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The Role of International Sci-tech Cooperation in the Global Distribution of Public Computer Networks

Computer networks serve a variety of purposes in the modern world: from governmental and banking networks to home and public networks. Computer networking for the purpose of more effective information sharing has in fact spread on a global scale. We will focus on arguably the most significant phenomenon of networking, namely public computer networks that are largely connected into a single global information network — the Internet.

Over the last forty-five years public computer networks have been developing hand-in-hand with computing equipment. It is safe to say that the idea of such networks stems from a series of articles by Joseph Licklider, published at Massachusetts Institute of Technology in August 1962.[1] Their author formulated the concept of a Galactic Network. In October 1962, Licklider was appointed the first head of the Information Processing Techniques Office at the Defense Advanced Research Projects Agency (DARPA) of the US Department of Defense, which discovered benefits of its own in the practical implementation of such a network.

Not surprisingly, at the early stages of this project international cooperation of any sort was out of the question. First of all, it was a US defense project. Secondly, at the time international cooperation was not typical in the development of computer technologies. It will be recalled that in the era of the so-called first-generation electronic computers, the basic circuit — a flip-flop — was developed in 1916 by the Soviet scientist Mikhail Bonch-Bruyevich,[2] and was reproduced three years later by the American scientists Eccles and Jordan.[3] The Americans developed it independently without cooperating with the Soviet pioneer. The first significant instance of cooperation happened at a much later time — in the epoch of third-generation electronic computers — and in a political system completely alien to American creators of computer networks: the first joint production of computers was launched by the USSR and other Socialist countries. Joint production of the first line of computer models started in 1972.[4]

Despite the defense nature of the ARPANET project, absence of international cooperation did not mean that the project was classified. Quite the contrary: from the very outset the government, industry, and academic community were partners in researching, developing, and deploying the packet switching technology that has come to form the core of public computer networks. But these were the government, industry, and academic community of only one country — the USA.

When the ARPANET plan was publicized in 1967, its authors found out that similar projects existed at the UK National Physical Laboratory (supervised by Donald Davis and Roger Scantlebury)[5] and at the American noncommercial organization RAND specializing in strategic R&D projects, where the research team was headed by Paul Baran[6]. Can it be said that the meeting of the authors of the three independent computer network projects marked a start of their cooperation or at least provoked any serious sharing of ideas? It would be an exaggeration to say that there was an exchange of ideas. The result that graphically illustrates the nature of such cooperation was that ARPANET creators merely borrowed the term "packet" and decided to increase twenty-fold the proposed speed of data transmission via the channels of the future ARPANET network.

Ice was finally broken and meaningful cooperation started in October 1972 during the International Conference of Computer Communications,

when the ARPANET network was shown in action. This made obvious the potential applications of the technology for a global unification of computer networks that could serve a variety of purposes, not just defense. DARPA signed three contracts for the implementation of an inter-network protocol (a software basis needed for the interaction of different computer networks): with the research center of Stanford University, where Vinton Cerf worked, with BBN, where work was supervised by Ray Tomlinson, and with the University College London, where work was supervised by Peter Kirstein.[7] Eventually, the network started to operate on the basis of TCP/IP protocols developed by Vinton Cerf.

By the end of the 1970s, the scientific community's interest in DARPA's project had become so substantial that the project management started to sense a growing need to coordinate the activity of various research groups in this field. Until then coordination happened spontaneously, as part of a self-regulation process, its most graphic example being a discussion by scientists of their accomplishments through articles which came to be known as RFCs (Requests for Comments).[8] Since the late 1960s, scientists used such articles to submit to the judgment of the academic community their discoveries, inventions, and proposed improvements in computer network design. The name "Request for Comments" means that the entire community was invited to discuss the ideas and solutions proposed in such articles. It was on the basis of such correspondence-based discussion groups (structured as networks) that the first society of computer network developers emerged, known as the ARPANET Network Working Group, which later evolved into the Internet Working Group.

Although quite successful, self-regulation deprived DARPA of control over the development of computer networks. For this very reason Vinton Cerf, who at the time headed the inter-network interaction program at DARPA ("Internet program"), founded the International Cooperation Board (ICB), the Internet Research Group (IRG), and the Internet Configuration Control Board (ICCB).

The purpose of these organizations was as follows: ICB coordinated cooperation with a number of European countries, IRG provided the environment for general information exchange, while ICCB was meant to assist Cerf in managing the growing activity of computer network users.[9]

Needless to say, of all the coordinating agencies, ICCB played the most dubious role from the viewpoint of independent developers. As a result, the Board was abolished in 1983, and replaced by so-called Task Forces. The heads of such task forces formed the Internet Activities Board (IAB). Notably, the personal composition of the abolished ICCB and the newly-created IAB was virtually identical.[10]

It is safe to say that changes to the coordination of computer networks development on the part of the DARPA Office were no more than a formality. In essence, everything remained unchanged.

The Internet Engineering Task Force (IETF) stood out from among the newly-created Task Forces. IETF meetings constantly drew a large number of specialists interested in various aspects of inrer-network interaction. As a result, a substructure originated within IETF, taking the form of working groups.

Coordination of other spontaneously emerging computer networks was performed by the US Federal Network Council. Because computer networks were created not in the US alone, international organizations were needed for their successful regulation. The Federal Network Council cooperated with such international organizations as RARE (Réseaux Associés pour la Récherche Européenne, the Association of European Research Networks) and CCIRN (Coordination Committee for Intercontinental Research Networks).[11]

The main purpose of these organizations was to coordinate support for the development of computer networks by the international research community. It is to the cooperation between the US Federal Network Commission and these organizations that we owe the Transatlantic communication channel that was financed by this exact American agency.

Since 1985, when the defense project was in fact completed and embodied in the MilNet computer network, there had been a sharp reduction in DARPA's activity in supporting continued development of computer networks. As a result, IAB was in fact left without the main sponsor, but this only boosted its managing role and did not harm it in any serious way. One of the main reasons behind this was international cooperation. In particular, a key role was played by such a form of cooperation as staff exchange.

In 1985, Dennis Jennings was invited to head the NSFNet program (the network of the National Science Foundation, which at the time was the largest public computer network). His name is associated with the decision on the

mandatory introduction of the TCP/IP protocol in NSFNet, which proved momentous for the global spread of public computer networks. It enabled the next NSFNet director, Steve Wolff, to set in 1986 the task of forming a global network infrastructure to serve broad academic and research communities on the basis of a principle of maximum independence of direct federal funding, which could not come at a more opportune time given the diminishing involvement of the defense agency.[12]

A new phase in international cooperation started in September 1988, when it was joined by broad business and industrial communities. Its start was concerned with the first commercial exhibition Interop that drew fifty companies and five thousand engineers from potential client organizations.[13]

It came as a pleasant surprise to the potential clients that vendors sought to ensure interoperability of their solutions with all other products, even those provided by rival vendors. It was extremely convenient for the commercial sector whose representatives became regular fixtures at IETF meetings as well as its main sponsors, which made this group more independent of the hierarchic coordination system created by Cerf, enabling IETF to become de-facto one of the most important centers in the international research network.

Not surprisingly, IETF underwent structural transformations. First, its task forces were grouped based on areas of their activity. Directors were appointed for each area. These directors formed the Internet Engineering Steering Group (IESG). IESG became the main review agency in the process of network technology standardization.[14]

The structure of IAB also changed under the pressure of such transformations. Task forces outside of the IETF hierarchy were combined into the Internet Research Task Force (IRTF) and renamed into research groups. As a result, the Internet Activities Board came to control two peer structural divisions — a research division and a design division. At the same time, the design division had more autonomy.

This led to the problem of openness and fairness of the technology standardization process. For purposes of "public" control of this process, in 1991 the Internet Society was established under the auspices of the Corporation for National Research Initiatives, which, as you might guess, was chaired by Cerf.[15] This was yet another attempt by the creators of the inter-

network interaction technology to regain the control over the development of their ideas, which was slipping away from them.

Yet this attempt can hardly be called a success. The creation of the global public organization Internet Society was followed by a reorganization of the Internet coordinating agencies. In 1992, the Internet Activities Board was transformed into the Internet Architecture Board (IAB) under the auspices of the Internet Society[16]. At this point the existing state of affairs gained de-jure legitimacy: a more equitable relationship between IAB and IESG was established. IETF and IESG assumed greater responsibility for adopting standards.

Meanwhile, the purpose of the Society was to create optimum conditions for the operation of IETF. As we can see, the Society was relegated to a secondary role. In this way, the globalization of public computer networks was simultaneously accompanied by changes in the nature of their coordination mechanisms. Regulation of such networks ceased to be the prerogative of the research community and was taken over by vendors, industrial and business communities that played a major role in the commercialization of the products that were created. However, we will not analyze the history of commercialization, much like the history of new players in international sci-tech cooperation whose appearance was connected with the emergence of a new global phenomenon — the worldwide web. Such analysis touches on a different subject — that of regulation of computer networks that have already spread on the global scale.

In an attempt to formulate a conclusion concerning the role of international sci-tech cooperation in the global spread of public computer networks, it is worth noting that this cooperation had objective causes: development of technologies, the need to operate and control a complex global infrastructure, a social aspect (the appeal of the broad community of Internet engineers), and, finally, commercialization. It was largely under the influence of these objective factors that sci-tech cooperation evolved. It was the development of network technologies and their global spread that predetermined the forms and trends of international sci-tech cooperation rather than the other way around.

(Footnotes)

[1] See: Licklider J. C. R., Clark, W. *On-Line Man-Computer Communication* // AFIPS Conference. Proceedings 21. Cambridge, MA, 1962, p. 113–128.

[2] See: Povarov G. H. *Mikhail Aleksandrovich Bonch-Bruyevich and his Invention of the First Electronic "Flip-Flop"* // Computing in Russia: The history of Computer Devices and Information Technology Revealed. Köln, 2001, p. 72.

[3] See: Dummer G., William G. *Electronic Inventions and Discoveries*. N.Y., 1983, p. 116.

[4] See: Naumann F. *The Development of Computer Engineering in the Countries of the Council for Mutual Economic Assistance (CMEA)* // Computing in Russia: The history of Computer Devices and Information Technology Revealed. Köln, 2001, p. 180.

[5] See: Gillies J., Cailliau R. *How the Web was born: the story of the World Wide Web*. Oxford, 2000, p. 25.

[6] See: Tuomi I. *Networks of Innovation: Change and Meaning in the Age of the Internet*. Oxford, 2002, p. 99.

[7] See: Leiner B. M. a.o. *A Brief History of the Internet* (http://www.isoc.org/internet/history/brief.shtml [10.12.2003]).

[8] See: IETF RFC Page (http://ietf.org/rfc.html [4.10.2007]).

[9] See: Tuomi I. Op. cit., p. 148.

[10] See: *A Brief History of the Internet Advisory* / Activities / Architecture Board (http://iab.org/about/history.html [4.10.2007]).

[11] See: Petersen J. K. *The Telecommunications Illustrated Dictionary*. Ann Arbor, 2002, p. 162.

[12] See: *NSFNET: A Partnership for High-Speed Networking Final Report 1987–1995*, p. 13. (http://www.merit.edu/about/history/pdf/NSFNET_final.pdf [4.10.2007]).

[13] See: Okin J. R. *The Internet revolution: the not-for-dummies guide to the history, technology, and use of the Internet*. Winter Harbor, 2005, p. 157.

[14] See: Schmidt S. K., Werle R. *Coordinating Technology. Studies in the International Standardization of Telecommunications*. Cambridge, MA, 1998, p. 55.

[15] See: Leiner B.M. a.o. *A Brief History of the Internet* (http://www.isoc.org/internet/history/brief.shtml [10.12.2003]).

[16] See: *A Brief History of the Internet Advisory* / Activities / Architecture Board (http://iab.org/about/history.html [4.10.2007]).