Appendix B: Complexities of Setting Export Control Thresholds: Computers

B

1993 COMPUTER EXPORT CONTROL CHANGES

In September, 1993, the Clinton Administration announced that it would:

- increase the threshold of computer capability above which U.S. licenses to most destinations would be required from 12.5 MTOPS (Million Theoretical Operations Per Second)[1] to the maximum that current Coordinating Committee on Multilateral Export Controls (COCOM) agreements would allow, 194 MTOPS;
- propose to COCOM partners to raise the multilateral threshold further to 500 MTOPS;
- propose to raise the definition of a supercomputer (in the bilateral control agreement with Japan) from 195 MTOPS to 2,000 MTOPS and review and update the requirements for safeguards on exported supercomputers;
- expand the availability of distribution 1icenses for computer exports; [2] and
- eliminate the control threshold for shipments to COCOM and COCOM-cooperating countries and increase the threshold for

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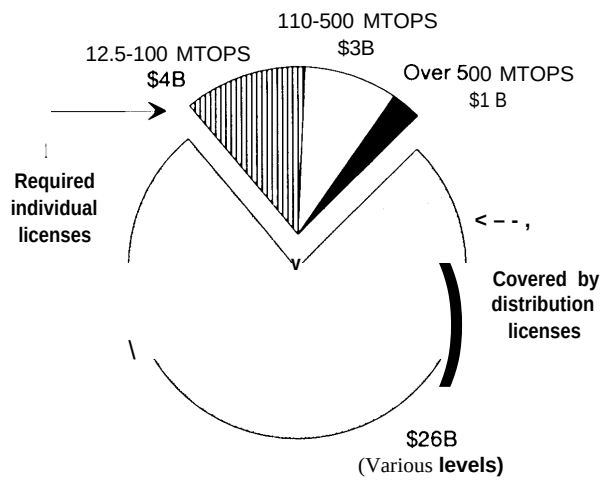
[1] MTOPS is the unit of measurement in the Department of Commerce's standard of "Composite Theoretical Performance" by which computers are compared for export control purposes.

[2] A distribution license allows a company to monitor its own exports for certain items, provided it maintains an internal control mechanism and submits to periodic government audits of its export records. See Export Administration Regulations, 15 CFR § 773.3 (Jan. 1, 1993).

shipments to many other destinations up to the supercomputer level.[3]

The Department of Commerce (DOC) estimated that the first step would free about $30 billion worth of computer exports annually from the requirement to obtain licensing authorization (see figure B-1). That $30 billion constitutes nearly 52 percent of the $58 billion worth of computer exports roughly estimated by the DOC to require either distribution licenses or individual validated licenses in fiscal year 1993 (note, however, that distribution licenses generally do not cover items controlled for nonproliferation reasons). The higher threshold for defining supercomputers would also freeup about $5 billion worth of computer exports annually from requirements for placing safeguards on their end uses.

FIGURE B–1: Value of Computer Export Licenses, FY 1993



SOURCE Department of Commerce, 1993

In ensuing negotiations, COCOM partners agreed only to decontrolling computers below 260, not 500 MTOPS, although U.S. officials considered this only an interim step. At the end of March 1994, the DOC announced that individual licenses would no longer be required for shipments of computers up to 1,000 MTOPS to former COCOM target countries. (The threshold would remain at 500 MTOPS for sales to nations listed in the Export Administration Regulations as being of nuclear proliferation concern.[4]) For the supercomputer control agreement, Japan would only agree to raising the threshold defining supercomputers to 1,500, not 2,000 MTOPS.

UTILITY OF COMPUTERS FOR DESIGNING WEAPONS OF MASS DESTRUCTION

Computers at the level of today's high-performance machines are not now—and never were—an essential technology for designing fairly sophisticated nuclear weapons.[5] Computers can contribute to weapon design by simulating the complex, high-speed physical processes occurring in a nuclear weapon. However, they are far from being critical tools that will make a difference in whether a country acquires nuclear weapons or not. Moreover, they are of most use to states with nuclear testing experience, since the calculations performed in weapon simulations are validated with test data.

Advanced weapon designers rely heavily on computers, and designers at any level of experience may also wish to use—although do not require—advanced computational capability. Nevertheless, the United States, drawing on its extensive body of nuclear test data, developed highly advanced nuclear weapons with computers

[3]Trade Promotion and Coordinating Committee, U.S. Department of Commerce, *A Message for Growth in a Global Economy: US Exports = US Jobs* (Washington, DC: U.S. Department of Commerce, 1993).

[4]In addition, computers above 6 MTOPS would continue to be denied to Iran and Syria, while Cuba, Iraq, and Libya continued to be generally embargoed by the United States.

[5]For a discussion of the utility of high-performance computers to a nuclear proliferant, see U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction.* OTA-BP-ISC-115 (Washington, DC: U.S. Government Printing Office, December 1993), pp. 125, 150-152.

vastly less capable than today's high performance machines. The Soviet Union and China developed their nuclear weapons with even less computing power.[6]

High-performance computers are relatively more important for advanced weapons, including thermonuclear ones, than for first-generation fission weapons. They can also be useful in the design of ballistic missiles' and other conventional military systems. According to a 1986 Department of Energy Report,

> With large-scale computers, we have been able to improve our designs by optimizing design parameters, while reducing the number of costly experiments in the design process. (Tests involving high explosives have been reduced from 180 tests for a 1 955-vintage weapon to fewer than 5 for today's weapons because of computation.)[8]

Moreover, although non-nuclear tests can provide information on the processes by which a nuclear explosion is triggered, no laboratory tests (other than computation) can simulate the processes of release of energy from nuclear materials. Therefore, the ability to carry out computer simulations can help weapon designers optimize the designs they want to test. Lacking adequate computational capabilities, the designers of the first U.S. nuclear weapons had to build in large margins of error, making the weapons much bulkier and heavier than they are today.

A U.S. supercomputer available in the early 1980s (the period immediately preceding the DOE report on supercomputer utility) was the Cray X-MP, whose peak performance was about 235 MFLOPS (Million Floating Point Operations Per Second—in this case roughly equivalent to the Commerce Department's MTOPS). This was about half the threshold that the Clinton Administration proposed in September 1993 to decontrol to most destinations and one-quarter of the March 1994 threshold.

LIMITS OF EXPORT CONTROLS

It is questionable how significant a role advanced computation may play in improving the designs of a nuclear proliferant such as Iraq, Pakistan, or North Korea, especially in the absence of nuclear testing. A judgment on this question would depend on:

- whether and to what extent the proliferant were able to obtain design information from one of the nuclear powers,
- how far both simulations and weapon designs can be refined in the total absence of actual nuclear tests,
- how capable the proliferant is of acquiring and using the necessary software, and
- the minimum practical thresholds of computational capability for carrying out the necessary s emulations.

THE QUESTION OF FOREIGN AVAILABILITY

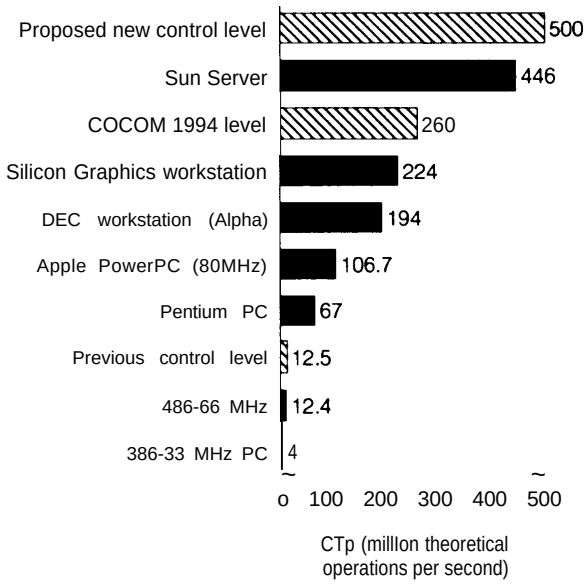
Critics of the Clinton Administration's relaxation of computer export controls have pointed out that the Nuclear Non-Proliferation Treaty (NFT) is a legally binding undertaking". . . not in any way to assist, encourage, or induce any non-nuclear-weapon State to manufacture . . ." nuclear weapons; in this view, the phrase "in any way" is not conditioned by whether other nations are providing assistance, by whether U.S. firms are losing

[6]See Jack Worlton, "Some Myths About High-Performance Computers and Their Role in the Design of Nuclear Weapons," Worlton & Associates Technical Report No. 32, June 22, 1990, and "Export Controls for High-Performance Computers in the 1990s: A Reassessment," Worlton & Associates Technical Report No. 43, Nov. 1, 1993. See also the testimony of John Han ey before the U.S. House of Representatives Committee on Science. Space. and Technology, Aug. 13, 1993.

[7]See Gary M ilhollin, "'Designing the Third World Bomb," *Wisconsin Academy Review*, winter 1990-1991, pp. 15-18.

[8]See William D. **Wilson** et al., "The Need for Supercomputers in Nuclear Weapons Design, " manuscript, U.S. Department of Energy, Office of Military Application, January 1986, p. 9.

FIGURE B–2: Composite Theoretical Performance (CTP) of Selected U.S. Computers



SOURCE Department of Commerce, 1993, Apple Computer, 1994, and Off Ice of Technology Assessment, 1994

legitimate exports because of NPT compliance, or by the degree of importance of the assistance.[9] The U.S. Nuclear Non-Proliferation Act of 1978 (Section 309) does specify that the Department of Commerce should control '*. . . all export items [other than those licensed by the Nuclear Regulatory Commission] which could be, if used for purposes other than those for which the export is intended, of significance for nuclear explosive purposes." The definition of "significance" is not given, but clearly nuclear weapon designers would rather have computers than not, and would rather have more computing power than less.

Proponents of the computer decontrols argue that the potential effectiveness of controls *should be* taken into account. Although computers above the thresholds previously controlled by the United States may be useful to proliferant nations, they are increasingly available from non-U.S. sources. Despite continuing to control supercomputers in part because of apparent nuclear proliferation risks, the United States was unable to persuade the other members of the international Nuclear Suppliers Group to place them on the Group's list of multilaterally controlled dual-use technologies.

Although COCOM did control computers above the 195 MTOPS level, Administration officials judged that agreement on this threshold could not be sustained as COCOM underwent further post-Cold-War revision. Figure B-2 shows the Composite Theoretical Performance (CTP) of several U.S.-made computers, for which the central processing units have become or soon will become widely available throughout the world. A 1992 Commerce Department study of foreign availability of computers showed that machines exceeding the 12.5 MTOPS threshold were available from Brazil, China, Hong Kong, India, South Korea, Singapore, and Taiwan—none of which was a member of COCOM. Machines exceeding 60 MTOPS were available from Hong Kong, India, and Taiwan. The report predicted that widely available first-generation workstations based on the newest microprocessors would have CTP values ranging from 50 to 194 MTOPS. In general, advanced microprocessor chips are not controlled, and would be very difficult to control because of their small size, low cost, and vast consumer distribution.

Not only are higher performance central processing units becoming more widely available, but personal computers and work stations can be networked to process data in parallel, allowing them to exceed the performance of any element in the network. The hardware and software for doing so is widely available and not difficult to use. [10] On the other hand, some kinds of simulations may not be amenable to parallel processing, but instead require direct access by a single central processing unit to a large amount of random access memory.

[9] Applying this stricture to dual-use exports, however, has not been subscribed to either by U.S. administrations or by other NPT members.

[10] Worlton, "Export Controls for High-Performance Computers . . ." ibid.

Depending on the job the weapon designer is trying to do, parallel processing may or may not be useful.

Since high-performance computers are available from foreign sources and are not essential to whether any nation acquires nuclear weapons, U.S. companies argued that requiring licensing and end-user controls on American computers penalized them while serving no useful purpose.[11] Moreover, with the coming widespread availability of new high-power commercial processors such as the Pentium, Alpha, and Power PC, U.S. computer makers could lose much of the new market likely to center on those chips.

[11] Testimony of Tim Dwyer of Sun Microsystems, speaking for the American Electronics Association at a hearing of the Subcommittee on Economic Policy, Trade, and Environment of the House Foreign Affairs Committee, June 9, 1993.