an interconnection based on this plan. What occurred was a demo during an ICCC conference in Toronto, 3-5 August 1976. There was a Cyclades terminal concentrator (like a TIP) connected to Paris with a leased phone line. There, a link to NPL was using the packet network EIN (alias Cost 11), (if I remember). Then at NPL it was connected to the internal local net. On the exhibit in Toronto, Derek Barber demonstrated using an NPL host through this patchwork. I felt it was amazing, if rather intricate."

"Another more elaborate attempt was the definition of a protocol subset allowing a TCP-IP host to talk to a Cyclades host, without a gateway, simply by using a restricted set of protocol features. This work was carried out by Alex McKenzie from BBN. He wrote an INWG note. Maybe someone has a copy! Presumably, there was not enough steam, and money, to implement the idea." (Pouzin, E-mail, April 28, 2003)

IV - Great Britain and the U.S. Plan to Collaborate

As early as the end of 1970, there was discussion between American and British research groups on how to link the U.S. and U.K. networks together. One plan was to utilize the connection between the U.S. and Norway connecting the NORwegian Seismic ARray (NORSAR) near Oslo to the U.S. Describing this discussion, Peter Kirstein of the University College London (UCL)[7] writes: "In late 1970, Larry Roberts proposed to Donald Davies that it would be very interesting to link their two networks together. The existence of the Washington to NORSAR line would make it comparatively cheap to break the connection in London and link in the NPL network. There were two problems with this plan; first of all we underestimated the tariff implications of adding the extra drop-off point; secondly, the timing could not have been worse from a British national perspective. The problem was that the British government had just applied to join the European Community; this made Europe good and the U.S. bad from a governmental policy standpoint. NPL was under the Department of Technology and Donald was quite unable to take up Larry's offer. He had to concentrate on European initiatives like the European Informatics Network (EIN). In the meantime, I had been interested in the ARPANET from the beginning; it was therefore agreed early in 1971, that we would attempt to set up a project link in UCL instead of NPL." (Kirstein, E-mail, July 3, 2002)

Through discussion between the U.K. and IPTO researchers, an agreement was reached for a research collaboration. Larry Roberts, according to Kirstein, "agreed to provide a Terminal Interface Message Processor (TIP) for the project, valued at 50,000 pounds, and to allow us to use the very expensive existing transatlantic link. It was merely for the U.K. to provide any manpower and travel costs needed to complete the project, and to provide the (assumed modest) cost of breaking the communications link in London.... By the end of 1971, the technical proposal was complete." (*Ibid.*)

Kirstein describes how he struggled through most of 1972 trying to get funding support from the British government without success. "These machinations," he notes, "took most of 1972, and by the end of that period, the situation looked hopeless. Neither the SRC (Science Research Council) nor the DOI (Department of Industry) would supply any finance." (*Ibid.*)

Also the situation had changed with regard to the Washington to NORSAR link. "The Scandinavian Tanum Earth Station in Sweden had come onstream," writes Kirstein. "As a result the U.S. Norway connection no longer passed through the U.K. Hence a new 9.6 kbps link between London and Kjeller was needed; the cost of this link was going to be very expensive." (*Ibid.*)[8]

Fortunately, the British Post Office (BPO) and NPL, two British government organizations, came through with the promise of support. Kirstein continues[9]: "Two senior directors of the BPO, Murray Laver of the National Data Processing Service, and Alec Merriman of Advanced Technology, agreed to provide the finance for the U.K. Norway link for one year. In addition, Donald Davies agreed to promise the most he could sign for personally, (5000 pounds). With these two modest contributions, I told Larry Roberts that we would proceed." (*Ibid.*)

Even with this support, however, Kirstein was faced with a difficult working environment in the U.K. He writes: "It would be nice, in retrospect, to have called it a British decision; it was not. There was grudging support, and the main research initiatives were in pursuit of the X.25 protocol suite and its upper levels. There was almost no European activity on the Internet Protocols outside Oslo and UCL." (Kirstein, E-mail, October 4, 2002)

V - U.S. and Norwegian Collaboration is Arranged

While these negotiations between UCL and IPTO were ongoing, IPTO invited Norwegian researchers to collaborate on resource sharing network research. After an invitation to the Norwegian Telecommunications Administration (NTA) did not generate interest, the IPTO extended an invitation to the Norwegian Defence Research Establishment (NDRE, "Forsvarets Forskningsinstitutt").

NDRE welcomed the proposed collaboration. According to Yngvar Lundh, one of the Internet pioneers in Norway, NDRE's interest in basic computing and networking research was the reason for the Norwegian collaboration with IPTO.[10]

On September 18, 1972, Larry Roberts and Robert (Bob) Kahn visited Norway, meeting with Lundh, then a research engineer at NDRE, Finn Lied, the director of NDRE, and Karl Holberg, the research superintendent of the NDRE electronics department. (Lundh, E-mail, April 24, 2002) Lundh had met Roberts several years earlier during Lundh's sabbatical in 1958-9 as a visiting researcher. He was at MIT's Electronics Systems Lab where Roberts was a graduate student finishing up his PhD. They were both using the TX-0.[11]

Lundh recalls that the meeting with the visitors from IPTO was held in Oslo at a civilian research administrative office at the Royal Norwegian Council for Scientific and Industrial Research. Also at the meeting were representatives from other Norwegian organizations. (Lundh, E-mail, April 26, 2002.) In a history in Norwegian of the role of Norway in early Internet development, Gisle Hannemyr writes that Lundh saw the collaboration with IPTO as "an opportunity to further advance data communication research in Norway." (Hannemyr, E-mail, his translation)

Roberts and Kahn invited NDRE to collaborate and recommended they send researchers to the first International Computer Communications Conference (ICCC'72) planned for October 1972 in Washington, DC. There was to be a demonstration of the resource sharing packet switching network that was being developed in the U.S. Describing the importance of this event, Donald Davies writes: "The meeting at the Washington Hilton in 1972 was quite the most important and influential conference I have ever attended.... I arrived at the Hilton Hotel early to see what was happening and met an extraordinary scene. On a podium was 'Terminal IMP' or TIP...joined to the existing ARPA network, surrounded by many terminal devices of all kinds."

"The astounding thing was a crowd of young, enthusiastic researchers who were rushing around or huddled in earnest discussions trying to get everything to work. Listening to their conversation we heard all that we had been trying to promote for the previous 5 years being talked about as self evident – a new and strange experience. Most of all, one had the impression of a great amount of intellectual effort now being applied to computer networking, which must grow in importance."

"It was a complete turn-around, seemingly in one day, though in fact it was the enormous efforts of the ARPA team that achieved this demonstration and caused the revolutionary change in thinking about networks."

"It completely changed attitudes to computer communications. Yet, many of the ideas it fostered had been talked about for five years or more. What happened in Washington was that people could now see these ideas in the form of practical achievements. They could get a glimpse of the intellectual impact that networks were destined to produce." (Donald W. Davies, "Early Thoughts on Computer Communications")

Lundh writes that he attended the ICCC conference on October 25 and 26, 1972. While at the demonstration, he was invited to attend a meeting with other networking researchers from around the world held after the ICCC'72 at the Comsat Corporation (at L'Enfant Plaza). He writes that this meeting "may well have been the first Internet meeting." (Lundh, E-mail April 26, 2002) This was also the meeting where the International Network Working Group(INWG) was created. Lundh reports that at the meeting at Comsat, "The discussion(s) were in rather general terms as I recall, and mainly clarifying reasons for establishing a net of nets where each individual net would use the best low level protocol for utilizing the respective transmission. He estimates that there were 10-15 people there that day. Certainly Bob Kahn and most likely Dick Binder from BBN." (Lundh, E-mail, June 24, 2002) Kirstein notes that he was there. Cerf adds that he was there, along with Steve Crocker from ARPA, Louis Pouzin, Gesualdo Lemoli, Roger Scantlebury and perhaps Donald Davies. Also Kirstein presented a paper at the ICCC'72 conference.[12]

Although the research proposed by IPTO was new to him, Lundh found "the ideas interesting and accepted the invitation to participate in the development." (Lundh, E-mail, April 9, 2002) To actively participate in the research, he built "a small group of researchers which became one of ten groups which took part in basic Internet research during a ten year period from 1972." (Lundh, E-mail, April 9, 2002) He was frustrated, however, trying to muster resources and was hoping for some assistance from ARPA. But he also realized that it was difficult for IPTO to help fund the Norwegian researchers. (Lundh, E-mail, July 12, 2002)

Lundh reports, "I had no financial support in the beginning, but I formalized a small 'job' called 'Radio Data Systems-RADA' at NDRE with the purpose (of) fitting in with ARPA's resource sharing (research)." In the beginning of the collaboration, Lundh had to support the travel and the research he did in his spare time with other projects he was working on. For the first few years, he recalls, he had help from two graduate students whose thesis work he was supervising.

The ARPANET TIP was not put at NDRE which was in a military area with restricted, and thus, limited access. Instead it was placed in NORSAR's building which was on the other side of the fence from NDRE. Lundh explains that "seismic array technology or test detection was not NDRE's reason for placing the NDRE TIP at NORSAR.[13] It was a practical arrangement for us, and probably a convenient arrangement for ARPA too." (Lundh, E-mail, April 18, 2002) The TIP at NORSAR was thus at a civilian facility, providing access for more widespread Norwegian participation in networking research and facilitating academic collaboration in networking.(Lundh, E-mail, April 18, 2002)

A problem the Norwegian group faced, according to Lundh, was that it was difficult to build a research team given the lack of funding. "It was hard to convince Norwegian financing sources of the importance of computer networking," Lundh writes. (Lundh, 18) He was excited by the concept of resource sharing. "My reasons for wanting to participate were that I intuitively thought the possibilities of resource sharing were fantastic." Lundh elaborates, "I saw 'resource sharing' as (providing -ed) interesting possibilities in several 'dimensions', resources being expensive programs, special data, ideas, people with various interests and capabilities, etc." (Lundh, E-mail, July 12, 2002) Despite these funding difficulties, the Norwegian research group made an important contribution to the development of TCP/IP and the Internet.

VI - How to Communicate Across Network Boundaries?

Shortly after the successful ICCC'72 conference, Bob Kahn left his job at Bolt Beranek and Newman (BBN) and went to work at IPTO. Joining IPTO as a program manager, Kahn initiated certain projects and also took over responsibility for one that had already been funded. A new initiative was to create a ground based packet radio network. An existing initiative was to create a satellite-based packet switching network. (Ronda Hauben, "The Birth of the Internet", 7)

The ground packet radio network would be of particular interest to the U.S. Department of Defense (DoD), as it would make packet switching computer networks possible in otherwise difficult to reach areas or conditions. Kahn's objective was to create a multinode ground packet radio network (PRNET) where each node could be mobile. In parallel, he sought to create a packet satellite network (SATNET) utilizing INTELSAT satellites.[14] The goal of the packet satellite network research was to make resource sharing computer communications networking possible with different European sites. Two of the networks (PRNET and SATNET) would use radio transmission and the third network which already existed (ARPANET) used shared point to point leased lines from the telephone company. Though Kahn originally considered the possibility of seeking changes to each of the constituent networks to solve the multiple network problem, he soon recognized the advantage of an architecture that would directly accommodate a diversity of networks. To join an existing network like the ARPANET would require another network to become a component of it. Kahn conceived that there was a need for an architectural conception that would allow the communicating networks to function as peers of each other, rather than requiring that any one become a component of another. He saw there was a need to design an architecture that would be open to all networks, an architecture that Kahn called "open architecture".[15]

VII - Designing Protocols and Specifications for an Internet

Once at IPTO, Kahn invited Vinton (Vint) Cerf to collaborate with him. Kahn wanted to design an open architecture protocol and needed Cerf's knowledge of computer operating systems to do it. Other researchers were also interested. For example, at an INWG meeting in June, 1973, in New York City, Kahn and Cerf were joined by E. Aupperle, R. Metcalfe, R. Scantlebury, D. Walden and H. Zimmerman. Scantlebury was from the U.K. and Zimmerman, from France. Others listed were members of the U.S. network research community. The document also credits G. Grossman and G. LeLann for contributing after the meeting. LeLann was from France. (*INWG note #39 NIC # 18764*, dated 9-13-73). Cerf explains that LeLann worked with Louis Pouzin at IRIA (now INRIA) and "spent 6 months working with me and others on the design of the Internet's TCP protocol." (Cerf, E-mail, April 13, 2003) Pouzin also remembers a June 1973 INWG meeting, noting that it was quite hot in NYC. (Pouzin, E-mail, April 28, 2003)

The *INWG note #39* is a draft paper that Kahn and Cerf prepared for presentation at the September 16, 1973 INWG meeting in Brighton, England. A revised draft of the paper was published in May, 1974, titled "A Protocol for Packet Network Intercommunication" in the *IEEE Transactions on Communications*. The paper describes the philosophy and design for the TCP/IP protocol, though the original paper called the protocol TCP, as the IP function was originally embedded in TCP.[16]

After designing a protocol, there is a need to write specifications to implement the design. [16a] Cerf refers to the development of two versions of the specifications for TCP developed at Stanford University, one in December 1974 and a second in March 1977. Subsequently two further specifications were developed with other groups.(Cerf) Among the names of those working on the initial specifications for TCP, Cerf lists U.S. researchers or graduate students including Y. Dalal, C. Sunshine, R. Karp, J. Estrin, and J. Mathis, at Stanford; R. Tomlinson and W. Plummer, at BBN; R. Metcalfe, D. Boggs, and John Schoch, at Xerox PARC. He also lists several researchers from the U.K., from UCL, F. Deignan, C. .J Bennett, A. .J Hinchley and M. Gallard. Cerf also thanks G. LeLann from the University of Rennes, France. Cerf writes that Dag Belsnes, from the University of Oslo, Norway provided "additional philosophical leavening which influenced the design of the protocol."(Cerf, *The Final Report, IEN 151*, 2)

When asked what he thought the term "philosophical leavening referred to," Belsnes responded, "I also wonder what 'philosophical leavening' is referring to. Perhaps that I always like to discuss and establish some understanding of problems."[17]

In 1973, Belsnes received a one year grant from the Norwegian Research Council. After meeting Vint Cerf at a conference in England in 1973, Belsnes contacted Cerf and was accepted to be part of the research effort at the Digital System Laboratory at Stanford University. "I got the opportunity," Belsnes writes, "to participate in his Protocol Design Group that worked on creating a specification for the Internet Transmission Control Program." Belsnes explains that among his main interests were "protocol correctness and flow congestion control." (Belsnes, E-mail, June 17, 2002)

Creating a design and then specifications for the development of a protocol for internetworking is a significant step. It is, however, part of a larger research process. Elaborating on the value of the experimental work, Paal Spilling, another of the Norwegian Internet pioneers, writes: "A group at Stanford University (SU) specified in detail a control program ... the Transmission Control Program (TCP) allowing computers in different inter-connected networks to communicate.... Although the TCP was specified in detail, it had to be considered as a first approach towards making a reliable process-to-process communication tool in an internetwork environment. Experience showed that this was the case.... The results obtained, helped in the debugging of this first version of the TCP, and uncovered some deficiencies in its design. Some of these could be taken care of rather easily, while others were subjects for further investigations." (Spilling, *Proposal to NATO*)

Kahn had recognized the need to include at least three different kinds of packet switching networks to test if the protocol created for intercommunication among dissimilar networks would be adequate. If a prototype has only two different entities, it is difficult to tell what is particular about each and what is general about the two. With three or more dissimilar networks as part of a prototype, it is possible to identify what is general to them all despite the dissimilar nature of each.

In June 1973, a TIP was installed at Kjeller, Norway for the NDRE researchers. By the end of July 1973, the UCL TIP in the U.K. was also passing packets between the U.S. and U.K. These packets went from the U.S. via satellite to the Tanum Earth Station in Sweden, via land and underwater lines to NORSAR in Sylvia, Norway, and then to London in the U.K. Kirstein and Kenny provide a diagram of the relation between the U.K. TIP, the Norwegian TIP and the U.S. ARPANET.[18]

Kirstein writes that one of the significant activities in the early work to develop the Internet was "an early protocol experiment in late 1974 between a junior assistant professor at Stanford (Vint Cerf) and a visiting scholar from Norway at UCL (Paal Spilling) of the Proposed Transmission Control Protocol." Spilling, visiting UCL from NDRE, worked with Kirstein's research group. Judy Estrin was a graduate student working with Vint Cerf at Stanford. Estrin and Spilling "did what was probably the first TCP tests with each other. They were independent implementations," Kirstein explains. (Kirstein, E-mail, May 20, 2002.) Describing this research, Spilling elaborates, "As I remember the fellows at the Stanford side may have been Judy Estrin and Jim Mathis. At the UCL side were Frank Deignan, Andrew Hinchley and me. Frank was the implementer. It was extremely exciting to observe packets coming from Stanford and after an initial debugging being accepted and processed by Frank's implementation of TCP. One critical problem I can remember was that the TCP checksum was applied slightly differently at Stanford and at UCL." (Spilling, E-mail, August 1, 2002)

Kirstein describes how the British government became more supportative of his research by 1975. He writes: "The British authorities became increasingly positive from 1975. I had set up a management committee to oversee the use of the ARPAnet link. This included representatives from the British Post Office, the Ministry of Defence, the Science Research Council and the Department of Industry. They had to approve all requests for usage. From 1976, there was increasing pressure for using the emerging X.25 infrastructure (International Packet Switched Service – IPSS) as an alternative to SATNET. First this involved a commercial 9.6 Kbps line from about 1978 between UCL and BBN; here it was necessary to arrange the link so that no commercial charges would arise to BBN and DARPA. Later, I think it was around 1980, a 64 Kbps IPSS link was provided also free of charge by the British Post Office. This link existed until around 1984, and allowed much fuller research into multiple routes with different capacity, charging and access control considerations. The IPSS link was always using IP; for this reason the multiple use of the commercial use and SATNET was an important landmark into the use of interconnected networks. It was their existence which allowed UCL to adopt a phased approach to the adoption of the Internet Protocol. We first proved it on the IPSS link without affecting NCP traffic on SATNET; this needed NCP-TCP relays at UCL and BBN. We could then move it onto SATNET, without impacting too drastically our service traffic – which could use the IPSS route in an emergency. Finally, when the ARPANET had moved to Internet Protocols, we could abandon our relays in BBN and also leave SATNET; all the traffic could use IP/X.25 over IPSS. It is the phased nature of this transition which explains why UCL finally left SATNET (see below) after the Norwegians – though they used IP for service traffic much earlier."

"By the time we got to around 1983, complete alternate mail nets, like UUCP and BITNET started coming into being. The various gateways these provided gave a much richer topology. When the DNS was added, its impact on the international infrastructure was not realised at first. When we introduced blocking on some of our IPSS routes, we suddenly realised the magnitude of international traffic that was passing over the U.K.-U.S. routes originating from these other networks. It was then that the work on peering and service agreements took on a new urgency for these data networks." (Kirstein, E-mail, October 8, 2002)

VIII - Early Norwegian Internet Research Challenges

During its earliest stage, Lundh's research group consisted of his 2 graduate students and himself. By 1974 he was able to get Paal Spilling assigned to his group, Spilling had a PhD in nuclear physics and was interested in the networking project. Subsequently other qualified engineers were assigned by NDRE to the research group. Lundh describes the change Spilling's participation made in the NDRE research group. He writes (Lundh, E-mail, June 12, 2002)[19]: "Paal Spilling came to my group in 1974.... I recruited him from one of my colleague's group(s) at NDRE where he had become superfluous. At that time I had good contact with people in PSP and INWG. I participated in their meetings and knew Peter Kirstein. They were all delighted that I finally got someone beside me. And - as I recall - Peter offered to have him at UCL for a couple of months to give a flying start, which was very good and useful indeed. Paal soon got the whole networking business 'under his skin' and after that participated together with me in all the meetings. He soon became the main contributor to the networking effort at NDRE, for some time being the only one who spent full time in it."

Lundh emphasizes that the continual invitation to the Norwegian Telecommunications Administration Research Establishment (NTA-RE) to participate in the research led to "the free loan for experimental purposes of a spare channel in the INTELSAT IV satellite and a spare line between NDRE and the existing Scandinavian Satellite Earth Station at Tanum, Sweden. This permission was obtained in 1975 permitting the SIMP - Satellite IMP - to be installed at the Tanum Station in mid 1975. From then on SATNET had three ground stations permitting experiments involving contentious traffic situations. Mario Gerla in Leonard Kleinrock's group at UCLA was very active in the SATNET studies which eventually resulted in the CPODA-protocol for Contention Priority Oriented Demand Access." (Lundh) According to Lundh, other researchers in Norway were not eager to use the NORSAR TIP during the 1970s. But interest was expressed by the staff at NORSAR in utilizing the ARPANET as an alternative to the channel they had for exchanging seismic data with the U.S. Lundh notes that "Commercial traffic was prohibited in the Arpanet from the outset and that was still the rule as the network changed into the Internet. The network was an experimental facility supported for research purposes."(Lundh, 18)[20]

IX - Creating an Internet

The protocol suite that makes the Internet possible is known as the TCP/IP protocol suite (Transmission Control Protocol/Internet Protocol). Lundh explains the extensive effort needed to transform the design into functioning protocol specifications. He describes the years of experiments, analysis of the results, and the design of new experiments to test the theory developed from the experimental process. Failures or surprises from the actual experience of the researchers helped them to make the needed changes in the implementation efforts. Lundh writes: "Those protocols resulted from an extremely thorough analysis and design. 'No stone was left unturned' during the development which took several years. Theoretical analyses were complemented by experiments. Combinations of traffic types and requirements, network topologies and application types were imagined, tried, failed, changed and tried again. The 'final' TCP and IP were not easily postulated and approved. Nobody can ever reproduce in a laboratory the chaotic traffic pattern of a lively telecom or computing network and even less the diverse demands of information exchange. The growing active dynamic traffic situation in the ARPANET prevailed during onwards development of its own underlying technology. That may be one reason for the robustness, elegance and survivability of the result." (Lundh, 12)

Lundh emphasizes the importance of a functional network with actual users and traffic as a laboratory for the researchers. He describes how theory grew out of experimental research and then was used to guide the experimental process. In this way, the theory was verified or modified.

Recalling his experience, Lundh writes, "During a period of intensively active development, methods were conceived and perfected until functioning well in an environment which was closer to reality than anyone might have dreamt up in a 'sterile' laboratory." This experimental process was closely intertwined with theoretical development. He adds: "At the same time a profound theoretical understanding was developed. It kept its scrutiny on experimental results and was both guiding and following up the work in an admirable teamwork." (Lundh, 12)

Describing the political conditions that had to be accommodated to create a protocol that would function for the international community, Spilling explains the rationale of the TCP design: "In order to allow Host computers, connected to different networks to communicate, these networks have to be interconnected. This is not a trivial matter, since different networks, in general, are supported by organizations with different requirements and therefore will develop differently. Any changes in existing networks in order to interconnect these, will be costly and impeded by political factors. The obvious approach therefore, would be to leave the local nets undisturbed and to perform the interconnections outside them. This is one of the main ideas behind the TCP." (Spilling, *Proposal to Nato*, 5)

The protocol requirements were such that the networks participating in the Internet would not be limited in their internal development or activities.[21] The use of gateway computers helped in this process. Gateway computers would reformat the packets of data from the form needed by one network into the form to meet the requirements of the next network on their journey to their final destination. The gateway software would also determine the best next path for the packets of data to take to get to their destination.

Spilling explains that when Host 1 (on Net 1) wants to exchange data with Host 2 (on Net 2), it forms the data into Internet packets according to the TCP format and encloses them in the format required by Net 1. This action, he says, is called "wrapping." (Spilling, *Proposal to Nato*, 6) Spilling attributes the term "wrapping" to an article by Louis Pouzin and H. Zimmerman. Internet packets are then transported to the gateway where they are unwrapped from the Net 1 format and rewrapped in the format for Net 2 for transmission to Host 2 (on Net 2).

X - 1970s Networking Collaboration to Develop Internet Technology

Critical to the scientific process of the development of the TCP protocol was the international collaboration of researchers working together on its development. Describing the role of this collaboration, Lundh writes: "(T)he network technology was further refined and developed in an intimate co-operation of ten research groups during the 1970s. That co-operation resulted in the technology underlying today's Internet." (Lundh, 10)

The results were documented and made openly available to anyone around the world, particularly to academic researchers. The period from 1973 to 1980 was a significant period in the research to develop the Internet. For Lundh, the Internet is the networking of interconnected nets. "From the initial ARPANET," he writes, "the technology was developed into a basically new computer cooperating technology – Internetworking technology. Its main constituents were defined as proposed standards around 1980." (Lundh, 10) Further important technical refinements and geographical expansion occurred in the 1980s.

This development was done on a non-commercial research basis. The earliest ARPANET development was done on the basis of leased telephone lines. The research in the mid to late 1970s and into the 1980s, however, included research on Ethernet, packet radio and packet satellite forms of communication. Lundh points out that not only was the ARPANET a laboratory, it was at the same time "an active telecom network, a resource sharing network and a forum of creative and critical people."(Lundh, 12)[22]

Lundh cites an experiment where three people were located in different geographical locations, Boston, MA in the U.S., London, England, and Kjeller, Norway. They held a demonstration conference using speech, which was observed by other researchers in a meeting at another ARPANET-TIP international site, at University College London (UCL). Lundh writes: "Each of the three sites... communicated through local area nets interconnected through gateways via ARPANET and SATNET. The packet traffic in that Internet situation (new then!) was a combination of that speech traffic together with 'natural' traffic in the Arpanet at the time." (Lundh, 13)

Lundh calls this experiment in 1978, "one of the several major milestones during development of Internet technology." He also emphasizes that not only did the Internet research result in important and robust standards, but it also influenced and actually pioneered a new methodology for developing telecommunication standards. (Lundh, 13)

According to Lundh, ten groups collaborated on developing the TCP/IP protocols. The whole team, he explains, referred to itself as the "Packet Switching Protocols Working Group - PSPWG." Eight of the groups were in the USA, one in England and a small group in Norway. "The development comprised investigation of a variety of suggested methods. They were thoroughly studied theoretically and experimentally." (Lundh, 13)[23] Kirstein adds that in phases of the SATNET research, there were researchers from Germany and Italy involved and there were also meetings at their sites.[24]

Communication via e-mail helped the research, along with in-person meetings held every three months that people from each group attended. Lundh credits DARPA/IPTO with providing the leadership and much of the funding for the work. The research, he emphasizes, "had the main purpose to study and develop resource-sharing networks." (Lundh, 14)

The resources to be shared were the 'power' of the computers, programs and data of various types. The human users were also seen as a significant resource. "Further, and not least," writes Lundh, "it was important to create an environment where human resources could co-operate and strengthen creativity and knowledge." (Lundh, 14)

Lundh lists ten of the research groups that collaborated on Internet research in the 1970s. (Lundh, 16)

1. ARPA in Washington, DC, USA; Advanced Research Projects Agency - Information Processing Techniques Office
2. BBN in Cambridge, MA, USA; Bolt Beranek and Newman
3. SRI in Menlo Park, CA, USA; Stanford Research International
4. UCLA in Los Angeles, CA, USA; University of California
5. ISI in Marina del Rey, CA, USA; Information Sciences Institute
6. Linkabit in San Diego, CA, USA; Linkabit Corporation
7. Comsat in Gaithersburg, Maryland, USA; Comsat Corporation
8. MIT in Cambridge, MA, USA; Massachusetts Institute of Technology
9. UCL in London, England; University College London
10. NDRE in Kjeller, Norway; Norwegian Defence Research Establishment

"The tone was open and could be heated although always friendly. A certain amount of social occasions usually took place and stimulated the smooth co-operative spirit. ... The assembled group," Lundh explains, "constituted a strong and inspiring research team." (Lundh, 17) When not assembled, "from day to day the researchers exchanged e-mail. It comprised of discussions, experimental results, comments and programs." (Lundh, 17) From 1977, the usual 2 day PSPWG was "supplemented," by a third day "Internet meeting dedicated to techniques for internet-working of different nets." (Lundh, 17) Also see Appendix.

Following is a list Lundh provides of some of the rotation of meetings. These were meetings between August 1974 and February 1978. (Lundh, 17):

10-11 Aug 74 On the ferry between Stockholm, Sweden and Abo, Finland

4-5 Sep 75 Linkabit Co, San Diego, California; Host: Irwin Jacobs

12-13 Nov 75 UCL, London, England; Host: Peter Kirstein

12-14 Feb 76 DCA and ARPA, Washington, DC.; Host: Bob Kahn

29-30 Apr 76 BBN, Cambridge, Massachusetts; Host: David Walden

29-30 Jun 76 NDRE, Kjeller, Norway; Host: Yngvar Lundh

23-24 Sep 76 UCLA, Los Angeles, California; Host: Leonard Kleinrock

9-10 Dec 76 UCL, London, England; Host: Peter Kirstein

10-11 Mar 77 Comsat, Washington, DC; Host: Estil Hoversten

8-10 Jun 77 NDRE, Kjeller, Norway; Host: Yngvar Lundh

17-19 Aug 77 Linkabit, San Diego, California; Host: Irwin Jacobs

31 Oct-2 Nov 77 BBN, Cambridge, MA; Host: Bob Bressler

1-3 Feb 78 UCLA, Los Angeles, California; Host: Wesley Chu

Dave Mills, who worked at COMSAT, as chief architect for the Internet from 1977–1982, adds that there were several meetings after the ones Lundh lists, at least until January 1, 1983 when ARPANET computers were officially to change to the TCP/IP protocol. The actual Internet coming out party, Mills writes was at the NCC in 1979. (Mills, E-mail, April 28, 2003)

The original vision of resource sharing networking was an important source of inspiration for Internet development. Included in this resource sharing were technical resources, and even more significantly, the sharing of human resources, ideas and suggestions. (Lundh, 10)

XI - The Vision

Spilling credits JCR Licklider with the vision that inspired the Internet developments. “Dr. Licklider, educated both in electrical engineering and psychology, had the vision of 'an on-line community of people,' where the computers should help people to communicate and provide support for the human decision processes....” (Spilling, *The Internet*)[25]

The vision Licklider proposed was of an “intergalactic network”. This was to be a human computer communications networking utility which would function like other utilities in that everyone would have access to it. However, this was to be global and to make it possible for governments, scientists and people around the world to communicate in a way that was unprecedented. Licklider's vision was of an on-line community of people. Computers would help humans to communicate with each other. This vision inspired the early development of the Internet.[26] It is articulated in diverse forms through this formative period of the Internet's development. For example, an editorial in the *ARPANET News* in February, 1974 explains: “Inherent in the concept of a resource sharing computer network is the idea of a cooperative, collaborative working mode. This calls for a very special 'place for people's heads' – a special ability to be cognizant of and concerned for the welfare of the whole. This long-term objective and viewpoint requires a personal feeling of responsibility for the welfare of the network instead of the shortsightedness of acquisitive self-interest.... With the backing of ARPA-IPT in this endeavor... the ARPANET shows every promise of becoming the global tool for enhanced communication and understanding between nations and their scientists and people that was envisioned for it in its beginning.”[27]

The *ARPANET News* editorial suggests that the ARPANET can be an international network. The researchers developing this worldwide networking system, though, recognized the need for something different from a centralized single network like the ARPANET. Networks like Cyclades in France, NPL in Great Britain, and the ARPANET in the U.S. were under the control of different national governments and were developing in different technical ways suited to the needs of the political and administrative entities they belonged to. This was the problem posed for networking researchers of the early 1970s. An international collaboration made it possible to solve the problem of interconnecting dissimilar packet switching networks to make communication possible across their boundaries. Lundh also credits Douglas Engelbart with contributing to the vision of resource sharing.

While Licklider formulated the vision which inspired networking research, Lundh points to Kahn's role in providing an overall direction toward realizing this vision. Lundh writes that “more than anybody else Kahn was the person who formulated goals and guided development of the Internet technology during the most active development period.” (Lundh, 16)

Kirstein concurs. He writes: “Others had much to do with protocol design and implementation detail, Kahn had the overall research goals and direction. He was personally responsible for formulating the programme, and for ensuring that they followed the right lines. Moreover, when other activities, like those of the PTTs at the time, threatened some of the directions of the programme, it was Kahn who formulated activities that kept the programme on the right lines without alienating the PTTs too much. Thus when the British Post Office insisted on the use of IPSS (see earlier), Kahn asked BBN to organise things with relays at BBN in a way that would allow those channels to be used on the U.S. side – even though this had no real interest to him in true Internet research.” (Kirstein, E-mail, October 8, 2002)

Kahn had worked on the BBN proposal to design the ARPANET. He was part of the BBN team to create the IMP subnetwork. He was the author of the original 1822 protocol specification for the interface between the IMPs and Hosts for the ARPANET. He also provided important leadership for the development of the Internet. In an article published in November, 1972, Kahn presents both human and computer interaction in information processing as a property of resource sharing networks. He writes: "A principal motive underlying computer network development is to provide a convenient and economic method for a wide variety of resources to be shared. Such a network provides more than an increased collection of hardware and software resources; it affords the capability for computers as well as individuals to interact in the exchange and processing of information." (Kahn, "Resource Sharing", 116)

Kahn describes how such networks encourage participation among users. This is a cooperative process that generates high levels of technical achievement. He writes: "Computer networks provide a unique mechanism for increased participation between individuals. Participation in research and development using the distributed resources of a computer network can lead to close cooperation between individuals who might otherwise have little incentive to work together. This interaction can further cross-fertilize the network community and encourage even higher levels of achievement through technical cooperation." (Kahn, "Resource Sharing", 117)

In 1972, before the design of the TCP/IP protocol, Kahn proposed that "a communication system not preclude the possibility that separate... data networks may be accessed through it if all resources are to be mutually accessible." (Kahn, "Resource Sharing", 120)[28]

The problem Kahn identified in his article on resource sharing networks is the need for a means to link the networks of different countries.[29]

Intimately tied to the problem of communicating across the boundaries of dissimilar packet switching networks, was the need to support a collaborative process to create a working protocol for an Internet. The requirements for this protocol were that it be as minimal as possible, asking only of the differing networks, what was necessary for internetworking communication. Also it was desirable to have the internetworking process implemented outside of the individual networks whenever possible (via gateways, which were later called routers). Then the networks, themselves, would require the least change, if there were to be a change in the protocol.

The TCP/IP protocol suite requires the agreement of the participating networks to certain gateway and operating system specifications in the host computers. Substantial collaborative scientific research and experimentation were required to develop the design and work out the implementation problems. Utilizing the SATNET research, IPTO and their research community, in collaboration with research groups in Norway and the U.K., developed and then spread a robust and functional protocol design and implementation. Subsequently, German and Italian researchers joined the cooperative efforts. Meanwhile other researchers, particularly French researchers contributed in important ways. This created the basis for a global Internet.[30]

In his book *The Future of Ideas*, Lawrence Lessig advocates preserving the Internet's unique architecture and culture.[31] He proposes that it is the end-to-end principle of networking architecture and shared code that are critical aspects of the Internet. The end-to-end principle requires that the network not be changed to accommodate the uses of individual entities. Instead such uses are to be implemented at the ends of the Internet. This is an important principle for the development of resource sharing in packet switching networks. This is not, however, sufficient to make an Internet a reality. Neither is the sharing of programming code, though this, too, is desirable for Internet development and a desirable networking goal. The critical aspect of the Internet's development is the ability to develop an architecture that asks as little as possible of the collaborating networks and that treats each network as a peer of the other, rather than subordinating any network to any other. This architecture, called by Kahn "open architecture", is the critical principle of the Internet.[32]

This architecture means that each network wanting to interconnect and to communicate does not have to ask any other network for permission to join. This is one characteristic that leads Lessig and others to call the Internet a "commons". Also Internet standards are freely available to all interested. Therefore, any network can implement the TCP/IP protocol suite as part of a host operating system and connect with a gateway to other networks. This "open architecture" of the Internet facilitates its ability to spread around the globe. Networks do not have to change their nature or ownership to become part of the global Internet. The Internet welcomes the technical and political diversity and provides for communication accommodating this diversity.[33] Communication among those with differences is a generative process. It is in the interaction of diverse ideas that new ideas emerge. (Michael Hauben, "The Net and the Netizen", in Hauben and Hauben, *Netizens*)[34]

XII - Conclusion

The earliest development of the Internet and its protocol suite TCP/IP solved the problem of sharing resources across the boundaries of differing networks and peoples. This development took place during the 1970s. It demonstrates the generative capacity of a collaborative environment where the researchers from different nations are able to work together to create an ever evolving and developing Internet. This is one of the most significant developments of the 20th century. Will it be studied and continued? Lessig and others raise the possibility that it may all be lost. A precious heritage has been contributed by visionaries like Licklider and Engelbart, and research pioneers like Kahn and Cerf, Davies and Kirstein, Lundh and Spilling, and Pouzin and Zimmerman. Many netizens have participated to create this important advance for modern society.[35] Its loss would be a great setback to our modern world. A collaborative and resource sharing environment, similar to the one that nourished the Internet's earliest development, continues to be needed, if we are to generate the means for the Internet's ongoing evolution.

Special thanks to Yngvar Lundh, Paal Spilling, Gisle Hannemyr, Peter Kirstein, Les Earnest, Louis Pouzin, Dag Belsnes, Andrew Hinchley, Robert Kahn, Dave Mills, Vint Cerf, Horst Claussen, and Hans Vorst for providing background or documents about this important period of Internet history. Ole Jacobsen, Patrice Flichy and Klaus Fuchs-Kittowski also provided helpful material or suggestions on people to contact, as did several people on mailing lists. Please know the help is appreciated. And thanks to Jay Hauben and in memoriam to Michael Hauben for the work done that has set a foundation for the understanding of Internet history. Also I want to thank Dr. Samuel Moyn for his encouragement, helpful comments and discussion toward the research for this paper.

Notes:

(1) There are several books that document aspects of Internet history, and others that document related developments that set the foundation for the Internet. These include Janet Abbate, *Inventing the Internet*, Cambridge, 1999; Katie Hafner and Matthew Lyon, *Where Wizards Stay Up Late*, N.Y, 1996; Michael Hauben and Ronda Hauben, *Netizens: On the History and Impact of Usenet and the Internet*, Los Alamitos, 1997, John Naughton, *A Brief History of the Future*, N.Y., 1999, Arthur Norberg and Judy O'Neill, *Transforming Computer Technology*, Baltimore, MD, 1996; Howard Reingold, *Tools for Thought*, 1985 and reprinted 2000; Peter Salus, *Casting the Net*, Reading, MA, 1995; Lawrence Lessig, *The Future of Ideas*, New York, 2001.

Vint Cerf observes that a lot has been left out of the current histories, and "that a lot of mistakes are made - the popular 'histories' being the worst. Even when principals write, we forget details or get them wrong." And that one of his biggest complaints is that many books focus mainly on the development of the ARPANET. (Cerf, E-mail, April 13, 2003)

An example of such confusion, mistaking the development of the ARPANET for the development of the Internet, is in *The Internet Galaxy*, where Manuel Castells writes: "The origins of the Internet are to be found in ARPANET.... The openness of the ARPANET's architecture allowed the future Internet to survive its most daunting challenge.... ARPANET's protocols were based on the diversity of networks." (pg 10, 26) (Oxford University Press, 2001)

(2) See Michael Hauben, "Social Forces Behind the Development of Usenet" in Hauben and Hauben, *Netizens*. Draft version online at http://www.columbia.edu/~hauben/netbook. Also see Robert Kahn, "The Introduction of Packet Satellite Communication", *PROC NTC*, November 1979.

To make communication possible among differ entities, there is a need to have some common conventions or agreements. In computer networking technology these are called protocols. Describing the nature of communication in computer networking, Cerf and Kirstein write: "A fundamental aspect of interprocess communication is that no communication can take place without some agreed upon conventions. The communicating processes must share some physical transmission medium (wire, shared memory, radio spectrum, etc.) and they must use common conventions or agreed upon translation methods in order to successfully exchange and interpret the data they wish to communicate. One of the key elements in any network intercommunication strategy is therefore how the required commonality is to be obtained. In some cases, it is enough to translate one protocol into another. In others, protocols can be held in common among the communicating parties." (Vinton Cerf and Peter Kirstein "Issues in Packet Network Interconnection".)

Kahn describes the importance of recognizing the potential for resource sharing in computer networking development: "Computer networks provide a unique mechanism for increased participation between individuals. Participation in research and development using the distributed resources of a computer network can lead to close cooperation between individuals who might otherwise have little incentive to work together. This interaction can further cross-fertilize the network community and encourage even higher levels of achievement through technical cooperation." (Robert Kahn, "Resource Sharing Computer Communications Networks".)

(3) "The ARPA computer communication network, ARPANET ... has been in operation since 1970. The main part of it operates within the U.S., but it has two tentacles, one to Hawaii and one

to Norway and England." (Spilling, *Research Proposal to NATO*, 1)

First Norway was connected to the ARPANET, and then Great Britain. Later even several Eastern European countries were involved with networking and knew of the ARPANET. (See *IIASA Networking Proceedings*, Laxenburg, Austria, 1975)

(4) Kirstein, commenting on the importance of the development of TCP/IP as the means to make an Internet possible writes: "Kahn is largely right, in that the ARPANET community in the U.S. did not address these problems. The Europeans connected to the ARPANET did. As early as 1974, mechanisms for connecting British and French networks with the ARPANET were being explored. By 1978, interconnection between the British Research Network and the ARPANET had one link via SATNET and one via International Packet Switched Service of the British Telecom and Telenet. The technology used was not that of the final Internet: the motivation was there. It was just that the protocol wars had not been settled."

He also comments, "This is the difference, the other mechanisms explored internetworking: they did not embrace the IP protocols." (Kirstein, E-mail, October 3, 2002)

(5) See Ronda Hauben, "Developing the New Field of Computer Communications" http://www.columbia.edu/~rh120/other/computer-communications.txt and Ronda Hauben, "The Birth of the Internet: An Architectural Conception for Solving the Multiple Network Problem" http://www.columbia.edu/~rh120/other/birth_internet.txt

Cyclades was the name for the network and the host computers, while Cigale, for the French word for grasshopper, was the packet switching subnetwork. In 2003, Louis Pouzin was awarded the Legion of Honor award by the French government for his networking contributions to the Internet's development.

Offering a description of the difficult environment that made solving this problem even more challenging, Kirstein writes: "By 1973, many PTTs were pursuing packet-switched networks which led to the emergence of X.25 - which was, incidentally embraced by Larry Roberts then at Telenet. This was meant to be, and actually was, an Internet. All the protocol structure could have been built on top of it. Indeed, in the British Coloured Books, embraced by the British research network, this was done. The technology was packet switched, but the interconnection was virtual circuit. This made it more difficult to move to much higher speeds at the time. However many half truths were prevalent in the '80s to state that X.25 could not exceed 1 Mbps - at a time that the British research network was operating at 8 Mbps." (Kirstein, E-mail, October 4, 2002)

(6) French researchers like Pouzin and others working on Cyclades, and U.S. and other researchers involved with the development of the Internet participated in a number of meetings where they met and shared their research. For example, at a relatively early stage in the development of the research to create Cyclades, the director of the program, Louis Pouzin remembers a visit by Bob Kahn and Vint Cerf to his project on March 19, 1973. Also during that year, Pouzin lists an INFOTECH workshop and INWG meeting in London, Feb. 20-23, 1973, and INWG meeting in NYC on June 7-8, 1973. He lists a NATO summer school in Brighton at the Univ of Sussex in England on Sept 10-14, 1973, and an ACM Data Communications Symposium in Tampa, Nov. 13-15, 1973. (Pouzin, E-mail, April 28, 2003)

(7) Robert Kahn also explains how there was the need to have access to an experimental system in order to develop a Satellite packet switching network. "This is the context in which an experimental program on packet satellite technology was first raised with the British Post Office, with... Comsat and subsequently with the Norwegian Telecommunications Administration and the NDRE." Kahn, "The Introduction of Packet Satellite Communications", Sec 4.5.2.

Dave Mills describes the important negotiations with INTELSAT that Kahn managed to achieve to be able to use satellite for the SATNET program. Mills writes: "I reviewed the common carrier documents for the satellite circuits. Bob actually accomplished something nobody had done before. The war games were played with the government telcos of six overseas countries and two domestic U.S. carriers. None of these guys could function relative to the others.... What seemed to make it work was the participation of the military and military research infrastructures of the U.S. (DoD), U.K. (RSRE) and Norway (NDRE)."

"I don't know where Germany (DFVLR) or the Italians got their support. There was considerable friction between the landline, earth station and satellite providers - they came from very different cultural groups with rigid expectations for revenue."

"Case in point was the INTELSAT tariff for SATNET. SATNET used a single 56-kbps SPADE satellite channel, but eventually seven earth stations shared the channel. INTELSAT wanted to charge full capacity for each earth station separately, even though only uplink operated at a time. Bob managed to negotiate more favorable terms, but then there were the earth station operators, who wanted their fair share of the loot."

"Example: INTELSAT charged the earth station operators about U.S. $.05 per connected minute for the satellite channel itself. You might remember the cost of a call between the U.S. and U.K. was U.S. $2.40 at the time. Guess who got the difference? For monthly cost to COMSAT for the INTELSAT channel of U.S. $2160, COMSAT charged DoD some U.S. $29,000. But, that included the SIMP depreciation used as the satellite interface. Similar gouging occurred overseas." (Mills, E-mail, April 19, 2003)

(8) The Tanum earth station built in 1970-71 made possible international telecom traffic between Sweden and the rest of the Nordic region.

When Dave Mills joined the research effort in 1976, he explains that the NORSAR circuit was multiplexed with SDAC seismic data and ARPANET traffic. The biggest problem he writes, "was the unreliability of the Tanum-Kjeller microwave link." (Mills, E-mail, April 19, 2003)

It is also helpful to know something about the creation of NORSAR to understand the collaborative relationship between NDRE and IPTO.

Lundh explains that NORSAR is the Seismic Observatory built in collaboration with ARPA in South Norway in the mid 1960s. "The initiative and most of the financing," he reports, "was made by ARPA's Nuclear Test Detection Office in an effort to build a foundation for (an) international nuclear test ban and to stop underground nuclear tests...." (Lund, E-mail, April 18, 2002)

This relationship was actually facilitated by a treaty between the U.S. and Norwegian governments signed in 1968. The agreement was toward the construction of a large seismic array and research installation at Kjeller, Norway, just outside of Oslo. After notes were exchanged between the American Ambassador to Norway at the time, Margaret Jay Tibbets and the Norwegian Minister for Foreign Affairs, John Lyng, an agreement was reached which concerned: "seismological research focused on development of methods and systems for detection and identification of underground nuclear explosions." See http://www.norsar.no

The NORSAR (NORwegian Seismic ARay) website describes the conditions of the treaty: "The agreement specified that the purpose of the installation was to be seismological research and experimentation primarily in the field of detection seismology. At the same time the agreement provided that the facility could be used for independent research at the direction of the Norwegian government. A framework for funding the construction and operation of the array facilities was also specified."

"Cooperating agencies were authorized on both sides to conclude administrative agreements to carry out the details of the agreement. The cooperating agency for the United States has for more than 25 years been the Advanced Research Projects Agency, while for Norway the cooperating agency during construction of the NORSAR large-aperture array was the Norwegian Defence Research Establishment, while the Royal Norwegian Council for Scientific and Industrial Research (NTNF)was chosen in 1970 as cooperating agency for the management of the facility...."

"NORSAR opened in 1969. Data gathered by it was transmitted to a data center in Virginia, the Seismic Data Analysis Center (SDAC). By 1970/71 the Nordic satellite station in Tanum, Sweden was opened to transmit the data via satellite. The transmission capacity of the satellite was 2.4 kb/s."

Cerf adds that "The ARPA office in charge of Nuclear Detection was called the Nuclear Monitoring Research Office. Col David C. Russell worked in that office before he succeeded Larry Roberts and J.C.R. Licklider as ARPA/IPTO director. On Russell's retirement from the U.S. Army, Bob Kahn, who was then deputy director of the office, became office director of IPTO." (Cerf, E-mail, April 13, 2003)

(9) With regard to funding the UCL research, eventually there was also "funding from IPTO on ARPANET and then TCP/IP experimentation. The funding mechanism involved the appropriate foreign security reviews, but was otherwise like any other funding." (Kahn, E-mail, July 22, 2002)

(10) It is generally believed that the transport of seismic data from Norway to the U.S. was the reason for the Norwegian connection to the ARPANET. Lundh explains that this is a misunderstanding. It was interest in the research that IPTO was doing, not the desire to transport seismic data more efficiently between the U.S. and Norway, that was the motivating factor for NDRE to accept the invitation from IPTO to join the Internet research program.

(11) Lundh reports that his first contact with ARPA was in Fall, 1965 when he "was invited to Washington and to Billings Montana" on the occasion of the opening of the seismic array in Montana LSSA (Large Scale Seismic Array). Lundh's interest was, he explains, in "powerful computing methods, notably multicomputers." His contacts at ARPA were Harry Sonneman and Stephen Lukasik and occasionally Bob Frosh. (Lundh, E-mail, April 18, 2002)

(12) Kirstein's paper was "On the Development of Computer and Data Networks in Europe", *Proc. Int. Conf. on Computer Communications*, Washington, 240-244, 1972.

Cerf describes some of those present at the ICCC'72. He lists Donald Davies from the U.K., National Physical Laboratory, Remi Despres who was involved with the French Reseau Communication par Paquet (RCP), and later with X.25 networking, Larry Roberts and Barry Wessler, from IPTO, Gesualdo LeMoli, an Italian network researcher; Kjell Samuelson from the Swedish Royal Institute, John Wedlake from British Telecom; Peter Kirstein from University College London; Louis Pouzin who led the Cyclades/Cigale packet network research program at the Institute Recherche d'Informatique et d'Automatique (IRIA, now INRIA, in France). Roger Scantlebury from NPL with Donald Davies may also have been there and Alex McKenzie from BBN probably was there. (Cerf, "How the Internet Came to Be")

Cerf writes that the IFWP later became the IFIP 6.1. with the help of Alex Curran who was the U.S. representative to IFIP Technical Committee 6. Cerf also credits Keith Uncapher and Dick Tanaka with helping this affiliation to be carried out. (Cerf, E-mail, April 13, 2003)

(13) Spilling, however, writes, "Yngvar and I disagree a little on this point. I had the impression that Bob Kahn was looking for a good demonstration object, sort of on a global scale, to defend all the spending on developing the technology. The seismic detection facility NORSAR had to send seismic information across a leased line to the processing plant in Washington, D.C. And what could be a better demonstration object, than to convey this information via packet switching technology from Norway to the U.S. From what I understood, Bob Kahn used this as an example of the usability of the technology – when NORSAR became connected – toward his defence funding party."

Lundh responds that: "I believe Paal may well be right in his impression of Bob's motive for inviting Norway. However, my reason for suggesting that NDRE accept the invitation to actively collaborate and to actually undertake that collaboration was my interest in resource sharing networking and its manifold possibilities. That interest was first inspired by Bob Kahn and Larry Roberts and the Washington, DC conference and demo in 1972. It was further strengthened later by all that we learned and experienced during the following years of collaboration." (Lundh, E-mail, October 15, 2002)

Cerf adds that "The original circuit was 2400 baud so the 9600 baud, circuit, though shared, was faster for the data transport. Later SATNET provided 64 kb/s service." (Cerf, E-mail, April 13, 2003)

Kirstein writes that "It (Seismic array technology or test detection-ed) was ARPA's original reason for placing a TIP there. From the time ARPANET came on-stream in 1970, ARPA wanted to bring the NORSAR array to SDAC in Washington over ARPANET. This is what justified the bulk of the ARPA expenditure (from the Nuclear Monitoring Research Office - NMROP on the link in the early days.) I do not know when the extension...which did result from the extended IPTO interest in the NMRO activity, put actual expenditure in the IPTO budget." (Kirstein, E-mail, October 8, 2002)

(14) Important developments in satellite technology in the 1960s and early 1970s led to the development of INTELSAT IV and made possible the SATNET packet switching network. Abramson and Kuo write: "In 1970 the ARPA Network came into existence as a communications network for the sharing of resources among a large number of computer centers. The ARPANET and its resource sharing capabilities became feasible because of the use of a new method of communication system organization – called packet switching.... In April 1965, the scope and nature of human communication was irreversibly altered by the successful launch of INTELSAT I, the first geosynchronous communication satellite. Since that time the cost of information transmission over long distances has decreased at a rate that makes even the present decrease in information processing costs seem mild by comparison. The cost per year of a single voice grade channel in INTELSAT I was about $20,000 per year; that satellite had a capacity of 24 such channels. The corresponding cost on INTELSAT IV, launched in January 1971 was about $2,000 per year, and each INTELSAT IV has about 5,000 channels...."

"By the beginning of 1973 the lower cost, higher channel capacity, higher power, and small ground stations required by new communication satellites had suggested the magnitude of the impact these developments would make in computer-communication networks of the future.... By the end of 1972, the worldwide satellite communication net of INTELSAT had been completed...." (from Preface, Norman Abramson and Franklin F. Kuo) *Computer-Communications Networks* edited by Abramson and Kuo, 1973, Englewood Cliffs, N.Y., xvii.)

(15) For further elaboration see Ronda Hauben, "The Birth of the Internet" http://www.columbia.edu/~rh120/other/birth_internet.txt and Ronda Hauben, "Open Architecture", in *The Encyclopedia of Computers and Computer History*. Raul Rojas, Editor, Fitzroy Dearborn, Chicago, 2001, vol 2, pp. 652-653.

Kirstein adds: "This was Kahn's thinking, but there was also a practical consideration. The basis of all the network itself between 1969 and 1974 was the IMP, and this was firmly under the control of one division of BBN. With the interest in the Packet Radio and SATNET, any attempt to connect them was delayed by the need to further develop the IMP to meet all its demands. This was one very important reason why Kahn proposed a 'gateway' which could be programmed by others, freeing the programs from the stranglehold of one group. In practice the IMPs could now be developed differently for the different network technologies. Moreover, an important development occurred. Shortly after, in 1975/76 when Dave Mills (then at COMSAT) programmed the 'fuzzballs', to provide a cheaper and more lightweight alternative to the BBN implementation." (Kirstein, E-mail, July 3, 2002)

Cerf elaborates, "In this case, the fuzzballs were functioning as routers - handled IP switching as opposed to the IMPs. The apples-to-apples comparison would be between fuzzballs and the BBN Internet Gateways. I believe in fact the fuzzballs were providing all the functionality of the IMPs and the gateways by switching IP packets." (Cerf, E-mail, April 13, 2003)

Kirstein adds that the development of the application level relay "during this period was also a new form of interconnection" which "allowed all the British network developments to occur independently of the U.S. ones, but traffic still to flow easily between the networks."

He explains that, "This was not an interconnection at the network level, but at the application protocol level (Telnet, FTP initially). This form of interconnection was new at the time, (and-ed) allowed the different networks to develop quite independently. In fact it was to exercise this new concept, that all the traffic between the U.K. and ARPANET was justified in the '70s and early '80s. Later in the '80s, this concept even allowed the U.S. to develop Mockapetris' Domain Name System, while the U.K. developed the 'Network Registration Service'."

"While these developments were quite different," Kirstein notes that, "the relay function allowed them to look to users as a single network.... Clearly application level relays are not adequate in performance or robustness, however, they played an important role prior to the world agreeing that IP was the way to go." (See the article by V.G. Cerf and P.T. Kirstein, "Issues in Packet Network Interconnection," *Proc IEEE* 66, 11, pp 1386-1408, November 1978. This is a special issue devoted to packet internetworking issues.)

Kirstein adds: "In fact the original grant I had from ARPA was to connect in two computers, the large IBM Computer at the Rutherford Laboratory near Oxford and the CDC in London. Both were the centre of centralised proprietary interactive and remote job entry networks. This connection was made as one between two networks from the beginning. It looked to ARPANET as if IBM was directly connected as a Host, and any ARPANET Host looked like a remote IBM device." (Higginson, PL, PT Kirstein and AV Stokes: "The Problems Connecting Hosts into ARPANET via Front-end Computers", *Workshop on Distributed Computer Systems*, Darmstadt (1974). Lloyd, D and PT Kirstein: "Alternative Approaches to the Interconnection of Computer Networks", London, *Proc European Comp. Conf. on Communications Networks*, London, Online, 499-515 (1975))

Kirstein continues: "This was not an Internet design; this was connections at an application level, and hence not very rugged. However, this mechanism continued for the next 15 years, while the British NREN became quite sophisticated, including packet switching, their version of the Domain Name Service (Name Registration Scheme), FTP, Telnet, mail, etc. By 1990, while the links to the Internet had long gone IP, the hosts on the British networks were running a totally different set of protocols. While history (and the analysis we made at the time) showed this was not the best, rugged or fast way to go, it allowed both interconnectivity and independent development of protocol structures to co-exist until all the bugs had been resolved in the Internet protocols, and also commercial products to be produced by new firms such as Cisco." (Kirstein, E-mail, Oct 3, 2002)

(16) The Brighton INWG meeting took place just after the NATO Advanced Institute. Though the original protocol was called TCP, it later was split into two parts and from then on called TCP/IP. When the paper describing the philosophy and design for TCP was officially published in May, 1974, the authors, Vint Cerf and Bob Kahn, wrote: "The authors wish to thank a number of colleagues for helpful comments during early discussions of international network protocols especially R. Metcalfe, R. Scantlebury, D. Walden, H. Zimmerman. D. Davies and L. Pouzin who constructively commented on the fragmentation and accounting issues, and S. Crocker who commented on the creative destruction of associations."(p 643) (See also, Ronda Hauben, "A Protocol for Packet Network Intercommunication", in *The Encyclopedia of Computers and Computer History*. Raul Rojas, Editor, Fitzroy Dearborn, Chicago, 2001, vol 2, pp. 652-653.)

16a)Describing the process of creating a protocol specification, or Request for Comment (RFC), Mills writes, "One of the principal drivers in the standardization effort was the published TCP and IP standards, which were issues both as RFCs and Military Specifications (MILSPEC). Bob considered this a major coup. Later, DoD policy saluted COTS (Commercial Off the Shelf) and told the agencies to avoid MILSPEC. Nobody at the time happened to notice that TCP and IP were MILSPECs.

There is a lot more to the formal specification issues. The RFCs were designed principally as instructions to system programmers on how to implement the protocol and as such should not be considered formal standard specifications. Later at great expense and contractor involvement (SDC) a formal specification was in fact prepared. I was consultant on that project, which did in fact do the right thing. So far as I know, the document is rusting in a dark place." (Mills, E-mail, April 28, 2003)

(17) Remembering the meeting in Brighton, U.K. in September 1973, Lundh writes that he first met Dag Belsnes at it. Lundh writes that "it was clear to me then that Dag knew much more than I did about protocol details."

Describing his introduction to networking research, Belsnes writes that he had "started working with data communication in 1970 at the University of Oslo. The university was (connected) by a CDC Cyber computer together with some other research institutions (among them, the Norwegian Defense Research Establishment, where Yngvar was working) and the computer was to be located about 25 km away from the university campus. I headed a team," he writes, "that implemented a network system to connect this remote (system-ed) at the university (a CDC 3300, Nord computer (a mini-computer of the Norwegian company Norsk Data) and later a DEC 10.) The design of the local university network was highly influenced by what we could read about ARPA and Cyclades networks." (Belsnes, E-mail, June 17, 2002) Explaining Belsnes' contribution, Cerf writes: "Actually Dag worked out the need for a 5-way handshake to assure that old duplicate packets would not be confused for new ones. We concluded this was too much overhead and chose a three way handshake with a timeout mechanism to 'clear the net' of old packets from a given connection. I considered Dag's work to provide a very solid ground for the TCP - as did Ray Tomlinson, Yogen Dalal who worked on the 3-way version and Carl Sunshine who did correctness proofs for this version." (Cerf, E-mail, April 13, 2003)

Also Kuninobu Tanno (from Tohoku University) from Japan was part of the Stanford seminars Cerf held to explore "how to get host computers to communicate across multiple packet networks without knowing the network technology underneath." (Cerf, "How the Internet Came to Be")

(18) See the diagram from the "Uses of the ARPA Network via the University College London Node" by Peter T Kirstein and Sylvia B. Kenny, *IIASA Conference on Networks*, Laxenburg, Austria, 1975, p. 54. Lundh calls Kjeller "the little townlet where some research establishments reside, some 20 km NE of OSLO."

Cerf explains that the TIPs were just part of the ARPANET, "we did not yet have gateways/routers running IP." (Cerf, E-mail, April 13, 2003)

(19) Lundh also writes: "Later, I believe, around 1981-82 when I could no longer get even the small support needed at NDRE, Paal left NDRE (with my blessings) and took the equipment with him to the neighboring institute ('TF'), the research establishment of the Norwegian Telecom Administration. They are located at Kjeller also, just across the street from NDRE and next to NORSAR. Paal was alone there being interested in Internetworking. NTA did not believe in the Internet until about 1995 – similarly to most telecom operators.... I think only one person at TF gave Paal some help during those years. Going back some years again, a few months after Paal joined me he also got another friend of his (Aage Stensby) over from his old group at NDRE, having become 'similarly superfluous' there. However, Paal was the main contributor without any doubt. Later on I was able to recruit a few more people to the networking effort.... The most active ones were Oyvind Hvinden and Finn Arve Aagesen. Both (were) very good people.... Finn Arve is an unusually able person and made a great contribution during the short time he was with us...." (Lundh, E-mail, June 12, 2002)

(20) Kirstein disagrees about the prohibition of commercial sites, though not of commercial traffic. He writes that the UCL connection was to the public telecom and consequently was accessible to both commercial and academic sites. There was broad usage of the network in the U.K. and hence there was much interest in it. As Kirstein explains, "A management committee, which included the British Post Office, had to approve all sites connected and their use. From the late '70s, applications included quasi-commercial usage where one site was a British contractor to a U.S. Agency, and the other the U.S. Agency or another such U.S. contractor – usually in relation to R & D projects. When requested by the U.S. such usage was normally approved; we were only concerned that the experimental nature of the interconnection would not lead to any legal responsibilities to the user entities. In the U.K. we connected the TIP to the Public Telephone network immediately (by September 1973, and to the British research networks (from late 1973))." (Kirstein, E-mail, October 8, 2002.) "I should add," he writes, that "the British Post Office was part of the management committee which was told all that we were doing. For this reason they tolerated activities they might otherwise have forbidden; they were clearly contrary to their monopoly."

(Kirstein, E-mail, Oct. 3, 2002)

(21) Spilling continues: "The control program therefore must be an integral part of the programs in the Host computers wishing to participate in internetwork connections. The device interconnecting the two networks is called a Gateway.... The Gateway is connected to the two networks. Net 1 and Net 2, in the same way as normal Host computers, and therefore looks like a Host to both networks. When Host 1 wishes to exchange data with Host 2, it forms an internet packet according to the TCP format and encloses it in the format required by Net 1, for communications in that network. This action...is called 'wrapping.' The internet packet is then transported to the Gateway where it is unwrapped from the Net 1 format and is re-wrapped in the format for Net 2 for transmission across the net to Host 2. This process can easily be extended through an arbitrary number of networks and gateways. This form of data exchange between Host 1 and Host 2 looks to all intermediate networks like normal host-host communications, thus the local networks are not aware of any internetwork activities. This is taken care of by the TCP's in Host 1 and Host 2 and by the Gateway." (Spilling, *Proposal to NATO*, pg 5)

Cerf explains the process using the term "encapsulation": "We adopted very early the idea of encapsulating IP packets in the packets of connected networks - the gateways would remove the IP packets from the carrying packet format and re-encapsulated it in the next networks packet structure. Of course, before we split IP from TCP, it was just TCP packets that were encapsulated." (Cerf, E-mail, April 13, 2003)

(22) See Spilling, "Final Report," for a description of how the SATNET program was initially developed using the ARPANET and gradually separated apart from the ARPANET. The SIMPs were the Satellite IMPs created for interfaces for SATNET. He writes: "The purpose of the Packet Satellite Program is to develop a general-purpose satellite network based upon the packet-switching principles... In order to utilize as much as possible the facilities available in ARPANET, the initial satellite network was an integral part of ARPANET.... During the program period, the SIMPs were developed to a stage where they could be separated from the ARPANET, so that the SIMP programs could be optimised for the satellite environment.... As mentioned, the SIMPs initially were logically a part of ARPANET and therefore had to obey the ARPANET IMP-IMP protocol. This was done in order to utilize the ARPANET techniques in maintaining and controlling the satellite part of the network from the Network Control Center (NCC) at BBN. Gradually the SIMP programs were evolved to such a level that SATNET could be separated from ARPANET, and its operation fine tuned to the satellite environment. The separation made it necessary to develop an interface both for host access to SATNET and for access to and from other nets...."

(23) See list of the PSPWG notes in Spilling, "Final Report".

(24) Kirstein writes, "Certainly by 1979, the SATNET project as a development project had been largely completed. There was a major meeting in Washington, with a session on SATNET. I know that UCL participated in it.... At that meeting we used packet voice to present part of the proceedings from London in Washington. I am sure that CNUCE (Pisa, Italy) and DFVLR (Munich, Germany) were well and truly aboard by them. Equally clearly the SATNET route had become an operational entity by around 1983, using TCP/IP. Shortly after that the academic parties in Italy and Germany dropped out. The Defence parts never played any important role in network development in Germany, Italy or the U.K." See also Kirstein, PT, et al. "SATNET Applications Activities", *Proc. Nat. Telecom. Conf. Washington*, 45.1.1-45.1.7(1979). (Kirstein, E-mail, October 3, 2002)

Cerf adds that "In fact, we formed a coordination board - the International Coordination Board (ICB) that included NDRE, UCL, the German DFVLR and the Italian CNUCE as well as DARPA to coordinate the international efforts." (Cerf, E-mail, April 13, 2003)

(25) In "The Internet- A Cuckoo in the Telecom Service Nest An Evolution in Packet Switching" Spilling gives as an example of such a decision process – the command and control processes of the Department of Defense.

(26) See Michael Hauben, "The Vision of Interactive Computing and the Future" and Ronda Hauben, "The Birth and Development of the ARPANET" in *Netizens* and Ronda Hauben, "Licklider" in *Encyclopedia of Computers and Computer History*. Often, in funding proposals, it seems that only computer resource sharing is referred to rather than human communication facilitated by computers. See for example Ronda Hauben, Chapter 1, in *Cyberhypes*(in German).

(27) *ARPANET News*, February 1974, Editorial, pp. 2-3.

(28) These statements of a vision for a communications system identified a goal for the development process and thus made it possible to evaluate whether the actual development makes progress toward this goal or not.

(29) Several articles provide an overview to document this international collaborative research process. Such a process, was essential to develop both a prototype and then the Internet. See for example: Kahn, Robert E., "The Introduction of Packet Satellite Communications," in *Proc NTC*, November, 1979, pp. 45.1.1-45.1.6.

Lundh, Yngvar, "Yngvar Lundh: Computers and Communication – Early development of Computing and Internet Technology - a Groundbreaking part of Technical History". in *Telektronikk* Vol 97 No 2/3 2001, pp. 3-19.

Paal Spilling, "Research Proposal presented to NATO, Scientific Affairs Division by Norwegian Defence Research Establishment also on behalf of University College London and Stanford University, California concerning A Study of the Transmission Control Program, a Novel Program for Internetwork Computer Communications." 2 December 1975, NDRE.

(30) Also the packet radio network (PRNET) program made important contributions to the creation of the Internet. See Kahn, Robert E., "The Organization of Computer Resources into a Packet Radio Network", *IEEE Transactions on Communications*, Vol Com-25, No. 1, January 1977, pp. 169-178.

(31) Lessig writes, "The environment of the Internet is now changing. Features of the architecture – both legal and technical that created this environment of free creativity are now being changed. They are being changed in ways that will reintroduce the very barriers that the Internet originally removed." (Lessig, p. 16)

(32) Considering the international collaborative process needed to develop "open architecture" as the foundation for the Internet, it is interesting that Lessig describes architecture as referring "to both the Internet's technical protocols (e.g. TCP/IP) and its entrenched structures of governance and social patterns of usage that themselves are not easily changeable, at least not without coordinated action by many parties." (from Lawrence Lessig and Paul Resnick, "Zoning Internet Speech," *Michigan Law Review,* 98 (1999):395, quoted as footnote 34 in Lawrence Lessig, *The Future of Ideas*, Random House, NY, 2001, p 276.)

(33) See Kirstein and Cerf's explanation of the conventions needed to make communication possible in their November 1978 article.

(34) Describing the work of Licklider and Taylor in their article "The Computer as a Communication Device", Michael Hauben writes: "Their concept of the sharing of both computing and human resources together matches the modern Net. The networking of various human connections quickly forms, changes its goals, disbands and reforms into new collaborations. The fluidity of such group dynamics leads to a quickening of the creation of new ideas. Groups can form to discuss an idea, focus in or broaden out and reform to fit the new ideas that have been worked out." from "The Net and Netizens: The Impact the Net has on People's Lives", Chapter 1 in *Netizens*.

(35) Michael Hauben, "Preface", *Netizens*.

Bibliography

ARPANET News, October 1973.

ARPANET News, February 1974. Issue 12 NIC 21646, http://198.92.252.3/arpanet/

Cerf, Vinton, "Final Report of the Stanford University TCP Project," *IEN 151*, 1 April 1980.

Cerf, Vinton, "How the Internet Came to Be: as told to Bernard Aboba," in *The Online User's Encyclopedia* by Bernard Aboba, Addison-Wesley, November 1993.

Cerf, V.G. and P.T. Kirstein, "Issues in Packet Network Interconnection," *Proc IEEE,* 66, 11, pp 1386-1408, November 1978.

Cerf, V., "Packet Satellite Technology Reference Sources," *RFC892*, November, 1982.

Cerf, V. and R. Kahn, "Towards Protocols for Internetwork Communication," IFIP/TC6.1, *NIC 18764*, *INWG 39*, Sept 13, 1973.

Cerf, V. and R. Kahn, "A Protocol for Packet Network Intercommunication", *IEEE Transactions on Communications*, vol com-22, No. 5, May 1974.

Davies Donald W., "Early Thoughts on Computer Communications", n.d.

Hannemyr, Gisle (1999) *Begynnelsen på en historie om Internett; I Nettsamfunn,* (red., Braa Hetland og Liestøl) Tano-Aschehoug, Oslo, 1999, pp. 11-27.

Hauben, Michael, "The Social Forces Behind the Development of Usenet," in *Netizens*.

Hauben, Michael, "The Vision of Interactive Computing and the Future," in *Netizens*.

Hauben, Michael and Ronda Hauben, *Netizens: On the History and Impact of Usenet and the Internet*, IEEE Computer Society Press, Los Alamitos, 1997.

Hauben, Ronda. "The Birth of the Internet: An Architectural Conception for Solving the Multiple Network Problem." http://www.columbia.edu/~rh120/other/birth_internet.txt

Hauben, Ronda, "Developing the New Field of Computer Communications" http://www.columbia.edu/~rh120/other/computer-communications.txt

Hauben, Ronda, "Licklider", in *The Encyclopedia of Computers and Computer History*. Raul Rojas, Editor, Fitzroy Dearborn, Chicago, 2001, vol 1, pp. 465-466.

Hauben, Ronda, "Open Architecture", in *The Encyclopedia of Computers and Computer History*. Raul Rojas, Editor, Fitzroy Dearborn, Chicago, 2001, vol 2, pp. 951-952.

Hauben, Ronda, "A Protocol for Packet Network Intercommunication", in *The Encyclopedia of Computers and Computer History*. Raul Rojas, Editor, Fitzroy Dearborn, Chicago, 2001, vol 2, pp. 652-653.

Hauben, Ronda, "Die Entstehung des Internet und die Rolle der Regierung"' in *Cyberhypes: Moglichkeiten und Grenzen des Internet*, Rudolf Maresch and Florien Rotzer, editors, Suhrkamf, Frankfurt am Main, 2001, pp. 27-52.

IIASA, *Workshop on Data Communications*, International Institute for Applied Systems Analysis, Laxenburg, Austria, September 15-19, 1975

Kahn, Robert E., "Resource-Sharing Computer Communications Networks," in *Proceedings of the IEEE*, November, 1972, pp. 1397-1407.

Kahn, Robert E., "The Organization of Computer Resources into a Packet Radio Network", *IEEE Transactions on Communications*, Vol Com-25, No. 1, January 1977, pp. 169-178.

Kahn, Robert E., Steven A Gronemeyer, Jerry Burchfiel, Ronald

C. Kunzelman, "Advances in Packet Radio Technology," *Proceedings of the IEEE*, Vol 26, no. 11, November 1978, p. 1468.

Kahn, Robert E., "The Introduction of Packet Satellite Communications," in *Proc NTC*, November, 1979, pp. 45.1.1-45.1.6.

Kahn, Robert E., Babbage Institute Interview (Arthur Norberg) 22 March 1989.

Kahn, Robert E., Babbage Institute Interview (Judy E. O'Neill), April 1990.

Kahn, Robert E., Vinton G. Cerf, "What Is The Internet (And What Makes It Work)", http://www.internetpolicy.org/ briefing/12_99_story.html

Kirstein, Peter, "Early Experiences with the ARPANET and INTERNET in the U.K." (http://www.computer.org/ annals/an1999/a1038abs.htm)

Kirstein, Peter and Sylvia B. Kenny, "The Uses of the ARPANET via the University College London Node," in IIASA *Workshop on Data Communications*, Laxenburg, Austria, 1975, pp. 53-62.

Kirstein, Peter, E-mail, July 3, 2002 E-mail, October 4, 2002

Leiner, Barry, "Globalization of the Internet", in *Internet System Handbook*, ed, Dan Lynch and Marshall Rose, Reading, MA: Addison Wesley, 1993.

Leiner, Barry, et al, "A Brief History of the Internet", Feb 20, 1998, http://www.isoc.org/internet/history/brief.html.

Lessig, Lawrence, *The Future of Ideas: The Fate of the Commons in a Connected World*, Random House, New York, 2001.

Licklider, J.C.R. and Robert Taylor, "The Computer as a Communication Device," in *Science and Technology: For the Technical Men in Management.* No 76. April, 1968, pp 21-31. Also reprinted in *In Memoriam: J.C.R. Licklider: 1915-1990, Report 61*, Systems Research Center, Digital Equipment Corporation, Palo Alto, California, August 7, 1990, pp. 21-41.

Lundh, Yngvar, "Yngvar Lundh: Computers and Communication - Early development of Computing and Internet Technology - a Groundbreaking part of Technical History". in *Telektronikk* Vol 97 No 2/3 2001, pp. 3-19.

Lundh, Yngvar, E-mail April 9, 2002 E-mail April 18, 2002 E-mail April 26, 2002

Mills, Dave, E-mail, April 19, 2003

NORSAR web site - http://www.norsar.no/

Pouzin, L., editor, *The Cyclades Computer Network*, North-Holland, Amsterdam, 1982.

Pouzin, Louis, E-mail, April 28, 2003

Rosenzweig, Roy, "Review Essay: Wizards, Bureaucrats, Warriors and Hackers: Writing the History of the Internet", *American Historical Review*, December, 1998.

Spilling, Paal, "The Internet - A Cuckoo in the Telecom Service Nest An Evolution in packet switching services," in ..... Spilling, P., "The Internet - An Evolution in Packet Switching", INDC'96 Conference, June 1996, Trondheim, Norway.

Spilling, P., Lundh Y, Aagensen F.A., "Final Report on the Packet Satellite Program", *Intern Rapport*, E-290, FFIE, December, 1978.

Spilling, Paal, "Research Proposal presented to NATO, Scientific Affairs Division by Norwegian Defence Research Establishment also on behalf of University College London and Stanford University, California concerning A Study of the Transmission Control Program, a Novel Program for Internetwork Computer Communications." 2 December 1975, NDRE.

Winkler, Stanley, editor, *Computer Communication: Impacts and Implications, the First International Conference on Computer Communication*, October 24-26, 1972, Washington, D.C.

Appendix
Additional Comments from the Researchers

An issue of the *Computer Communications Review* (vol 20, no 5, Oct 1990) provides a set of ARPANET maps documenting different phases in the development of the ARPANET. The maps are also helpful in providing a chronology of the transition from the ARPANET to the Internet.

Following are some of the relevant dates:

Jun. '75 - Satellite circuits now cross oceans to Hawaii and the U.K. First TCP implementations tested in this configuration by Stanford, Bolt Beranek and Newman (BBN), and University College London (UCL).

April '79 - Multiple satellite links to U.K. and Norway. According to Kirstein, one U.K.-U.S. link made via the commercial British Post Office International Packet Switched Service(IPSS) using IP/X.25, the other using the SATNET. Some U.K. traffic starts using the IPSS route.

Mar '82 - Norway leaves the ARPANET and become an Internet connection via TCP/IP over SATNET.

Nov '82 - UCL leaves the ARPANET and becomes an Internet connection.

Cerf writes that in 1979 satellite systems were extended to include the ground stations in Italy and Germany. (Cerf, "How the Internet Came to Be") Horst Claussen confirms this:

Describing the participation of Germany in SATNET, Claussen writes: "Having no access to some of the documents I saved back in Salzburg: the first access to the ARPAnet was established in the 1977-1978 time frame when I was involved in the DARPA HOL program which later on led to the programming language Ada. We connected through a Public Data Network to the VAN gateway at BBN and were 'on the net'. Later on the idea came up to cooperate with the German Space

Research Center (then DFVLR - now called DLR) in Oberpfaffenhofen who was involved in satellite communications and had a cooperation with Comsat Labs. Comsat Labs also was involved in the SATNET and this way we got back to DARPA - Bob Kahn was very supportive and so was Vint Cerf. Then I joined DFVLR in 1981 and we found support in the German Ministry of Defense and we also could get funding for a PSP (I recall that the thing cost U.S. $275K - and that at a time when the exchange rate for the German Mark fell through the bottom!) The most difficult thing was to get the support of the German PTT - Research Center people who 'owned' and operated the old Symphonie Station at Raisting; Symphonie was an early satellite project funded by the EEC which had been terminated and there was this beautiful antenna and ground station building sitting empty at Raisting. Mostly through the unofficial support by the local engineers we were able to set up the PSP and the gateway at Raisting and connect to the research center at Oberpfaffenhofen which is some 20 miles away. Don't ask me how much we had to pay for the 9.6kbit/sec leased line from Oberpfaffenhofen to Raisting - horribly expensive.

When it comes to the exact dates I will have to dig up some of my old files but officially it must have been at least 1982, maybe even 1983 until we got the official permission, however, we did operate the SATNET station almost a year under a 'temporary testing agreement'.

In May 1985 we ran a combined Packet Radio - SATNET demonstration for the German Armed Forces and for the U.S. Army at Heidelberg simultaneously and this was quite successful. SATNET was in operation after I left DFVLR for another year or two and used mainly for measurements and tests besides being used for Internet protocol development. (I forgot to mention that we did implement IP, TCP, UDP etc. in Modula-2 for our own VAX system and that this implementation was later ported to the Siemens computers used by FGAN (another government lab working for MOD) for the Packet Radio - SATNET demonstrations." (Horst Claussen, E-mail, April 17, 2003)

Hans Dodel offers a similar account: "The German participation in SATNET began in the seventies, when the German military became interested enough to ask their 'Consultant Agency' IABG to watch what was going on there. Within IABG it was Dr. Horst Claussen who would come to the SATNET meetings then, which I joined in 1979 or 1980."

"Horst and I both joined the German Air and Space Administration DFVLR and spent many years there, working on SATNET and establishing the first Gateway to SATNET in continental Europe. (I think the Royal Signals and Radar Establishment in Malvern, U.K., beat us by a few months.)" (Hans Dodel, E-mail, April 17, 2003)

These accounts help to document that there were both ARPANET and Internet connections between UCL, Norway, Germany and the U.S. The Packet Satellite Program (PSP) provides a means of understanding the transition from the ARPANET to the Internet with the development of TCP/IP. First the ARPANET was used to develop TCP/IP. Then SATNET was created as a packet satellite network, and the research on TCP/IP was transitioned from the ARPANET to SATNET providing communication between diverse networks via TCP/IP. Hence this was an important step to creating the Internet. A series of Packet Satellite Program Working Papers (PSPWP) were issued to document "Ideas, specific investigations, and results and software and hardware specifications." (Spilling, Lundh, and Aagesen) Like the Packet Switching Protocol group that Lundh describes, the Packet Satellite Program (PSP) held regularly scheduled meetings, rotating through the institutions where the researchers worked. This was to encourage the exchange of ideas and the coordination of their activities. Norwegian researchers explain the nature of the program. They write (Spilling, Lundh, and Aagesen): "In mid 1975 the Packet Satellite Program (PSP) was initiated by DARPA, with the purpose to develop a satellite-based, packet-switching communication network, to demonstrate its capabilities, and to investigate its performance factors."

The program involved the collaboration of a number of research groups in the U.S. and Europe. In the appendix to the Report they list the groups.

SATNET was used as an experimental testbed for their research. To begin with, SATNET was an integral part of the ARPANET, but as the research evolved, SATNET became a free standing separate network. The devices connecting SATNET with the ARPANET were called Gateways.

Describing the importance of gateways and Kahn's foresight regarding the development of the Internet, Kirstein writes (Kirstein, E-mail, July 3, 2002): "Bob Kahn's real contribution here was to recognize in 1974 the conceptual need of these gateways and to design them at a level which would endure."

Kirstein also describes other important innovations that were crucial at the time, but didn't endure. Yet these innovations played an important role in helping the Internet survive a number of obstacles it faced. Kirstein writes, (Ibid): "One of the really important developments of the mid '70s was the ability to create relays and gateways between networks to allow different technologies to be interconnected – without a complete capitulation by each group to adopt the U.S. and Internet Suite. Some like DECNET and BITNET capitulated in the late '80s; others like the British networks, stayed different until the early '90s. However, it was because they were interconnected, and IP was then demonstrated to be better that it really won the war.... My own approach was pragmatic; it worked well at the level, and for the purpose, that I intended; however, it could not be extended to meet the needs of the future generation. To give...an example of the importance of the connection capability, I was ordered by 1977 (by people in our research council) to stop work on IP networks, because they were contrary to the British activities. It was only because of support from other bodies in the U.K. and U.S., and because I could continue to work with the IP networks connected to the favoured British flavours, that the large-scale experimental services could continue over the next 10-12 years."

Elaborating on how ARPANET and SATNET were different entities, Spilling writes: "ARPANET and SATNET operated in parallel for a long period. UCL in London and NDRE at Kjeller had both access to ARPANET via a TIP at UCL and a TIP at Kjeller.... There was a leased line from London to Kjeller and a fully or partly defence-related line from Kjeller to Wiesbaden in Germany and then over satellite to the ARPANET in the U.S. This was the situation as far as I can remember until say mid 1982. The SATNET experiment ran from 1976 till 1979. Then it turned 'operational.' That meant, no real experiments. Further it meant that European sites, mainly

NDRE and UCL could start interconnecting their local networks to SATNET via Gateways at Kjeller and UCL, and communicate with U.S. hosts through a Gateway in the U.S. This replaced gradually the services provided by the TIPs or via the TIPs. This was then to be known as the INTERNET, with capital letters, and as such was a fact at the end of 1979."

Spilling notes that: "ARPANET links from the U.S. over satellite to Kjeller and a narrow-bank link further on to UCL, were not efficient and required special treatment by BBN. It was therefore a push to move away from ARPANET and over on SATNET. NDRE had its first INTERNET host up 1981/82, making use of Dave Mills' 'fuzzball' software."

But Spilling does not have a direct reference to when the ARPANET link to Kjeller/London was decommissioned. Kahn confirms these accounts. Kirstein remembers that it was in 1981 that UCL used SATNET. He writes, "UCL was the first to introduce the Internet protocols as their sole way of communicating with the ARPANET in 1981. This was not to be pioneering. We changed computers and the new ones did not support NCP." (Kirstein, E-mail, October 3, 2002.)

Spilling writes (Kahn, E-mail, Sept. 5, 2002): "(I)n the 1970s, I initiated a broadcast packet satellite (SATNET) experiment on INTELSAT IV with the first participants being the U.S. and U.K. The third participant (of what eventually were five participants) was Norway. We were already conducting internet experiments over SATNET in the late 1970s using TCP/IP.

In the early 1980s, we decided to rely solely on SATNET for connectivity with Europe and thus the two 9.6 kbps lines, which were running in parallel with the SATNET connections, were decommissioned."

As Kirstein and Kahn emphasize, there were five nations who were participants in the SATNET experiment. He writes that SATNET included not only the U.S., Norway and Great Britain, but eventually also sites at DFVLR in Oberpfaffinghofen, Germany (near Munich), and CNUCE in Pisa, attached to the Fucino earth station in Italy. (Kirstein, E-mail, July 3, 2002)

Providing a general chronology of the development of the 3 different packet networks that TCP/IP interconnected to become the Internet, Spilling writes, "DARPA...had three different networking technologies under development in the '70s, namely:

o The ARPANET; 1969 ->
o The Packet Radio Network (PRNET); 1973 ->
o A packet satellite network, called SATNET; 1976-1979"

"This implies," Spilling writes, "that the need for a protocol that would connect these diverse networks was recognized early on and that resulted in the paper by Cerf and Kahn, 'A Protocol for Packet Network Intercommunication.'"

Explaining the difficulty of involving different countries in the research process, Spilling writes: "The start of the development and experimentation with SATNET was considerably delayed. The idea was to use one 64 kb/s channel in the so called 'Multi-destination half duplex' mode, with ground stations in Norway, England, Germany, Italy and the USA. The end-points of this channel were terminated in equipment owned by different organizations. This was unheard of in the Intelsat/Comsat organisations, and they had no policy for handling this case – no regulations and no tariff ratings.

If I remember correctly, Bob Kahn spent a long time hammering on the satellite organizations – more than a year – to have them accept this new mode of operation."

Spilling explains the result of the creation of SATNET was the creation of the INTERNET. He writes: "When SATNET development was ending in 1979 and the TCP/IP protocols were matured sufficiently, SATNET was used as a means to interconnect local area networks in Norway, England, Germany, and Italy with ARPANET, which interconnected many LANs scattered all over the U.S. continent. This constellation formed the INTERNET with capital letters, interconnecting defence institutions and research institutions with military contracts, hence forming a very closed community. As you have mentioned, you needed permission from DARPA in order to connect with this community."

According to Kahn, by the 1980s there was a connection between these different country networks using a gateway to SATNET and then a gateway to connect to the ARPANET, "This was not a link over ARPANET," he emphasizes(Kahn, E-mail, Sept 11, 2002), "It was a connection using SATNET, which was a broadcast satellite system.... This is if you like an ETHERNET IN THE SKY with drops in Norway (actually routed via Sweden) and then the U.K. and later Germany and Italy. (Graphic IV)

Kahn explains that NDRE and UCL had been experimenting with TCP/IP before the cutover to TCP/IP took place on the ARPANET in January 1983. Therefore until January 1983, NDRE and UCL had two paths they would use. They could still use NCP over the ARPANET links until they were dismantled...and in parallel TCP/IP could be used over SATNET. Once the ARPANET links were dismantled, they had only the SATNET remaining." (See also From the ARPANET to the Internet: A Study of the ARPANET TCP/IP Digest.) http://www.ais.org/~ronda/new.papers/ tcpdraft.txt

When the ARPANET nodes serving the U.K. and Norway were decommissioned, researchers in these countries had to use TCP/IP over SATNET. Responding to a question as to whether the 1983 cutover to TCP/IP on the ARPANET created a new form of connection on the ARPANET, Kahn replies, "No. It was not a new form of connection so much as it was using a different protocol over the ARPANET (i.e. TCP/IP vs NCP) and thus, in effect, everyone on the ARPANET was now Internet enabled since they could talk with anyone else with TCP/IP on the Internet."

GRAPHICS

Graphic I – Diagram of NPL, CYCLADES and ARPANET as prototype for Internet
http://www.ais.org/~ronda/new.papers/1.pdf

Graphic II – Diagram of UCL, NORSAR and ARPANET links from Kirstein's 1975 paper
http://www.ais.org/~ronda/new.papers/2.pdf

Graphic III – Diagram of plan for 1981 IIASA computer networking linking research centers in Eastern and Western Europe and U.S. http://www.ais.org/~ronda/new.papers/3.pdf

Graphic IV – SATNET as an Ethernet in the Sky
http://www.ais.org /~ronda/new.papers/4.pdf

Graphic V – 1977 Internet Experiment
http://www.ais.org/~ronda/new.papers/5.pdf

[Editor's Note: This article was written in May 1996 to document the importance of Netizen ship in Japan. The story it tells is still important as Izumi Aizu's other article in this issue demonstrates.]

Emergence of Netizens in Japan and Its Cultural Implications for the Net Society

Izumi Aizu
izumi@glocom.ac.jp

In Japan, just as in many other countries of the world, the Internet (the Net) has become a popular subject for the business and general press. Despite this interest, few TV programs seriously picked up on the 'culture' of the Net, or of its Netizens. In February 1996, one network designed a program to discuss the future of the Net, by the Netizens, and for the Netizens. The combined use of TV and the Internet highlighted some of the differences in the roles and features of these two very different media. The exchange also suggested new possibilities for mixing the two. Most important, the program presented a dynamic picture of social change in Japan.

Netizens And Live TV

On February 17, 1996, a Friday evening turning into Saturday morning, past midnight, close to 1:15 A.M., TV Tokyo began the live TV discussion program "What's Going to Happen to the Internet in Japan?" For the next two and one-half hours a panel of 15 experts representing the spectrum of knowledge in Japan about the Internet participated in a spirited discussion. A few meters from the main table were nearly 40 spectators, or Netizens, all avid Internet users. They stood the entire time like a crowd in a British football stadium.

One week before the broadcast, an Internet E-mail list was created and nearly 800 participants were polled on their views of how the discussion should be formatted, what issues should be presented, who should be on the panel, and what style of discussion would be most suitable to the TV medium. Few respondents, if any, were specialists in TV production. There are examples where the Internet was used during a TV program to get some input via E-mail or CU-SeeMe to the studio, but this was different. Opening the planning process of a TV program for the public's input via [an Internet] mailing list before it was aired is, as far as I know, the first attempt in the TV production business in Japan.

The live TV program was designed to be interactive, yet it was extremely difficult to handle much of the input from the Internet on a real-time basis. A few comments were selected and read from E-mails sent in during the program, but it was not easy to incorporate effectively such external inputs into an ongoing broadcast framework. Rather, the preceding discussion on the [Internet] mail list felt much more constructive in terms of its actual contribution to the program. It gave a greater sense of 'sharing' the process among the mailing list participants. The real-time interaction had significant constraints.

The network planning team released the original production plan to the mailing list. The producers planned to pick-up such themes as "Cyberporn in the Net" including the passage of the CDA (Communication Decency Act) in United States and the citizen protests against it. At the time, it was the hottest topic on the Net around the world. Although some people didn't like the idea of beginning the show with such a "filthy" story, others found it an important cultural and ethical issue. The production people also said they want to pick up Bob Metcalfe's "Internet Catastrophe" article in InfoWorld that pointed out ten reasons why the Internet may collapse during 1996. Among them being: slow and expensive telephone lines, greedy commercial business invasion, and strict content regulations. Several strong opinions against using this pessimistic approach were presented and discussed, leading to a slightly modified original format.

The Internet mailing list was named "Netizen-TV," suggesting who were the main actors of the show. The live program was open to the Netizens who wanted to participate, speak out or observe the program on that day. The room was not an ordinary TV studio, it was the main conference room of GLOCOM, a nonprofit research institute in Tokyo with the mission to study and build the next generation of Networked Society. There was a large screen with a T1 connection to the Internet in the conference room.

The center panel included: Dr. Shumpei Kumon, expert in social systems study, particularly the networked society and its historic, civilizational context; Mr. Yasuki Hamano, a leading analyst and practitioner in interactive digital media; Mr. Joichi Ito, an Internet evangelist, almost American in his worldview, head of PSI Japan and Eccosys, an Internet service provider; Mr. Hiroyuki Kokubu, a 22 year old entrepreneur specializing in the testing and evaluation of new video games before they appear on the market and who is now forming his own company to enter the broader Internet business arena; Dr. Kazuhiko Nishi, President of ASCII corporation, who originally introduced Microsoft into the Japanese market and who is a strong advocate in personal computing in Japan; Ms. Kaori Sasaki, President of Unicul International, a multi-lingual communications service company, a female entrepreneur who was later invited to a special luncheon with Hillary Rodham Clinton when the U.S. President came to Tokyo in April. They represent a 'new breed' of Japanese efforts towards the "Information Revolution."

First Arrest on Cyberporn in Japan

The TV program began by reporting on an incident that occurred just two weeks before. On February 1, two people in Tokyo were investigated by the police because of their illegal distribution of hardcore pornography from their personal Web pages. One defendant was actually a 16-year old German high school student and the other was a 28-year old Japanese businessman. The businessman was arrested the next day and later prosecuted for his illegal redistribution of pornographic pictures taken from newsgroups on the Internet. This was perhaps the first, and is still the only, arrest of its kind in Japan.

In Japan, showing or distributing hardcore pornographic pictures in public is definitely against the criminal code, even among adults. There is little room to escape from being sentenced guilty once all the evidence is presented. In Japan, Internet distribution of hardcore pornographic pictures is not unknown. The two individuals in questions, however, were less discrete than others.

They used the rental homepage server of an Internet service provider called Bekkoame International that has the largest individual subscriber base among providers in Japan. Bekkoame also became the subject of the police investigation. The police obtained a search warrant from the court and seized all the related E-mail files addressed to the two people as well as the hard disk containing the materials used for the Web server. The police needed the hard evidence. Here, the secrecy and freedom of communication of using E-mail was sacrificed or yielded to the "public interest" of keeping society "clean."

The police had received an anonymous tip two months before the arrest. They evidently felt that such activities could not be ignored and wanted to demonstrate that distributing hardcore pornography over the Internet is illegal in Japan. The two "distributors" became the symbolic victims to give a broader warning to the society at large. Immediately after the arrest was reported by the press, many pictures including very legal ones simply disappeared from Web pages and the Net traffic became fairly smooth.

Most of the panel members at the TV program were very reluctant to accept the idea of government regulating Internet contents. Nishi suggested some software solution such as an automatic filtering of undesirable pictures to children. Others like Joichi Ito expressed strong concern about government intrusion upon freedom of communication. Special guest Ken'ichi Ozaki, President of Bekkoame, another young entrepreneur, described how ignorant the police were when they came in: they did not even know that a ton of "illegal" material can be easily accessed by merely clicking the button on the Web pages that have links to the many adult-oriented servers outside Japan!

To date, few, if any, protests have been made by Japan's Internet users groups or providers. The challenge remaining to the Japanese authorities is not to prove the defendants guilty, but to effectively shut-out pornography from crossing the borders into Japan via the Internet. What is against the law in Japan is, in effect, not illegal in Cyberspace. There is no effective legal or social system, at least at this moment, to constrain these activities beyond one's border.

One is left wondering if this incident in Japan indicates that the Net culture is emerging mostly among the American-dominated Western cultural sphere of the globe and the Oriental and other non-Western cultures remain closed within their traditional norms. Does this case reflect a symbolic challenge to our overall, international 20th century modern society? How should we foresee the coming of new culture and new society in a global perspective?

What Is A Netizen?

To answer these questions, we need to focus on the concept of Netizen. The term “netizen” was first coined by Michael Hauben in 1992 while he was a sophomore at Columbia University in New York City. He had been a very active user of the Net since he was 14. After spending considerable time on his local BBS (bulletin board system) and then with the Usenet community, he became interested in finding the roots of this community of people.

Hauben wrote: “What Is a Netizen? In conducting research online to determine people's uses for the global computer communications network (i.e., the Net), I became aware that there was a new social institution developing and I grew excited at the prospects of this new social institution. In response to the excitement I discovered from those who wrote me (and which I also experienced), I felt that the people I was writing about were citizens of the Net. Sometimes people on the Net would call users of the Net, a net.citizen (read net citizen). This idea I transformed into Net Citizen, which in shortened form is Netizen. Netizens are Net Citizens who utilize the Net from their homes, workplaces, schools, libraries, or other locations. These people are among those who populate the Net and make it a human resource.” (See, http://www.columbia.edu/~hauben/text/WhatIsNetizen.html)

Netizens Put Into Historic Context

At my research institute GLOCOM, we found Michael Hauben's “Netizen” homepage via the Internet index service Yahoo in late 1994. Dr. Shumpei Kumon, Executive Director of GLOCOM, read Hauben's online papers and added further depth from his own research to the term Netizen. According to Kumon, a Netizen must have some historic roles. Just like the citizens who were the main actors of the social revolutions in France and elsewhere that formed the basis of modern democratic society, the netizens should play a key role in bringing a new social system, using the Net as well as creating the new networked society of the 21st century.

This revolution, according to Kumon, is a mixed one. It should be first considered as “the third phase of the Industrial Revolution.” It follows the first industrial revolution of the late-18th century that was brought about mainly by steam engines, textile manufacturing, and railways. The second one occurred in the late 19th century, and was fostered by the steel industry, heavy chemical, and electrical industries. He sees the third revolution as “completing” the industrialization of modern society, not creating a new paradigm. At the same time, or perhaps shortly after it is over, a newer and deeper social revolution will also emerge, triggered by the third industrial revolution and its completion, but it will have much deeper consequences. This can be called the “Information Revolution” as the third Social Revolution following the first “Agricultural Revolution” and the second “Industrial Revolution.”

In this sense, we are preparing for the grand social revolution by producing new actors, that is the Netizens. We, ourselves, may not be fully qualified as the genuine Netizens; our children and their descendants will be the central force of the new civilizational transformation. Whether one is born “b.c. (before computers)” or “a.c. (after computers)” makes a big difference. Likewise, before or after networking will be the most critical difference in carrying out the Information Revolution.

What seems to be the cultural gap between Western and Eastern societies, as is shown by the strict police charges in Japan against the Cyberporn or similar tendencies found in Singapore or China, could be regarded as more of the transitional conflict between the 'ancient regime' of our very society and coming 'new regime' initiated by the Netizens. The Netizens will, over time, learn how to build and operate a more comfortable society without disturbing the harmony and dignity of people and their community, be it real or virtual, as well as without loosing the precious value of the Net that includes the true freedom of communication and expression down to the individual end users.

Where Do Netizens Emerge From?

Where do Netizens emerge from? A tentative answer is “from the grassroots.” Let us examine this observation.

In Japan, typical grassroots activities by local citizens using computer networks to create a new community movement can be found in quite a few places. One such case is COARA (Compunication of Oita Amateur Research Association, “Compunication” is a composite of computer and communication) which started in May 1985 in Oita, a local prefecture in Kyushu, the western-most island of the Japanese archipelago. COARA was originally planned as a local database service to provide business-related information to local management and business people. Soon they found that it did not work. Not many people showed an interest in getting company profiles or local sightseeing information online – via 300 or 1200 bps text-only one-way communication.

A few months after its start, a high school student broke in and found that the small BBS was almost dead. He was close to leaving, but stopped and questioned himself: “The quality of a BBS is defined by its users' activities, and if I am a user then I should contribute something that can interest the others. What can I write that can satisfy these unknown business people?”

This student, Masaharu Baba in a few weeks started his monologue “High School Life Series” online. He wrote of his daily life at High School – how lonely the students felt, how distant the teachers were, and one day he even disclosed his bad marks on mid-term examinations. At first senior members of COARA were highly skeptical about the real intention of this strange kid. Then they gradually realized that this is a real person, trying to communicate on a peer-to-peer basis. Some started to send e-mail to him saying “You shouldn't spend too much time online, you better study more for classes.”

Baba went on to disclose his more personal story, his relationship with his mother, and so on. Six months after he started to write regularly online, he graduated from high school and joined a software company as a programmer. He thanked to the members of COARA as the first people who seriously treated him as “real person” and listened to him. He felt that this was the real kind of education missing in school and he was only able to find it on the Net.

Through these and other trials and errors, COARA members found that the fundamental value of using an online network is the ability to communicate with others. The two-way interaction made possible by using computer networks was a real, new means of interaction that these citizens never before had. You can say anything you like at any time; no matter how young you are, male or female, in a professional field or not, crossing many physical and social borders.

COARA recognized the importance of this people-to-people, two-way communication early on and shifted their project's direction. In contrast, most of the mainstream experts in Tokyo still believed that Videotext online shopping and database services, all one-way provisions of commercial information or services, would become the core of then “new media.” Instead, as COARA began to demonstrate, the citizens became both supplier and user of the information they created and shared. These citizens had started to formulate new kind of social institution, a new community of people, as it began to be called, a “Network Community” in 1987.

More than five years have passed and the COARA members started their quest again. This time, under the banner of “hypernetwork society,” they looked into the future of the network community or network society as a whole, made possible by the marriage of high speed communications networks and high powered personal computers, now known as “multimedia networks.”

After several internal debates as well as technical, institutional and financial struggles, COARA was finally able to connect to the global Internet in the summer of 1994. It was one of the very first regional networks to have full IP connectivity outside of the academic and research networks in Japan. In 1994, the World Wide Web was starting to grab everyone's attention. The Japanese Prime Minister's office started its Web homepage in August 1994 and the White House's debued its “Citizens' Interactive Handbook” homepage in October.

Yet COARA tried to remain a bit different. In July 1994, COARA's first homepage was opened, with the banner saying “Citizens' Diary.” The COARA members wanted to preserve the culture of their two-way, people-to-people communications experiment by using the narrative and casual style of writing and reporting. They did not like the institutionalized and one-way style of some of the Web pages run by serious organizations. For them, online communications should be always casual, frank, and people-oriented. One day some of their members went to the then-Prime Minister Murayama's own small and very humble house in Oita city, took some digital pictures, and put them on the diary homepage. A local policeman came to question these young people, and his picture was also taken and soon put online.

Other citizen members started their own individual homepages. It was then aggregated and titled "One Person, One Homepage." The governor of Oita prefecture, Morihiko Hiramatsu is globally well-recognized by his invention of the "One Village One Product" movement to promote local industry from the grassroots. The COARA members brought this same idea to the Internet. Most of their individual homepages still have a strong personal and communicative nature thus giving the reader a sense of belonging to a community.

How Netizens Emerge?

By observing how the people of COARA behaved, we see that they are quite genuine Netizens. Computers are linked to connect people. The people become open and form a kind of community, an extension of their local community – many COARA members are from outside Oita but feel that COARA is their own home. Nobody really made any strong decision to form a "virtual community" explicitly, but it does firmly exist. It just emerged.

It can be safe to say that Netizens and their virtual community emerged through continuous people-to-people discourses online. It is made from the bottom up. At first they didn't set any clear objectives. It was naturally built around self-organizing activities, with a dozen or two (but not more than that) core enthusiastic members, or the Netizens. Some new people join the core while others occasionally leave with various reasons. They enjoy "off-line" meetings most – COARA holds monthly regular meetings and always has a party after.

These are typical characteristics of Netizens and their virtual community that exists on the Net. Howard Rheingold's historic book Virtual Community describes well the story of how he met with COARA and witnessed how other cases, such as the WELL (Whole Earth eLectronic Link) in San Francisco Bay Area or BBS groups in England are all so similar in the nature of community building.

Language Barrier?

A culture is often defined by the language its people use. People then often ask "is the Internet dominated by English?" If so, most Japanese must have difficulty in participating fully with the Net culture. Quite often, a Japanese who doesn't know much about the Internet fears that his or her lack of English skills will make it impossible to use the Net.

Globally speaking, it is true that the Internet is as a whole an English-speaking community. Yet, if one looks at it locally, many people are using their own native language on the Net. One of the first things the pioneers of the Net in Japan, such as Jun Murai, did was to create software that can allow people to handle Japanese character codes easily on the Net. Only after making these daily tools available to the majority of local people did the Japanese Net began to grow.

In all aspects of life it is very unusual for Japanese to communicate with each other in anything other than their own language, and the Internet is no exception. At least in the domestic sense, language will not become an obstacle to the diffusion of the Net. Unfortunately, there are still people who express the potential danger that the Internet might damage the culture and language of Japan.

Of course, one of the great strengths of the Internet is its global connectivity. Here you need to speak a common language and, now, English is by far the most dominant. If Japanese (or any other non-English speaking folks) want to keep up with what is going on in the world, we have no choice but use the language that other people of the world are using. Unlike native English or other Roman-character-based speakers, the Roman alphabet is still very foreign to most Japanese. The distance between English and German or Spanish is much less than that between English and Japanese.

In one sense, this is clearly a cultural impediment to Japan's global use of the Internet. Yet there have been at least two occasions in history when Japanese society was determined to learn and master English. The first was in the 1850s, when U.S. Admiral Perry demanded that the samurai-governed, feudal Japan open the country to the world. The second was, of course, when Imperial Japan lost the Second World War in 1945 and the U.S. military forces occupied Japan. Both times the Japanese not only learned the language, but were able to adapt to advances in the world, through hard work and innovative efforts. It was a difficult but rewarding challenge, as history shows.

Netizens To Open New Culture

The rapid spread of the Internet is not a military occupation nor a cultural invasion. Opening up the country to a networked world does not mean giving up cultural assets. It is, to the contrary, an opportunity to bring Japan's own cultural contributions to the world. It also opens the possibility for badly needed change: perhaps Japan will become a less rigid, more decentralized society, following the network paradigm of the distributed nature of the Internet itself.

Like most other countries, today's Netizens in Japan still belong to the minority. They are less than one percent of the whole population. They are more individualistic, better-educated, and have higher incomes than the average. Roughly 90 percent are male, living mostly in urban cities. They love to communicate and they are looking for buddies. Sometimes they take each other too seriously and become arrogant. Yet they like to do things for others, as was shown right after the Kobe Great Earthquake in 1995, when many online volunteers gathered, and tried to help the victims. We know these characters are not unique to the Japanese Netizens at all, but this may have been the first resounding shot, the Bastille Day of the Japanese Information Revolution.

In Howard Rheingold's book *The Virtual Community*, Joichi Ito, a Net pioneer and co-founder of TWICS, one of the first Internet access providers in Japan, is quoted as saying that the widespread use of the Net could change the Japanese system for the first time in thousands of years. Ito thinks it might cause a kind of unprecedented allergic reaction in Japan. No one doubts that Japan may need to go through these "allergic" symptoms, but the results – a truly internationalized Japan literally hard-wired to the world – will be ultimately worthwhile. The Japanese people have traditionally felt that they are isolated geographically, surrounded by the seas, far from the center of the world. Now if you can connect to any other people in the world in relatively effortless, prompt ways, using the Net, then this sense of isolation will, at least over time, fade away.

Whether this will or will not really happen is unknown. It is up to the first generation of Netizens in Japan, perhaps together with Netizens in other parts of the world. If any existing cultural force, no matter which one it is, tends to dominate the entire Net world too much, then the anticipated reaction might become very negative, making the world more fragmented, and in each fragmentation will exist stronger central control. Freedom is not given. It only becomes reality through people's efforts and fights.

Not all Netizens are born equal, or rather alike. They speak different languages with different geographic and cultural backgrounds. The Net, however, can absorb and preserve these differences without putting them into direct conflict. To keep the diversity and to work together – that is the working principle of the Internet and from which today's Netizens should learn and grow. The world is getting more diverse, thanks to the Internet, and the world is getting closer and closer, again thanks to the network of networks. Both chaos and conflict resolution are possible on tomorrow's Net.

Izumi Aizu
Institute for HyperNetwork Society
GLOCOM (Center for Global Communications)
International University of Japan
Haakusu Roppongi Building, 1F
6-15-21 Roppongi
Minato-ku, Tokyo 106
E-mail: izumi@glocom.ac.jp
Personal Homepage: http://az.glocom.ac.jp
http://www.glocom.ac.jp

BIBLIOGRAPHY

Aizu, Izumi. "The Emergence of Netizens: The Cultural Impact of Network Evolution in Japan," *NIRA Review*, Fall, 1995. http://www.nira.go.jp/publication/review/95autumn/aizu.html This essay describes how Japan was lagging behind the U.S. in terms of Internet penetration and how Japan has been trying to catch-up, starting around 1994, with some observations of Japanese Internet user profiles, language barrier issues, and concludes that over time the "virtual marathon" will have no winners nor losers.

Bressand, Albert. Networld (a private report originally written in English), translated into Japanese by Izumi Aizu, published by Toyo Keizai Shimposha, 1991. Albert Bressand started an independent nonprofit think-tank in Paris in 1985, to explore the emerging societal forces around networking or "Networld." His vision of networking is the combination of human, economic/financial, and technical/computer-wise, with such unique concepts as "Infrastructure" plus "Infostructure" as well as "Infoculture."

Kumon, Shumpei and Aizu, Izumi. "Co-emulation: The Case for a Global HyperNetwork Society" in *Global Networks*. Cambridge: MIT PRESS, 1994. This paper is a chapter in an edited book with more than 20 authors including Mitch Kapor and Howard Rheingold. Each author was given the theme of how global networks will be shaped. Based on Kumon's "co-emulation" theory, Japan can and should try to accommodate the creativeness of Western individualism while still maintaining her traditional cultural assets such as group orientation and team behavior. Aizu introduced one case history of Japan's computer networking community, COARA, a decade-long, local-based grassroots citizens' networking activity. The writing process of this book required all the authors to use Internet mailing lists for mutual discussion. (COARA can be reached at http:// www.coara.or.jp)

Hauben, Michael. Mr. Hauben first coined the phrase Netizen. He is forming a Neitzen association. In the fall of 1995, Mr. Hauben visited Japan and GLOCOM. His homepage can be found at: http://www.columbia.edu/~hauben/

Kelly, Kevin. *Out of Control*. Addison-Wesley, 1994. This book is about the complexity and the significance of biology to the human culture and society. It is by far, I believe, the best discourse linking the experiences of biology, technology, and computer networking.

McGurn, William. "English Rising: Asia's New Language of Opportunity." Cover Story, *Far Eastern Economic Review*. March 21, 1996. pp.40-44. One of a number of articles appearing in the Western press discussing the rising use of English in international commerce. There have also appeared specific articles on English on the Internet.

Rheingold, Howard. *Virtual Community*. New York: Simon and Schuster, 1994 http://www.well.com /user/hlr/vcbook/index.html When Howard Rheingold was first invited to Japan, he was asked to give a keynote talk at the first "HyperNetwork Conference" in Oita, home of the COARA citizens' network. After the official program was all over, he joined the COARA members' party where he found so much similarity among the networkers' behavior and relationships with each other and of the WELL, a San Francisco-based networking community. That strange finding led him to write this book *Virtual Community*. A whole chapter is devoted to the history of computer networking in Japan. This book was translated by Izumi Aizu into Japanese in 1995.

ELECTRONIC EDITION

Starting with Vol. 4, No. 2-3, *The Amateur Computerist* has been available via e-mail. To obtain a free copy or for a free e-mail subscription, send e-mail to:

ronda@panix.com or jrh@ais.org

The Amateur Computerist back issues are available via anonymous ftp and on the World Wide Web:

ftp://wuarchive.wustl.edu/doc/misc/acn/
http://www.ais.org/~jrh/acn/Back_Issues

The Amateur Computerist invites submissions.
Articles can be submitted via e-mail: jrh@ais.org