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GAO REPORT ON HIGH PERFORMANCE COMPUTERS

HEARING

BEFORE THE

SUBCOMMITTEE ON INTERNATIONAL SECURITY, PROLIFERATION, AND FEDERAL SERVICES

OF THE

COMMITTEE ON GOVERNMENTAL AFFAIRS
UNITED STATES SENATE

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WEDNESDAY, SEPTEMBER 16, 1998

U.S. SENATE,
SUBCOMMITTEE ON INTERNATIONAL SECURITY,
PROLIFERATION, AND FEDERAL SERVICES,
OF THE COMMITTEE ON GOVERNMENTAL AFFAIRS,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2 p.m. in room 342, Senate Dirksen Building, Hon. Thad Cochran, Chairman of the Subcommittee, presiding.

Present: Senators Cochran, Levin, and Thompson [ex officio].

OPENING STATEMENT OF SENATOR COCHRAN

Senator COCHRAN. The Subcommittee will come to order. I apologize for the delay in convening the hearing. We appreciate very much the attendance of our witnesses and welcome everyone to this hearing of our Subcommittee on International Security, Proliferation, and Federal Services.

Today we are reviewing a report by the General Accounting Office on the administration's 1995 decision to liberalize export controls on high performance computers, known as "HPCs," or "supercomputers."

In October 1995, President Clinton announced a broad decontrol of HPCs, which subsequently reduced the number of individual licenses granted for supercomputer exports by almost 90 percent.

After learning that the Russian and Chinese nuclear weapons complexes had obtained American supercomputers following the administration's change in policy, Congress acted last year to ensure that the Federal Government would have a greater role in determining who would be using exported high performance computers and how they would be used in certain foreign countries that pose proliferation threats.

At the same time, I asked the General Accounting Office to study the analysis on which the administration based its 1995 decision to liberalize high performance computer export controls, and to assess the soundness of the administration's current policy. This study can also serve as a basis for analyzing any future administration proposals to decontrol supercomputer exports.

Our witnesses today include Harold Johnson, Associate Director, General Accounting Office for International Relations and Trade

Issues, who will present the GAO's report.[1] He is joined at the witness table by two of his associates from GAO who directed this study, James Shafer and Jeffrey Phillips.

We also have with us today Commerce Under Secretary William Reinsch, who will respond with the administration's view of the GAO report.

I am happy to yield to the distinguished Chairman of the Governmental Affairs Committee, Senator Thompson, for any comments or remarks he would like to make.

Senator THOMPSON. Thank you, Mr. Chairman. I think I'll wait and follow regular order.

I do have to leave in about 25 mintues for a downtown meeting, but if we can follow the regular order, then I think I can get my questions in. Thank you very much.

Senator COCHRAN. Thank you, Senator.

Let me ask the Associate Director of the General Accounting Office, Harold Johnson, to proceed.

STATEMENT OF HAROLD J. JOHNSON,[2] ASSOCIATE DIRECTOR, INTERNATIONAL RELATIONS AND TRADE ISSUES, U.S. GENERAL ACCOUNTING OFFICE, ACCOMPANIED BY JAMES SHAFER, NATIONAL SECURITY AND INTERNATIONAL AFFAIRS DIVISION AND JEFFREY D. PHILLIPS, NATIONAL SECURITY AND INTERNATIONAL AFFAIRS DIVISION

Mr. JOHNSON. Thank you very much, Mr. Chairman. We are pleased to be here to discuss the export controls on high performance computers.

As you mentioned, you had expressed concern about sales to Russia and China and asked us to do an assessment of the basis for the Executive Branch's revision to HPC export controls, and to identify changes in licensing activities and export enforcement requirements resulting from these revisions.

You also asked us to determine the current foreign availability of HPCs, particularly for countries of national security concern.

Because the unlicensed exports to Russia and China that you mentioned were under investigation by Commerce, Justice, and Customs Service, we did not specifically address this matter in our assessment. Also, I would like to point out that our examination did not determine the appropriate threshold levels for controlling HPCs. Instead, as you requested, we evaluated the process by which the Executive Branch made its decision and the adequacy of the information available for that purpose.

Our report on the decision to revise export controls is being released today, as is our companion report responding to a requirement of the fiscal year 1998 National Defense Authorization Act. Therefore, my prepared statement is fairly short and I will summarize our principal findings. But first, I think a little background might be useful.

As we have stated in previous testimony, the U.S. export control system is basically about managing risk. Exports to some countries

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[1] GAO report entitled "Export Controls: Information on the Decision to Revise High Performance Computer Controls," September 1998, GAO/NSIAD–98–196, submitted by Mr. Johnson, appears in the Appendix on page 54.

[2] The prepared statement of Mr. Johnson appears in the Appendix on page 41.

involve less risk than to other countries, and exports of some items involve less risk than others. The President has the responsibility and the authority to control and require licenses for the export of licenses that may pose a national security or foreign policy concern, and he may remove or revise export controls as U.S. concerns and interests change. It should be noted that the law does not require that a foreign availability analysis be performed when deciding to remove or relax controls.

In 1995, the Executive Branch conducted a review of export controls on high performance computers to determine how changes in computer technology and its military applications should affect U.S. export control regulations. This review was a continuation of a process that had begun in the 1980's to take into account the technological advances in the computer industry. And I would point out that as recently as 1993, the export of computers with a composite theoretic performance of 195 MTOPS were controlled. This was raised to 1,500 MTOPS in February, so there have been changes as we have progressed along that timeline.

A key element of the Executive Branch's review was a Stanford University study, jointly commissioned by the Departments of Commerce and Defense. Among other things, the Stanford report stated that, first, U.S.-manufactured computers with a composite theoretic performance of up to 4,000 to 5,000 MTOPS were currently widely available and uncontrollable worldwide; second, that computers with a performance level of up to 7,000 MTOPS would become widely available and uncontrollable worldwide by 1997; and, third, that many high performance computer applications used in national security programs occur at about 7,000 MTOPS, or above 10,000 MTOPS.

The report also stated that it would be too expensive for the government and industry to effectively control exports of computing systems with performance below 7,000 MTOPS, and that attempts to control HPC exports below this level would become increasingly ineffectual and an unreasonable burden on the computer industry.

In announcing its 1996 change to export controls, the Executive Branch stated that one goal of the revised export control was to permit the government to tailor the controls to levels and licensing conditions to the national security or proliferation risks posed at specific destinations. The revised export control policy removed license requirements for most HPC exports with performance levels up to 2,000 MTOPS, an increase from what I mentioned previously, of 1,500 MTOPS.

The policy also organized the countries into four computer tiers, with each tier—after tier 1—representing a successively higher level of concern to U.S. security interests.

A dual control system was established for tier 3, such countries as Russia and China. For these countries, HPCs of up to 7,000 MTOPS could be exported to civilian end-users without a license, while exports at or above 2,000 MTOPS to end-users of concern for military or proliferation of weapons of mass destruction reasons did require a license. Exports of HPCs above 7,000 MTOPS in this category also required a license.

These are shown graphically in the report on page 25 for reference.

The January, 1996 regulation also made other changes. It specified that the exporters would be responsible for determining whether an export license is required based on the MTOPS levels of the computer, screening end users and end uses for military or proliferation concerns, and keeping records and reporting on exports of computers with performance levels of 2,000 MTOPS.

The 1998 Defense Authorization Act modified the regulations by requiring exporters to notify the Commerce Department of any planned sales of computers with performance levels greater than 2,000 MTOPS to tier 3 countries, and the government now has 10 days to assess and notify the vendor whether a proposed HPC sale requires a license.

The law also now requires Commerce to perform post-shipment verification on all HPC exports with performance levels above 2,000 MTOPS to tier 3 countries.

As I indicated, one focus of our work was to assess whether the empirical evidence presented in the Stanford study, which was a key element in the decision to revise HPC export controls, supported its conclusions. Our analysis showed that it had two significant limitations.

First, the study lacked empirical evidence or analysis to support its conclusions that HPCs were uncontrollable based on, one, worldwide availability, and two, insufficient resources to control them.

Second, the study did not assess the capabilities of countries of concern to use HPCs for military or other national security applications, as required by its tasking.

The study's principal author said that the U.S. Government data were insufficient to make such an assessment, and the study recommended that better data be gathered so that such an analysis could be done in the future.

Except for nuclear weapons, the Executive Branch has not completed an assessment of the national security risks of exporting HPCs to tier 3 countries, and the nuclear assessment was completed by the Department of Energy in June of this year, more than 2 years after the export control policy for HPCs was revised.

The Executive Branch has identified high performance computing as having applications in such national defense areas as nuclear weapons programs, cryptology, conventional weapons, and military operations, and with the exception of nuclear weapons, the Executive Branch has not identified how and at what performance levels specific countries of concern may use HPCs for national defense applications, an important factor in assessing the risk of the sales of HPCs to those countries.

In December of last year, the House Committee on National Security directed the Departments of Energy and Defense to make that assessment. DOE's study on nuclear weapons has shown that nuclear weapons programs in tier 3 countries, especially in China, India, and Pakistan, could benefit from the acquisition of HPC capabilities. The Executive Branch has not finished identifying how specific countries of concern could use HPCs for non-nuclear national defense applications.

Based on Commerce's view of the worldwide availability of computing power and the technological advancements in this area, the

Executive Branch raised the MTOPS threshold for HPCs. The 1996 revision to export control policies had three key consequences.

First, by increasing the performance threshold of computers that require license, the 1996 revision decreased the number of license applications from 459 in 1995 to 125 in 1997, and of approved export license applications for HPCs from 395 in 1995 to 42 in 1997.

Second, as I have indicated, the revision shifted some of the government's end-use screening responsibilities from the government to the computer industry. In essence, the exporter had to decide whether a license was required, since the decision is made on the basis of end use, the end user, and a computer's performance capability. This decision could be particularly difficult for some tier 3 countries like China, where identifying the distinction between a civilian and a military end user can be very difficult.

In response to several allegations of improper sales to Russia and China, Congress partly reversed this situation by passing the fiscal year 1998 National Defense Authorization Act, which requires exporters to notify Commerce of all HPC sales over 2,000 MTOPS to tier 3 countries prior to their export.

Third, the regulation required HPC manufacturers to keep records of end users of all HPC exports over 2,000 MTOPS. Based on our review of records provided by the manufacturers to the Commerce Department from January 1996 through September 1997, we noted that China ranked first in the number of HPCs acquired by tier 3 countries, having purchased a total of 77 HPCs during this period. These exports were all made without an individual license being required; in other words, they were supposedly to civilian end users, and below 7,000 MTOPS. Examining how these machines are being used, however, was beyond the scope of our review.

Responsibility for post-shipment verification checks on exports remained with the government, but information on these exports reported to the government has been incomplete. Post-shipment verifications for computers generally have been of somewhat reduced value because of how the process is implemented. First, post-shipment verification really only verifies the physical location of the HPC, not how it is used. There are some exceptions to that. Also, some governments, such as China, have not allowed the United States to conduct post-shipment verifications.

With regard to foreign availability, we found that subsidiaries of U.S. computer manufacturers dominate the overseas HPC market, and they must comply with U.S. controls. Russia, China, and India have developed HPCs, but their capabilities are believed to be limited.

Thus, our analysis suggests that HPCs over 2,000 MTOPS are not readily available to tier 3 countries from foreign sources without restriction.

Our report contained two recommendations, one that requires action by the Secretary of Defense and one that requires action by the Secretary of Commerce, with support from Defense, Energy, State, and the Arms Control and Disarmament Agency.

First, we recommended that to compliment the studies undertaken by DOD and DOE for the House Committee on National Security, that the Secretary of Defense should assess and report on

the national security threat and proliferation impact of U.S. exports of HPCs to countries of national security and proliferation concern. It seems to us that this assessment should, at a minimum: one, address how and at what performance levels countries of concern use HPCs for military modernization and proliferation activities; two, whether such uses are a threat to U.S. national security interests; and three, the extent to which such HPCs are controllable.

Second, and these would have to come in sequence, upon completion of that analysis we would recommend that the Secretary of Commerce, in conjunction with the other agencies that I mentioned, jointly evaluate and report on options to safeguard U.S. national security interests regarding HPCs. Such options should include, but not be limited to, one, requiring government review and control of the export of computers at their highest scalable MTOPS performance levels, and two, requiring that HPCs destined for tier 3 countries be physically modified to prevent their upgrade beyond allowable levels.

These are just some suggestions as to areas that ought to be considered. There may be others.

I would like to comment just briefly on the agency's response to our report. In addition to Commerce and Defense, the Departments of Energy and State, as well as the Arms Control and Disarmament Agency, offered some views.

Commerce said that the President's decision was intended to change the computer export policy from what it referred to as ''a relic of the Cold War'' to one more in tune with today's technology and international security environment, and was based on, one, rapid technological change in the computer industry; two, wide availability; three, limited controllability; and four, limited national security applications for HPCs. Commerce further stated that our report focused too much on how countries might use HPCs for proliferation and military uses rather than on what it called ''an outdated Cold War concept of foreign availability.'' The Department said that our analysis of foreign availability was too narrow and that foreign availability is not an adequate measure of the problem.

Now, we agree that rapid technological advances in the computer industry have made the controllability of HPCs a more difficult problem. However, we disagree that foreign availability is necessarily an ''outdated Cold War concept'' that has no relevance in today's environment. While the threats to U.S. security may have changed, they have not been eliminated. Commerce itself recognized this in its March, 1998 annual report to the Congress in which it stated, ''The key to effective export controls is setting control levels above foreign availability.''

Commerce also commented that the need to control the export of HPCs because of their importance for national security applications is limited. It stated that many national security applications can be performed satisfactorily on uncontrollable low-level technology, and that computers ''are not a choke point for military production.'' Commerce said that having access to HPCs alone will not improve a country's military and industrial capabilities.

While it may be true that many of our modern weapons systems were designed with less powerful computer systems, Commerce's

view seems to be inconsistent with the requirement for DOD to identify militarily-critical technologies. In assessing these militarily-critical technologies, DOD has determined that high performance computing is an enabling technology for modern tactical and strategic warfare, and also important in the development, deployment, and use of weapons of mass destruction.

High performance computing has also played a major role in the ability of the United States to maintain and increase the technological superiority of its war-fighting support systems. DOD has noted in its High Performance Computing Modernization Program Annual Plan that "the use of HPC technology has led to lower costs for systems deployment and improved the effectiveness of complex weapons systems."

DOD further stated that as it transitions its weapons systems design and testing process to rely more heavily on modelling and simulation, the Nation can expect more examples of the profound effect that HPC capability has on both military and civilian applications.

In DOD's comments on our report, it said that it had considered the threats associated with HPC exports to countries of national security and proliferation concern. DOD referred to its identification of how HPCs in the United States are used for national security applications.

While our report recognized that such an assessment of domestic uses had been done, this did not answer our concern. We reported that the Stanford study did not assess the capabilities of countries of concern, such as China, Russia, Indian, or Pakistan, to use HPCs for military or other national security applications, as required by its tasking, and the Executive Branch did not undertake a specific threat analysis of providing HPCs to such countries.

As we reported, the principal author of the Stanford study noted that no assessment had been done of the national security impact of allowing HPCs to go to particular countries of concern, and of what military advantage such countries could achieve. In fact, in its most recent report—its April, 1998 report—on HPC export controls, the same principal author also noted that identifying which countries could use HPCs to pursue which military applications remained a critical issue on which the Executive Branch provided little information. State, Energy, and ACDA all generally agreed with our report.

That concludes my prepared statement.

Senator COCHRAN. Thank you, Mr. Johnson, for your statement and for your work on this report.

With the concurrence of the distinguished Ranking Member of the Subcommittee, we're going to yield first to the distinguished Chairman of the full Committee, Senator Thompson, for any questions or remarks he would like to make.

OPENING STATEMENT OF SENATOR THOMPSON

Senator THOMPSON. Thank you very much, Mr. Chairman.

First of all, let's establish exactly what it is we're dealing with regarding these sophisticated computers and their significance with regard to nuclear proliferation and military uses.

Referring to the final paragraph on page 7 of your report, you say, ''Prior to the Executive Branch's decision to change computer thresholds, scientists at the Department of Energy National Laboratories and other U.S. Government officials had accumulated information to show how countries of concern could use HPCs to facilitate the design of nuclear weapons and to improve advanced nuclear weapons in the absence of tests of nuclear explosives. However, this information was not used as part of the decisionmaking process.'' Is that correct?

Mr. JOHNSON. That's what was reported to us, yes, sir.

Senator THOMPSON. So the Department of Energy's report came down after the new rules went into effect in January 1996?

Mr. JOHNSON. Well, the report came down after the new rules came into effect, but the information that was available that you referred to was available prior to that.

Senator THOMPSON. All right.

Mr. JOHNSON. As we understand it, it wasn't necessarily put into the form of a report.

Senator THOMPSON. So that information had been available, certainly——

Mr. JOHNSON. It was available, had it been sought.

Senator THOMPSON [continuing]. At the time that the Stanford report was being written. Is that correct?

Mr. JOHNSON. That is correct, yes.

Senator THOMPSON. That these computers could facilitate the design of nuclear weapons.

I refer to page 17 of your report, where the Department of Defense comments on this issue. It says, ''Moreover, Commerce's position on this matter is not consistent with that of''—they're talking about another position of Commerce, different from the one I just articulated—''DOD, in its Militarily Critical Technologies List, has determined that high performance computing is an enabling technology for modern tactical and strategic warfare, and is also important in the development, deployment, and use of weapons of mass destruction. High performance computing has also played a major role in the ability of the United States to maintain and increase the technological superiority of its war-fighting support systems.'' And then you go on to point out that more and more we have to rely upon simulation and modelling and so forth, that it is more significant.

So you have got both the Department of Energy and the Department—when was this Militarily Critical Technologies List published?

Mr. JOHNSON. Well, they do one periodically, I think on an annual basis.

Mr. PHILLIPS. It's essentially on an ongoing basis, and information from the one during the 1995 period was carried over into 1996.

Senator THOMPSON. So this is the one that was extant at the time that this report was produced?

Mr. JOHNSON. Right.

Senator THOMPSON. So you have both the Department of Energy and the Department of Defense saying that these are computers that can assist people in their design of nuclear weapons and is an

enabling technology for modern tactical and strategic warfare and the use of weapons of mass destruction.

So this is the background that we have when the administration decided to change the rules of the game in January 1996 and to lower the bar and make it easier for us to export these computers?

Mr. JOHNSON. Right.

Senator THOMPSON. So the answer, as I understand it, is multifold. I am amazed that the Department of Defense is under the impression that the issue of whether or not these can be converted for military uses was addressed by the Stanford report, when in fact it obviously was not.

Mr. JOHNSON. Well, one small part of it, I think, to give them their due. They did consider how HPCs were used domestically in our weapons system development and other aspects. But that doesn't convert, right.

Senator THOMPSON. Well, our major concern is not in that area, is it? I mean, it's what China is doing with them, it's what India is doing with them.

Mr. JOHNSON. The countries of concern——

Senator THOMPSON. That was not addressed?

Mr. JOHNSON. That was not addressed.

Senator THOMPSON. So as I understand it, they rely upon the Stanford study to justify what they did, a study which to me is pretty clearly based on commercial interests more than anything else, as evidenced once again by the lead of the Department of Commerce. But they rely on this study, and you found when you looked at this study, it was faulty in more than one respect. First of all, there is the argument that "everybody does it, everybody has it." You looked at the lay of the land, and first of all, there is nothing in the report—and, I take it, nothing in your conversations with the people who did the report—to indicate any backup or any basis for the conclusions that they came to. Is that correct?

Mr. JOHNSON. The concern that we had was that there was a lack of empirical evidence to support the conclusions that they had come to.

Senator THOMPSON. And when you looked at the situation, you found that—referring to page 12—the only global competitors for general computer technology are three Japanese companies, two of which primarily compete for sales of high-end computers, systems sold in small volumes and performing at advanced levels. Two of those companies reported no HPC exports to tier 3 countries; and China and Pakistan, of course, are tier 3 countries——

Mr. JOHNSON. Correct.

Senator THOMPSON [continuing]. While the third company reported some exports on a regional, rather than country, basis. That's Japan.

One German company sells these computers, primarily in Europe, and has reported several sales over 2,000 MTOPS to tier 3 countries.

One was a British company, but this company said that it never sold a system outside the European Union.

You say that a 1995 Commerce Department study of this global market showed that American dominance had prevailed at that

time, as well. So basically what you're saying is that America has the clear dominance in this area?

Mr. JOHNSON. That's right.

Senator THOMPSON. And has had for some time?

Mr. JOHNSON. Yes.

Senator THOMPSON. And you also state, "Available information indicates the capabilities of China, India, and Russia to build their own HPCs still lag well behind that of the United States, Japan, and European countries." Is that correct?

Mr. JOHNSON. That is what was reported to us, right.

Senator THOMPSON. Another problem you had with the report, besides the fact that there was not supporting documentation for the conclusion that this was uncontrollable and everybody has it or is going to soon have it, is that this report was supposed to assess the capability of countries of concern to use these computers for military purposes. That was supposed to be a part of this Stanford report, wasn't it?

Mr. JOHNSON. Yes. That was one of the taskings, but we also recognize and acknowledge that that tasking could not have been fulfilled because of a lack of information that only the U.S. Government can provide.

Senator THOMPSON. Well, I understand. I'm not asking you why it wasn't fulfilled, I'm asking, was it supposed to be in there? And the answer to that is yes?

Mr. JOHNSON. Yes.

Senator THOMPSON. And the next question is, was it in there?

Mr. JOHNSON. No, it was not.

Senator THOMPSON. And the answer to that is no. In fact, in the report they refer to the fact that it's not in there. They acknowledge that they do not address that, and they have certain recommendations as to what they feel needs to be done in order for this government to determine whether or not the countries to which these are being shipped could convert them for military purposes. But as far as we know, that was not done.

Mr. JOHNSON. That has not been done, and that recommendation is contained in Dr. Goodman's April, 1998 study, as well. So that is still an area of concern.

Senator THOMPSON. I notice on page 8 of your report, the DOE study concluded that "The acquisition and application of these computers to nuclear weapons development would have the greatest potential impact on the Chinese nuclear program,"——

Mr. JOHNSON. Yes.

Senator THOMPSON [continuing]. "Particularly in the event of a ban on all nuclear weapons testing." Also, the study indicates that India and Pakistan may now be able to make better use of the HPCs in the 1,000 to 4,000 MTOPS range for their nuclear weapons programs because of the testing data that they acquired in May 1998 from underground detonations of nuclear devices. Is that right?

Mr. JOHNSON. That is correct.

Senator THOMPSON. So now it appears, as of the time of this report, the opinion is that India and Pakistan can use these computers in the 1,000 to 4,000 MTOPS range for their nuclear programs.

On page 10, where you're dealing with the fact that license applications have declined, you say, "Also during this period, 77 HPCs were exported to China and 19 were exported to India, all without individual licenses. Most U.S. HPCs exported in this period, about 85 percent, had performance levels between 2,000 and 5,000 MTOPS."

Mr. JOHNSON. Yes.

Senator THOMPSON. So am I to understand that some computers with 2,000 and 5,000 MTOPS were exported to both China and India?

Mr. JOHNSON. Yes. In fact, all of the ones that were exported during this period of time to China and India were within that range, that are included in that 77.

Senator THOMPSON. And that is the range that has the greatest potential impact on the Chinese program, and India and Pakistan may better use computers in that range for their nuclear weapons programs. I find that amazing.

I have no further questions.

Senator COCHRAN. Thank you very much, Mr. Chairman.

Senator Levin, I'm going to call on you now, if you would like to proceed with your questions, then I will follow you.

OPENING STATEMENT OF SENATOR LEVIN

Senator LEVIN. Thank you, Mr. Chairman. Thank you, and I also have a prepared statement which I would appreciate being made a part of the record.[1]

Senator COCHRAN. Without objection it will be printed in the record.

Senator LEVIN. Thank you, Mr. Chairman.

First of all, in terms of the national security questions which are the most significant questions, as part of the studies which you have done for this Subcommittee and for the Senate Armed Services Committee, did the GAO assess and reach a conclusion as to whether the 1996 restructuring of computer export controls has had any negative effect on U.S. national security?

Mr. JOHNSON. We don't have that kind of capability. But what we looked at was whether or not the Executive Branch had performed that, and they had not.

Senator LEVIN. Let me get to the DOD questions, because you said that they have not done it, and yet the DOD says that it did. In their letter to Mr. Nelson, the DOD says that "The GAO draft report inaccurately states that DOD did not consider the threats associated with high performance computer exports. DOD did take into account the security risks associated with the export of HPCs to countries of national security and proliferation concern. DOD identified numerous national security applications that require various levels of computing power, which helped to determine licensing policies for the various country groups and to establish specific safeguards on computer exports. Countries of greatest national security and proliferation concern are subject to the most stringent licensing and safeguard requirements."

Do you disagree with that statement of the DOD?

[1] The prepared statement of Senator Levin appears in the Appendix on page 39.

Mr. JOHNSON. Yes. Substantially, what DOD is referring to are the analyses and the information that they provided on how HPCs are used for domestic—for our own weapons systems development. Now, when the tier system was created, they did take into account—they had six different criteria, and took into account the potential of how a country might use an HPC, whether they were a member of the nonproliferation treaty, and a number of other criteria. But they did not do a specific threat analysis of how individual countries might use HPCs or how that might threaten our own national security. That's the part that was not done.

Senator LEVIN. Are you disagreeing with the statement of the DOD which says that "the GAO draft report inaccurately states that DOD did not consider the threats associated with high performance computer exports." You disagree with that?

Mr. JOHNSON. Yes.

Senator LEVIN. So there's just a difference here between the DOD and the GAO on that specific statement?

Mr. JOHNSON. Right.

Senator LEVIN. And then it says in the next sentence, "The DOD did take into account the security risks associated with the exports of HPCs to countries of national security and proliferation concern." On that specific sentence, do you disagree with that?

Mr. JOHNSON. Not entirely. Like I said, they did take some aspects of that into account as part of their development of the tier system.

Senator LEVIN. On that sentence, then, you agree in part and disagree in part?

Mr. JOHNSON. Right.

Senator LEVIN. And on the first sentence, you say you just disagree with it.

On the third sentence, "DOD identified numerous national security applications that require various levels of computing power, which helped to determine licensing policies for the various country groups and to establish specific safeguards on computer exports." You disagree in part, or totally——

Mr. JOHNSON. I totally disagree with the specific words that they use there because, as I mentioned, they are referring to the determination of how we use those HPCs in weapons development.

Senator LEVIN. And the fourth statement in that paragraph, "Countries of greatest national security and proliferation concern are subject to the most stringent licensing and safeguard requirements." Do you disagree with that?

Mr. JOHNSON. Well, I really can't respond to that because, like I said, we didn't ourselves develop special levels. The export controls that have been established are being enforced to the extent that they can, but I can't comment specifically on that assertion.

Senator LEVIN. OK. The next paragraph says the following, "The GAO recommends that the Secretary of Defense assess how and at what performance levels countries of concern use HPCs for military modernization and proliferation activities," and then they go on to say, "These factors were taken into account by DOD and the interagency process in the 1995 review of computer export controls." Do you disagree with that?

Mr. JOHNSON. Well, I don't know what they mean, "taken into account," but I do know that they didn't do an assessment of countries of concern and how they might use high performance computers for the development of their systems.

Senator LEVIN. Well, let me re-read it to you. It seems to me there's just a conflict on this one——

Mr. JOHNSON. Well, there may be. What I don't know is what they mean by they "took it into account." Did they think about it? We were unable to see any study, any documentation where they took that into account.

Senator LEVIN. So you don't deny that they took that into account, you just haven't seen the documents in which they did take them into account?

Mr. JOHNSON. Yes, it's like suggesting that somebody consider something, and they may consider it for 30 seconds, and go on. But we did not see a study or an analysis that would satisfy what we were intending in our recommendation.

Senator LEVIN. So again, I just want to be really clear on this, because we ought to ask the DOD these questions, Mr. Chairman. I would hope we would ask the DOD for the information here, because there seems to be a conflict between the Department of Defense and the GAO here, and I just want to repeat this sentence.

Senator COCHRAN. We received a request to invite a witness from the Department of Defense. Our staff called and talked to Sandi Stewart over in the Secretary's office to convey that request. The Defense Department was unable to provide a witness, but we would be happy to hear from them at some future point.

Senator LEVIN. Well, I don't know if anyone's here. I have no idea. But in any event, I think we ought to ask the Department of Defense that question because there is a difference here between the GAO and the Department of Defense. The Department of Defense——

Senator COCHRAN. We can submit that to them in letter form, and I will join you in the request.

Senator LEVIN. All right. Because when the DOD represents here that it represents to you folks—that these factors—I'd better repeat the whole sentence.

"The GAO recommends that the Secretary of Defense assess how and at what performance levels countries of concern use HPCs for military modernization and proliferation activities. These factors were taken into account by DOD and the interagency process in the 1995 review of computer export controls."

It seems to me there's a conflict here between the GAO and the DOD, and we ought to ask the DOD what they mean because they obviously just differ with the GAO on this point.

It's clear there's a difference here, isn't that right?

Mr. JOHNSON. Yes.

Senator LEVIN. Now, in terms of the DOD, they also say the following——

Your comment is that the Stanford University study did not incorporate—did not consider certain material.

Here's what they say about the Stanford study. They say, "The Stanford University study referred to in the GAO report was just one of many inputs considered by the Executive Branch in its 1995

assessment of computer export controls. Information and analysis was also provided by various Defense components, as well as other U.S. Government agencies, including the intelligence community."

Do you agree with that statement?

Mr. JOHNSON. Yes, but the key component, the key study, was the Stanford study.

Senator LEVIN. Do you know what other inputs there were from other U.S. Government agencies, including the intelligence community, on the part that the Stanford study said it did not have adequate information on?

Mr. JOHNSON. We know that there was a study by the Institute for Defense Analysis, IDA, and that there were other documents that we reviewed that were provided to us, because we asked for everything, the whole range of considerations from all the agencies—not just DOD, but from Commerce and Energy as well, and we evaluated those.

Senator LEVIN. Did that include the intelligence community?

Mr. JOHNSON. Yes.

Senator LEVIN. So you would agree, then, with the statement of the DOD that the Stanford University study was just one of many inputs, and that information and analysis was also provided by various Defense components, as well as other government agencies, including the intelligence community?

Mr. JOHNSON. Right.

Senator LEVIN. You would agree with that.

Mr. PHILLIPS. May I add an elaboration to that, a little more detail?

Senator LEVIN. Sure.

Mr. PHILLIPS. There were a few items that were presented to us as being part of the study. One was information from the intelligence community which was largely a ranking of countries by general proliferation activities and concerns. There was nothing from the intelligence community or DOD that looked at how HPCs, particularly, were of a threat nature or were going to be used. So it was more of general proliferation activity. They looked at the effectiveness of the export controls of different countries, that type of thing.

There was another study, one from Institute for Defense Analysis, which really talked about a technical feasibility study, on a very technical level, that did not seem to be a major part of the information in the decision.

Finally, they alluded to some DOD analyses related to Defense applications. Again, there was no specific document that anyone provided to us to show us what that was, and the information seemed to overlap considerably with what was presented in the Stanford study. Some people told us that whatever DOD did, they did collaboratively with the Stanford study, and it was, again, incorporated in there together. They also mentioned some Internet search, but they had not kept that material.

That was about the extent of what was presented to us.

Senator LEVIN. Is there certain information that the National Security Council had that was not made available to you?

Mr. JOHNSON. Well, we don't know, because we asked to meet with a National Security Council representative on this issue and were told that they would not meet with us.

Senator LEVIN. All right.

You have a statement here that "We requested, but were denied access to, information from the National Security Council and data and analyses that were used in the interagency forum to reach the final decision to revise controls." So, according to your statement here, anyway, there was certain information from them that they would not release——

Mr. JOHNSON. That may exist——

Senator LEVIN [continuing]. That may exist that was not provided to you?

Mr. JOHNSON. Right.

Mr. PHILLIPS. The one point I would want to make on that, when we talked to the NSC representatives, they wouldn't talk to us but they referred us back to the agencies involved and said that they would have whatever analysis they were using.

Senator LEVIN. Well, did they say there was no additional analysis? Because your statement here says they would not give you the data and analysis that were used, it says here, in the interagency forum. So it implies that there may have been data that was used there other than the data that you received from the agencies. That's the implication here.

Mr. PHILLIPS. No, we have no knowledge if there was anything else that was used. Again, they wouldn't discuss the decisionmaking with us, so we can't say what they actually used. But as far as what was provided to us, or what we were referred to, again, they said go back to the agencies and ask them.

Senator LEVIN. Did you, or could you, list for the National Security Council the data and analysis which you received from the agencies and ask them whether there was any other material which they used? Could you do that?

Mr. JOHNSON. Yes, we could.

Senator LEVIN. Because I think that would be useful to us, so that we can find out whether or not there is additional data which they don't wish to disclose, other than what you've already seen from the agencies.

As I understand it, the DOD played a critical role in designing this four-tier structure, is that correct?

Mr. JOHNSON. That's my understanding, yes.

Senator LEVIN. So this was essentially a DOD design?

Mr. JOHNSON. I'm not sure I would consider it essentially a DOD design. I would say it's an Executive Branch design. It was through an interagency process that that was done, but some of the groundwork was by DOD.

Senator LEVIN. They support this design?

Mr. JOHNSON. Yes.

Senator LEVIN. And finally—I think I'm probably over my time, Mr. Chairman, I'm sorry, I haven't tracked it—in the tier 3 licenses, as I understand it, if a license is granted and any of the agencies that are involved here, including DOD or DOE, have an objection to the license, there is an appeal process. Is that correct?

Mr. JOHNSON. That's correct.

Senator LEVIN. So any one of these agencies that are involved here can effectively stop a sale if it doesn't approve of it, and then kick it up two or three levels, is that correct?

Mr. JOHNSON. That's correct.

Senator LEVIN. All right. I have additional questions but I am way over my time limit, Mr. Chairman.

Senator COCHRAN. Let me go back if I may, Mr. Johnson, and review the conclusions you reached about this report on which the administration based much of its reason for making the change in export control policy, the so-called Goodman Report or the Stanford University report that was led by Dr. Goodman.

Your conclusion, as I understand it, is that the administration placed great weight on that report——

Mr. JOHNSON. Yes.

Senator COCHRAN [continuing]. And that they——

Mr. JOHNSON. That was a key component of the decision process.

Senator COCHRAN. That was what?

Mr. JOHNSON. A key component, I'm sorry.

Senator COCHRAN. One could conclude that it was a very important part of the decisionmaking process, is that correct?

Mr. JOHNSON. That's correct.

Senator COCHRAN. And in your analysis of the Stanford study, you tell us in your report that there was a lack of, in your words, "empirical evidence or analysis" to support the conclusions reached by that report. Is that correct?

Mr. JOHNSON. That's right, yes.

Senator COCHRAN. Well, do you conclude, therefore, after you've reviewed the study and you've looked to find the evidence on which the policy changes were based—do you conclude that the Stanford study lacks credibility because its assumptions and conclusions are not supported by the empirical evidence or any analysis?

Mr. JOHNSON. I'm not sure I would want to characterize it quite like that, but what I would say is that our conclusion is that more information should have been made available to the Executive Branch in making that decision. There should have been further analysis done on the cost of implementing the export controls, and on the aspects of controllability. The conclusion that Dr. Goodman came to, that certain levels were uncontrollable, simply didn't have the empirical data to support that. I don't want to be so harsh as to say it lacks credibility, but it did have those limitations.

Senator COCHRAN. One example that your report points out is that officials could not explain nor provide documentation as to how they arrived at the decision to set the license requirements for exports of HPCs to tier 3 countries for military or proliferation end users at 2,000 MTOPS.

Mr. JOHNSON. Right.

Senator COCHRAN. The study concluded that the computing power 4,000 or 5,000 MTOPS was uncontrollable.

Mr. JOHNSON. That's right. Essentially, we were told that that was an interagency process that was undocumented, and that it was done that way to be conservative.

Senator COCHRAN. Could you tell us which administrative officials or Executive Branch officials you are referring to?

Mr. JOHNSON. Well, we asked a number of Executive Branch officials, but primarily in the Department of Commerce, and at several levels, including the higher levels in the Department of Commerce, Bureau for Export Administration.

Senator COCHRAN. Did these officials give you any explanation for the recommendations that resulted in the licensing parameters for tier 3 countries?

Mr. JOHNSON. Well, they did, in terms of the 2,000. They explained that it was an interagency process and it was established at 2,000 rather than at the higher levels, to be more conservative. We asked for documentation to help us track through that decision-making process, and we were not provided documentation.

Senator COCHRAN. Were you told that there was any? What was the response? Did you actually know of some documentation, or suspect that there was some?

Mr. JOHNSON. No, we did not know of any.

Senator COCHRAN. The suspicion was the other way, then, that there wasn't any?

Mr. JOHNSON. Yes.

Senator COCHRAN. I'm speculating, now, but——

Mr. JOHNSON. We did ask for the actual minutes of the interagency meetings and were told that there were none.

Senator COCHRAN. Would it be fair to conclude that this was a result of the influence of the computer industry and its pressure on the administration to set that parameter as it was set?

Mr. JOHNSON. I'm not sure that I would necessarily agree with that conclusion. I would think that if there was strong influence by the computer industry, that the level would have been set higher than at the 2,000 level. But I'm purely speculating. I can't speak for what was in their minds in establishing the control levels.

Senator COCHRAN. You say in the report that the Stanford study described uncontrollability as "the relationship between the difficulty of controlling computers, and the willingness of government and industry to meet the costs of tracking and controlling them."

Mr. JOHNSON. Right.

Senator COCHRAN. Does this mean that computers could be uncontrollable, simply based on a limited willingness on the part of government and industry to control them?

Mr. JOHNSON. One could certainly interpret it that way. If they decided that they—either government or industry—decided that they didn't want to spend anything on controlling HPC's, that would indicate an unwillingness to——

Senator COCHRAN. That means that based on the Stanford study, then—the description is that "U.S. high performance computers are uncontrollable."

Mr. JOHNSON. Well, if the conclusion were reached that they didn't want to spend any money, then they clearly be uncontrollable.

Senator COCHRAN. Does GAO agree with the Stanford study's description of "uncontrollability"?

Mr. JOHNSON. Well, in a sense we would, but we think that in reaching that conclusion there should be some data on how much is spent, what the cost is, and a comparison of cost to risk. We didn't see any of that in the study.

Senator COCHRAN. Your report also says, Mr. Johnson, that the Stanford study was "tasked with assessing the capabilities of countries of concern to use HPCs for military and other national security applications, and it did not do so."

Mr. JOHNSON. Correct.

Senator COCHRAN. Is that based on a written directive to Dr. Goodman from the Department of Defense and the Department of Energy?

Mr. JOHNSON. It's in the tasking, yes.

Senator COCHRAN. This was in the formal letter? So this was a specific request that was made of the university?

Mr. JOHNSON. That's correct. It was in its tasking, right.

Senator COCHRAN. Were any officials in the Executive Branch able to identify for you other studies that substantially informed the October, 1995 decision to decontrol high performance computers?

Mr. JOHNSON. No.

Senator COCHRAN. Even though I know, as Senator Levin has pointed out, there is the Department of Defense letter responding to the report,[1] saying that there were other considerations. But even in your efforts to find out what these sources were or what the information was, no one ever produced anything?

Mr. JOHNSON. That's right. When we talk about the limitations of that study, I think we would come to the conclusion that the most important limitation has to do with the lack of determination as to national security risks involved for providing HPCs to countries of concern.

It seems to us that if that analysis were made, and a decision is made that there are no risks, then there is no point in controlling computers, regardless of the capability. There needs to be, first of all, the establishment of some national security reason for doing that, for controlling high performance computers. We see that as a significant limitation in the analysis.

Senator COCHRAN. You use the terms in your report of "scalability," "upgrading," and "clustering."

Mr. JOHNSON. Right.

Senator COCHRAN. Could you tell us if there are problems associated with these efforts and difficulties in adapting software or the like?

Mr. JOHNSON. Yes, we can respond to that, but I'm going to ask my expert to.

Mr. PHILLIPS. Yes. As far as clustering goes, there is a lot of disagreement within the computer community that we came across about how mature that technology actually is. Clustering refers to linking computers together, usually by some kind of hard-wire interface. And the problems that come in—in theory, the more processors you put together, the more power you should get out of a computer system. But in reality, as you add more, you also have limitations based on the memory and on the communications speed between each of the processors communicating with each other. So in reality, when you are dealing with these systems in parallel, the benefit should be that they can deal with different problems at dif-

[1] The letter referred to, dated December 8, 1998, appears in the Appendix on page 122.

ferent speeds, but in reality the slowest part of the system is going to slow down the whole system.

These are limiting factors in the capabilities of clustering machines. Most people in the community think that they are not insurmountable problems, and that technological advances have been getting better. But still, at this point, a number of people—including the authors of the Stanford study—did not think that clustering technology in and of itself should be driving the thresholds for the export controls.

Senator COCHRAN. In regard to scalability, could this be detected in a post-shipment verification to try to determine whether or not these computers have been upgraded by the end user?

Mr. JOHNSON. If there is adequate expertise by those people doing the post-shipment verification, it could be. The problem with post-shipment verifications for the most part is that people don't have the expertise to do that kind of testing or analysis.

Senator COCHRAN. On that subject, who under the current regime is doing the post-shipment verification? The industry? Or government officials?

Mr. JOHNSON. Ordinarily it is government officials from the local embassy. There are teams that are sent out from Washington, called Special Verification Teams, and they probably would most likely have the capability to detect a machine that had been scaled up. But most of the post-shipment verifications are done by officials of embassies that may not have that kind of capability. So that is a limitation, but at the very least they know whether or not the machine is physically located there, so there is value to the post-shipment verification.

Senator COCHRAN. Senator Levin, that's a good stopping place for me in this round, if you would like to ask additional questions.

Senator LEVIN. Thank you, Mr. Chairman. Just a few additional questions.

We've gone through some of the disagreements that you have with the Department of Defense. In their letter—it's not dated, but it's about August 9——

Mr. JOHNSON. Yes, thereabouts. I think we received their letter a few days after we received the response from Commerce.

Senator LEVIN. OK. But it's addressed to Benjamin Nelson of the GAO.

Mr. JOHNSON. Yes.

Senator LEVIN. We've gone through some of the disagreements between you and the Department of Defense. There is an additional statement in that letter, and I want to see whether you agree or disagree with that one as well.

That letter says that "We in the Department of Defense determined that computers with performance below the current license threshold for tier 3 countries are widely available globally."

That's the first one. From what you've testified to already, I take it that you disagree with that statement of the DOD, that computers with performance below the tier 3 license threshold are widely available globally. Would you disagree with that?

Mr. JOHNSON. We don't have data on that, nor was data presented in the Goodman study——

Senator LEVIN. No, I mean—it says here that the DOD determined that. Do you disagree that they determined that?

Mr. JOHNSON. We did not see where they had made that determination.

Senator LEVIN. All right. And you yourselves have not determined whether or not computers below the threshold level for tier 3 are widely available globally? You have not made your own determination of that?

Mr. JOHNSON. No, but below the license level I would believe that they would be widely available. But we don't have that data, either.

Senator LEVIN. We're talking about tier 3 licensing?

Mr. JOHNSON. Yes.

Senator LEVIN. So you would believe that computers below the 2,000 level are widely available?

Mr. JOHNSON. Probably.

Senator LEVIN. OK. That would sound like you agree with them on that one.

Now, on Stanford, I gather that you had some discussions with the Stanford study folks——

Mr. JOHNSON. Yes, indeed.

Senator LEVIN [continuing]. But their response to your comments is not attached because it's not the practice of the GAO——

Mr. JOHNSON. We——

Senator LEVIN. If I could finish.

Mr. JOHNSON. I'm sorry.

Senator LEVIN [continuing]. As I understand it, it's not the practice of the GAO to incorporate the comments of contractors in your own reports, whereas you would incorporate comments of agencies that you're looking at? Is that accurate?

Mr. JOHNSON. That's generally our policy and our practice. There are times when we do incorporate comments of contractors. In this case, we didn't specifically seek written comments on our reports. If the Commerce Department wished to do that, that was their prerogative.

Senator LEVIN. The Commerce Department could have incorporated the Stanford response in their response?

Mr. JOHNSON. That's correct. They could have done that. I don't know that they did.

Senator LEVIN. All right.

Mr. JOHNSON. But we had several discussions with the authors of the Stanford study and tried as best we could to reflect their comments in the text of our report.

Senator LEVIN. Your report criticizes the Stanford study for concluding that computers in the 4,000 to 5,000 MTOPS range were widely available, without citing any empirical evidence for their conclusions. Is that correct?

Mr. JOHNSON. Yes.

Senator LEVIN. And do they—when you talk to them, do they agree with you?

Mr. JOHNSON. They felt that the information that they had available, working from the theoretic basis that they were working from, was sufficient.

Senator LEVIN. So they felt they did have adequate evidence to reach that conclusion?

Mr. JOHNSON. Yes, but not specifically empirical data on what the installed base is at any particular level, they did not have.

Senator LEVIN. Just so that I am clear on this, they felt that they did have an adequate basis for their conclusion, but you felt they did not?

Mr. JOHNSON. Yes.

Senator LEVIN. So you disagree with the Stanford folks on that specific issue.

Mr. PHILLIPS. I'd like to add a point on that, Senator.

What they did feel less certain about, though, was the precision of their own definition of what "uncontrollable" means, and that was the term that they used predominantly throughout the report. Availability was just one aspect of uncontrollability.

In reaching a conclusion that computers within the 4,000 to 5,000 MTOPS range were uncontrollable, they themselves admitted that they did not fulfill the terms of the definition that they had set up to do that.

Senator LEVIN. OK.

I think it would be useful if the Commerce—I don't think the Commerce Department incorporated the Stanford response. I may be wrong on this, but if they haven't, I think it would be useful for the Subcommittee, Mr. Chairman, to request either the Commerce Department or Stanford to comment on the findings of the GAO relative to the Stanford study. [1]

Senator COCHRAN. We have the Commerce Department represented here today, so we can ask that question now.

Senator LEVIN. All right.

Senator COCHRAN. Do you want to write a letter to Stanford and ask them for a response to the report?

Senator LEVIN. I think so.

Mr. JOHNSON. I think that would be fair.

Senator COCHRAN. Is Dr. Goodman still around?

Mr. JOHNSON. Yes.

Senator COCHRAN. He's been a witness in here, hasn't he? Not yet?

Senator LEVIN. We have disagreements between GAO and DOD. We have disagreements between GAO and Stanford, and it seems to me we ought to give both the DOD and Stanford—ask them for their explanation of their position, given the GAO report.

Thank you very much, Mr. Chairman, for doing that, and for holding this hearing.

Senator COCHRAN. Mr. Johnson, one of the assumptions underlying the decontrol of HPCs in 1995 was that there would be widespread availability of HPCs, at least to the level of 7,000 MTOPS, by 1997. But according to your report, "Our analysis shows that subsidiaries of U.S. companies dominate the overseas sales of HPCs."

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[1] GAO responses to the comments of the Stanford Study and DOD appear in the Appendix on pages 104 and 121 respectively.

If U.S. companies dominate the overseas sale of HPCs, can there be widespread availability of HPCs overseas only if the United States elects not to control the computers?

Mr. JOHNSON. Not on an unrestricted basis.

Senator COCHRAN. The Department of Commerce suggested to GAO in the course of conducting this study that foreign availability is an outmoded Cold War concept—or that was your report?

Mr. JOHNSON. No, that was our characterization of it.

Senator COCHRAN. Right. You included that in your report?

Mr. JOHNSON. Yes.

Senator COCHRAN. Has the Commerce Department, to your knowledge, reported otherwise in the recent past to Congress? Or does GAO agree with this suggestion, that it's an outmoded Cold War concept?

Mr. JOHNSON. No, we don't agree that it's an outmoded concept. And yes, Commerce has used that same terminology and concept, which is described in the Export Administration Act, in its most recent report to the Congress in March. It makes reference to foreign availability being established at a level above what is available in the market elsewhere.

So that concept still exists. I would mention, though, that foreign availability—and I think I mentioned that in my statement—the notion of doing a foreign availability analysis is not specifically required for relaxation of controls. That concept is used more often in determining that controls ought to remain on a commodity rather than being taken off. The concept still exists.

Senator COCHRAN. Your report also notes that there is a German company that has had some sales of HPCs over 2,000 MTOPS to tier 3 countries. Does that, in your opinion, constitute widespread foreign availability?

Mr. JOHNSON. No.

Senator COCHRAN. Let me ask you how similar to the United States are the export control regimes of Germany and Japan for HPCs.

Mr. JOHNSON. They are quite similar.

Senator COCHRAN. If a German company, therefore, has made limited sales of HPCs capable above 2,000 MTOPS to tier 3 countries, why don't more tier 3 countries buy computers from Germany instead of from the United States to avoid dealing with the U.S. export controls?

Mr. JOHNSON. What we're told is that we have better technology, and we'll accept that. But they also would have to deal with the export control systems of Germany, as well.

Senator COCHRAN. The report says also that "available information indicates that"—this is on page 13 of your report—"available information indicates that the capabilities of China, India, and Russia to build their own HPCs still lag well behind that of the United States, Japan, and European countries."

For how long does GAO expect that these countries will lag behind U.S. HPC capabilities?

Mr. JOHNSON. Well, we don't have information on China and India. Russia, we were told, is 3 to 7 years behind.

Mr. PHILLIPS. Yes, from various sources, as little as 3 years and as many as 10 years, perhaps.

Senator COCHRAN. You note on page 42 in your report that you asked the Commerce Department to provide data to support its assertion on foreign manufacturers, but "we received no documentary support." What did Commerce say about this?

Mr. PHILLIPS. When we talked with them, they said they were relying largely on some HPC world market studies that had been done in the 1995 time period. That was the essential explanation.

Senator COCHRAN. And you had requested data from the Commerce Department on this subject to support its assertion?

Mr. PHILLIPS. That's correct.

Senator COCHRAN. And that's what you got in response?

Mr. PHILLIPS. Yes.

Senator COCHRAN. Did you get copies of the data?

Mr. PHILLIPS. We had those reports earlier. They had provided them to us at an earlier time, and we in fact even referred to them in our report.

Senator COCHRAN. Mr. Johnson, during the preparation of your report, did any U.S. exporters provide GAO with evidence of a lost sale due to implementation of the requirement in the recent Defense Authorization Act to notify the Commerce Department of planned sales above 2,000 MTOPS to a tier 3 country?

Mr. JOHNSON. No, they did not, and we queried companies to see if there had been an effect and we were told that nothing had changed.

Senator COCHRAN. This is off the subject, but did you get at all into the recent decision that led to a fine, and an agreement to pay a fine, by IBM for violating export regulations?

Mr. JOHNSON. No, we did not. That was under investigation during most of the course of our work, so if a case is under investigation, we stay away from it. We are aware of the settlement that was reached, but——

Senator COCHRAN. What was the settlement, can you tell us?

Mr. JOHNSON. As I understand it, IBM—their East European subsidiary—entered a plea and paid a fine of $8.5 million, which I understand is the steepest fine that has been levied.

Senator COCHRAN. And what was that fine imposed for? What regulation was violated? Was it the regulations as decontrolled by the administration, as relaxed, or was it earlier regulations?

Mr. JOHNSON. No, as relaxed. They had violated the controls in existence.

Senator COCHRAN. The new controls?

Mr. JOHNSON. Right.

Senator COCHRAN. The new limited controls that exist for exports?

Mr. JOHNSON. Yes.

Senator COCHRAN. OK.

Thank you very much. If we have some other questions that we need to ask you to clarify provisions in the report, we will submit them to you. But we appreciate your doing this study and we appreciate your delivering this, and you have instructions here on how you can get more copies and everything, right? It's available?

Mr. JOHNSON. Yes, on the back page.

Senator COCHRAN. On the back page here. So if anybody wants copies for friends, that's how you can order them.

Thank you very much.

Mr. JOHNSON. Thank you, Mr. Chairman.

Senator COCHRAN. Our next panel is the Hon. William Reinsch, Under Secretary for Export Administration, U.S. Department of Commerce.

Mr. Reinsch, we thank you for being here and your patience and your cooperation with our Subcommittee.

You are free to proceed with any comments or statement you would care to make in response to the GAO report or the subject at hand, and then I will have a few questions for you.

STATEMENT OF HON. WILLIAM REINSCH,[1] UNDER SECRETARY FOR EXPORT ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Mr. REINSCH. Thank you, Mr. Chairman.

Let me say first that this is the third time I've been here this year, not counting times previous, and I want to begin by expressing my appreciation for your courtesy on every occasion. We haven't always agreed on these things, and I have a lingering suspicion that we won't agree today, but you have been on every occasion fair and generous in giving me time to present the administration's point of view, and I want you to know that I appreciate that.

Mr. JOHNSON. I also harbor the lingering—probably naive—hope that one of these days I'm going to convince you that we're right and you're wrong—— [Laughter.]

But I suspect that will be another day.

Mr. REINSCH. I am tempted to dump my statement and respond to some of the questions that were asked of the panel, but what I would like to do is deliver an abbreviated version of it, if I may, and then hope that you ask me some of the same questions that you asked them, because I would be pleased to respond to some of this.

The debate over computer export policy has been marked by a good deal of smoke and heat, but perhaps not as much light as one could wish. I want to try today to explain our policy and its derivations, and in doing so will comment—albeit indirectly—on the substance of most of GAO's comments.

The fundamental premises of our policy are that, like it or not, rapid technological progress has rendered control of high performance computers increasingly difficult, and that it is more important to our national security to have a healthy computer industry supplying state-of-the-art products to our military and intelligence services than it is to attempt to "control the uncontrollable" and jeopardize our companies' futures in the process.

Four factors have shaped our thinking.

The first is technological change. Improvements in microprocessor design have allowed high performance computers to become ever smaller, cheaper, and faster. At the same time, improvements in microprocessors have made routine desktop PCs capable of performing at what were considered supercomputer levels a few years ago.

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[1] The prepared statement of Mr. Reinsch appears in the Appendix on page 123.

The second factor is global diffusion. We must assess realistically our ability to control the distribution of computers when they are produced in the thousands, even tens of thousands, and sold from a variety of sources around the world.

Third is the growth of parallel processing, which greatly increases computer performance and the concomitant ability of users to easily upgrade performance.

Finally, there is our conclusion, based on our research and the 1995 and 1998 studies, that computer power is a secondary consideration for many applications of national security concern.

We have also kept in mind the nature of the computer market, which is a vital element of U.S. economic strength. We are world leaders in this very competitive market, with $2 billion a year in revenue, and this leadership helps us across the board in the information technology sector. The policy adopted by the United States in 1995 affected more than $10 billion in exports, which supported 140,000 jobs annually. If misapplied, export controls can profoundly damage this important sector, put these jobs at risk, and—relevant to your consideration today—seriously damage our national security by crippling our companies, just as our national security establishment's reliance on them is growing.

The competitive and increasingly global market has strong implications for controls. Roughly half the computers made in the United States are exported, and the sales fall in the ranges below—my written statement provides that. Computers up to 400 MTOPS, which are your standard PCs, have been sold in the millions; 400 to 1,000 MTOPS, in the tens of thousands; 1,000 to 5,000 MTOPS, in the thousands range; and a few thousand computers capable of 5,000 to 10,000 MTOPS have been sold, and some hundreds at levels beyond that.

Some of these computers can be reconfigured by their users to have much higher performance, and in the future, in response to market demands, more and more computers will be scalable. Our fundamental reality is that computers which are available in the thousands in markets around the world cannot be effectively controlled, even if they are built in the United States or based on U.S. technology. The 1995 study predicted many of these developments, and everything we have learned since then confirms them. And I want to emphasize that point, Mr. Chairman.

It seems to me that the previous discussion had a certain note of unreality because it concerned itself primarily with whether or not the Stanford study presented empirical data. What GAO has not really commented on is a look at the marketplace in 1996, 1997, and 1998 to see reality, because the 1995 study was predictive. And I would suggest that if you look at reality today, you will find that what the 1995 study predicted came true in their assessment of what the marketplace would look like this year. It is confirmed by the facts of what we have right now. To me, that's the best empirical evidence that you have. I can address the study later in more detail.

Now, on technological change particularly, the term means that computer performance is constantly improving, creating unavoidable pressure on export controls. There are few sectors that we deal with where technological change has been so rapid and so dra-

matic. I want to make the point here that our reference to GAO about foreign availability being an outdated Cold War concept was a reference that was specifically confined to the question of computers. That is not a statement that we subscribe to as a general matter with respect to what we do. It is a statement that we think is accurate with respect to this sector.

Five years ago, the U.S. controlled as a supercomputer machines with a performance of 195 MTOPS. Today's average desktop PC is more powerful; if you have a Pentium II in your machine, it is probably twice as powerful, and the software which can run on it is more sophisticated.

The engine of change is the microprocessor. Computer chips are produced in the millions in plants in the United States and overseas, and I want to emphasize this point. This discussion should not be about the box; it should be about the chips, because the chips are the critical ingredient. You are all familiar with Moore's Law, which states that the performance of chips doubles every 18 months. These performance increases are the result of both improved design and improved manufacturing techniques. As of August, 1998, chips capable of roughly 500 MTOPS alone are being produced in the millions, and chips capable of 1,800 MTOPS are being produced in the tens of thousands. Although the United States is the most advanced producer, plants around the world can make these chips. Within 12 months, if industry projections are correct, we can expect to see chips capable of 2,000 MTOPS entered into mass production. It happens, Mr. Chairman, that I have one of them with me. For the record, this little goodie is smaller than the size of my fingernail. This is IBM's latest announced chip, a copper-based chip, which operates at 1 gigahertz, or 1,000 megahertz. It is scheduled to start going into IBM's product line toward the end of next year or in early 2000. It will probably start in the RS–6000 workstation line and mainframe server lines, which are the kinds of technologies that we are talking about in this debate. Thereafter, it and chips like it will start to appear in our PC server line. The actual MTOPS rating of this chip is proprietary, but I can tell you that it will operate at well over 2,000 MTOPS, and that's a single chip.

In addition, I can tell you that advances in processor design, and also advances in semiconductor process technology, will allow Intel to create processors with double their current MTOPS rating of approximately 500 MTOPS today, to over 1,000 MTOPS by early 1999. Intel will be able to provide specific information about these developments next year. Much of the details of these things, including the exact ratings, are proprietary.

Other technological changes have made it easier to upgrade performance. These include the increased sophistication of software, which is very important here, including for clustering, and the increased availability of interconnect technologies which offer substantial improvements in performance and which may allow numbers of low level workstations to be clustered together to give high performance. The spread of parallel processing, which allows many microprocessors to work simultaneously on the same problem, has also reduced the controllability of high performance computers.

You may have read, Mr. Chairman, of several recent occasions in which the "encryption community," if you will, announced success in breaking 56-bit encryption. One of the devices that they used in the first contest was, essentially, parallel processing, to get thousands of computers working together in a coordinated fashion to attack a particularly complicated problem.

Another element of technological change could be called attainable performance, or scalability, which you alluded to earlier. Manufacturers have sought to build platforms which can be easily upgraded through the addition of new boards. This allows users to buy computers at one performance threshold, and then increase the performance later through upgrades. Some computers are designed to allow these upgrades to be performed without even turning off the machine, and with system software that automatically adjusts to the higher performance levels. The result is that it is possible to buy a number of systems that perform well below 2,000 MTOPS, or even below 1,000 MTOPS, and thus do not require a license for export, and then upgrade these machines to 5,000 or 6,000 MTOPS or more.

Now, on foreign availability, the availability of high performance computers built by foreign manufacturers with foreign parts and technology was a key determinant of our export policy during the Cold War. We believe for computers it now makes little sense and is of secondary importance in determining policy. We cannot realistically control the many thousands of U.S.-made computers sold freely in Europe, Asia and elsewhere. Many countries we sell to do not have re-export controls; in fact, the *New York Times* recently quoted an official from a close European ally as saying that they advise their exporters to ignore U.S. re-export controls. We know there is a flourishing market in second-hand high performance computers overseas; some can be ordered directly over the Internet. In fact, Mr. Chairman, I asked one of my staff to do a little surfing. We've been able to come up with a substantial number of web sites here, including sites in the Netherlands, Canada, Austria, and Israel, all of which offer for sale substantial numbers of computers, many of them in excess of 2,000 MTOPS.

Now, as a result, even though the United States today dominates the market for high performance computers, there is a performance threshold below which we cannot realistically expect to maintain control of computers unless we restrict sales to everybody, including our closest allies. That is why we have focused on controllability—whether licensing can be effective in restricting access to HPCs. The studies in 1995 and the new one in 1998 suggest that HPCs are becoming less and less controllable because they are becoming smaller, cheaper, more powerful, and more reliable, requiring less vendor support. The availability of fast, well-designed microprocessors has allowed manufacturers to build more and better computers. Machines capable of 4,000 to 5,000 MTOPS are small and easily transportable. Computers well above 2,000 MTOPS are freely available on the global secondhand market, as I just alluded to. We cannot realistically expect to keep the organizations responsible for weapons development in states of concern, organizations that are technically sophisticated and well funded

and which enjoy strong government support, from clandestinely obtaining computers with a performance much below 10,000 MTOPS.

Let me also make the point, Mr. Chairman, that one of the other problems with the old standard of foreign availability is its basis of searching for comparable quality and sufficient quantity, as the basis for availability. The point when it comes to proliferation isn't sufficient quantity. In order to determine availability, we don't have to determine that the Chinese have an industry that can compete with IBM or HP or SGI. The Chinese need four or five, or maybe ten, computers to meet a lot of their proliferation needs. That doesn't require a full-scale industry that is competitive with ours in third markets. It requires the capability to produce those machines at a small scale, and perhaps significant expense. But that's very different from the statutory definition.

In addition, let me say, in our judgment computers are not a "choke point" for military production. High performance computers have attained a symbolic importance in our export control debates which their real utility may not warrant. The fundamental premise of critics of our policy is that high performance computers are essential for making advanced weaponry. We believe this is wrong. The weapon systems found in the U.S. arsenal today—the tanks, the airplanes, the missiles, the ships—were built with computers whose performance was below 1,000 MTOPS. These were the supercomputers of the 1980's, but today you can find more capable machines on many office desktops.

We have found that the amount of computing power needed to design and manufacture modern weapons, once you get over a few hundred MTOPS, is not significant. For example, the level of computational power used to develop all the bombs in the current U.S. nuclear arsenal is less than that found in many workstations. Other factors—skill in software design, access to sophisticated manufacturing techniques, experience in building weapons, and good test data—are much more important than a high performance computer.

To say that this is an enabling technology, which is what the MCTL does, which is what GAO commented on, is very different from saying that this is a choke point.

There are a number of national security applications—precise weather forecasting; computational fluid dynamics, and particle dynamics in particular, which is what happens when you set off an explosion or what happens when you set off a chemical weapon and where do the particles go—which are areas where high-level computing power are significant, and our policy attempts to identify those and, where possible, protect them. This differs from those who have argued that high performance computers will give countries like China the ability to leap forward in military production. HPCs no doubt provide some incremental benefit, as would a wide range of items, but we do not believe that they constitute a choke point in weapons development and, as stated previously, even if they did, there are serious limitations on our ability to control them at all but the highest levels. In fact, none of the proliferation regimes—the Missile Technology Control Regime, the Nuclear Suppliers Group, or the Australia Group, which controls chemical and biological items—consider computers important enough to control.

The only regime which controls computers is the Wassenaar Arrangement, which inherited the old economic warfare controls aimed at the Soviet Union. In the end, these controls did not work very well in preventing the Soviet Bloc from getting its hands on widely-available computers. They were helpful in keeping big machines that require extensive support out of enemy hands, but they failed to stop computers available in the thousands, sold freely at relatively low prices around the globe without significant vendor support.

We would do well to remember this lesson, because what we are experiencing now, as demonstrated in both the 1995 study and the 1998 study, and what anybody in this industry will tell you, is essentially an acceleration in the rate that ever-higher performing computers are becoming available. In other words, we have controlled the high end; we can still control the high end. But whereas that high end used to be measured in hundreds of MTOPs, now it is measured in ten thousands of MTOPS.

Maintaining our status as world leader in information technology and computer manufacturing is critical to both our economic growth and our national security. Exports account for roughly half the revenues of U.S. computer companies. Ill-advised export controls would put this vital sector at risk, and at the same time compromise our security by making it harder for the Pentagon to obtain the cutting edge technology it needs. Events since 1995 have confirmed that we are on the right course, and I hope the Congress will support the administration as it moves into a new review of control parameters.

Now, let me emphasize that final point, Mr. Chairman, because that was mentioned in the previous dialogue. In fact, the proposal that the President adopted in 1995 was the recommendation of the Department of Defense. There were other recommendations made by other agencies; it was the Department of Defense recommendation that everyone coalesced around and supported, and it was the one that the President adopted.

Now, the Department of Defense is in the best position to explain to you why they came to that conclusion, and I can add my own thoughts. But let me put in my own words a little bit of what I think their reasoning is.

They have realized that as warfare becomes more electronic-based—meaning not only smart bombs and electronic-based weapons systems, but also more sophisticated command and control and communications—their reliance on high performance computers is ever increasing and becoming much more important. They also know that they don't buy enough to keep any of these companies in business. Military business for these companies is less than 10 percent of their total business.

What the Pentagon figured out in 1995, and what is reflected in its letter embodied in the GAO report, and what they still believe based on my most recent discussions with them, is that the most useful thing they can do to make sure that they have access to cutting edge technology, to make sure that their weapons systems and C^3 facilities are generations ahead of everybody else's, is to have a strong, healthy domestic computing industry, which means one that is successfully exporting, because that's where they make their

money. And the money they make there, they plow back into R&D, which is of direct benefit to the Pentagon.

In closing, Mr. Chairman, I would ask your indulgence and ask to submit into the record an article which I want to commend to everyone's attention, which I think is quite thoughtful. It's in the current issue of *Foreign Affairs* magazine. It's by Michael Hirsh, who is a reporter for *Newsweek*, and it's entitled "The Great Technology Giveaway?" with a question mark after it, and it is one of the best dissections that I've seen of what has happened to the economy as it is globalized, and what has happened to the relationship between our military and our defense establishment and our intelligence establishment, and the civilian sector of the economy. Whereas in the 1960's and 1970's you had MILSPEC and military technologies driving the train of R&D, now it is reversed. It is the civilian sector that is driving the train and the military that is buying commercial off-the-shelf items, which means the health of these sectors is critical—not just for jobs, which I care about and you care about—and not just for the economy, but for our national security. If the companies whose representatives are in the back of the room here go broke, the biggest loser is the Department of Defense, not the Chinese.

With that, I am happy to answer your questions.

Senator COCHRAN. Thank you very much.

The article by Michael Hirsch you referred to will be made a part of the hearing record.[1]

To what extent have the changes that the Congress recently made affected the ability of our computer industry to make sales in the foreign markets? Do you know of any downturn in sales that could be attributed to the changes that the Congress made?

Mr. REINSCH. We have not specifically asked them that question, Mr. Chairman, and I would recommend that you do. I don't know of any in particular. I would say that as far as the 10-day notification process is concerned, as a process matter, it appears to be working; that is, companies are submitting notifications and agencies are responding within the timeframe, and the system appears to be going forward. The objection rate, if you will, has been steady from the beginning at around 15 or 16 percent, and a little higher in some cases and lower in other cases. That seems to be going forward.

What I can tell you happens is that when there is an objection, that then converts that notification into an application for an individual license, which means that it takes a much longer time. We are discovering that most of them are being returned without action because we don't have sufficient information in order to process an individual application. And what we are then finding is that many of them are not coming back; that is, the company is just folding and not going forward. Whether that is because it's too much trouble, whether it's because the sale went away anyway, whether it's because it was a shaky sale and they didn't think they could get it approved, I couldn't tell you. But I can just say, that's one of the results that we've noticed.

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[1] The article referred to from *Foreign Affairs* magazine by Michael Hirst, appears in the Appendix on page 126.

Senator COCHRAN. What about the review of a sale after it has been consummated? There is a process now where you have people from embassies around the world going in and checking to see if the end use is what you expected it to be, and the end user is who you expected it to be. How is that working? Are there problems there that need to be discussed?

Mr. REINSCH. The problem that we will ultimately encounter, Mr. Chairman, is volume, because we were tasked to visit every one of them without regard to whether or not it made sense to visit every one of them. And I can give you an illustration.

A number of these, particularly—and when I say every one of them, every one at tier 3; I don't mean the other tiers—a lot of these are sold, not all of them, in fact a declining portion, but a number of them are sold under warranty or with established vendor support or with a relationship where something breaks, they call up the American company and they go out and examine it and fix it.

In a number of cases where we've had some questions about the nature of the end user, one of the things we've done is consult with the companies, and we discovered that they very recently—within 2 or 3 weeks, often—have made a warranty visit or a repair visit and have been able to provide us some reassurance as to both the location of the computer and its use, without us visiting it. Yet, we're going to have to visit all those anyway.

Senator COCHRAN. You're not taking their word for it, are you?

Mr. REINSCH. No, we're not taking their word for it. The law doesn't permit us to take their word for it. But I will tell you that, from the standpoint of management, with limited resources and limited people, I would be inclined to put those at the bottom of the list, and put at the top of the list the ones where we have no feedback from companies, that are more problematical.

Now, in point of fact our obligation statutorily stems from those sold since November 19, 1997, which is a smaller portion of the universe. We have, I believe—and I can't speak for the last few days—I believe we've conducted about 66 post-shipment visits in tier 3 countries. Let me put it this way: All of those have checked out favorably with the exception of one, which was not a Chinese case. But I would prefer not to go into detail about that one in public session.

Senator COCHRAN. Do you think that's a useful thing to do, given the fact that we have seen some situations, particularly in Russia, with the computers winding up in the weapons laboratories. Where a Russian official, the Minister of Atomic Energy, almost gloated over the fact that they had obtained these high performance computers——

Mr. REINSCH. Let me say first, Mr. Chairman, that, of course, was in our judgment an outright violation of our rules, not something that fell between the cracks. We thought our rules were clear, and they were violated, and that relates to the settlement in the one case that you referred to earlier.

We have always felt that post-shipment visits are a useful enforcement tool. We have used them in the past on a wide variety of merchandise and we intend to continue to use them, because we think that they provide a lot of information. While on computers

GAO makes a valid point—certainly, what they tell you is whether it's still there; that's the most obvious thing they tell you—and while it is also true that without someone specially trained in computers, you might not learn a lot more about exactly what the machine is being used for, I can tell you two other things.

First, our people are being trained; in fact, we have a group of about 55 of them in town who are being trained tomorrow on this very subject.

Second, without going into a lot of detail in open session, I can tell you that the encounters that we have in these visits give us a great deal of information above and beyond the mere physical presence of the item.

My objection to the provision is based not on the concept but on the flat requirement that we visit every one of them, whether we believe it makes sense from a management and control perspective or not. My enforcement people tell me that they would much prefer to be able to exercise some judgment and visit more intensively the ones that they think are problematical and deserve visits, and not have to waste time and money going to places where a vendor that we have confidence in was there 2 weeks ago, or where we have other means of ascertaining what that computer is for. They don't have that choice, and as you know from this list of tier 3 countries, these places are not all easy to get to. These are expensive visits. And if I sent somebody out for 6 weeks on a Safeguards mission to do 20 of these, you're talking about $30,000 or $40,000 when you add up the air fares and hotel bills and per diem and all the other stuff.

We're going to do the best we can because the statute requires us to, but that's our problem with it.

Senator COCHRAN. Is there any limitation in the statute in terms of the time within which the visit has to be conducted? I don't recall there being.

Mr. REINSCH. No, sir, there is not. And our general practice is not to arrange the visit until sometime after it arrived, because it would be stupid to show up before it was installed. Our general rule of thumb is, I think, to make those requests between 4 and 8 months after we've ascertained that it has arrived.

Now, in the case of computers, what we have put into place is essentially a double reporting system. That is, under the current system, notifications have to be reported to us, as you pointed out, under the law. A notification doesn't constitute a sale, and these things often fall through, even after they've been notified. We get notified on specs, sometimes. So our enforcement agents also require companies to notify us of actual sales, actual deliveries, and we base our visiting requirements on those reports, not on the notification reports.

Senator COCHRAN. Can you tell us the extent to which you have encountered difficulty of access? Are some countries just saying that you can't have access?

Mr. REINSCH. I think with respect to the one I alluded to, that was part of the problem. I think there is another case where one is pending that we have not yet received an answer, or we may have gotten an adverse answer.

In the case of China, which you may be building up to, as of the President's summit we have an agreement with them on this issue—which is not computer-specific—and we have thus far put forward one computer post-shipment request, and the nature of the agreement gives us a certain amount of time to put that request forward, which we did, and gives them a certain amount of time to respond, and we're in the middle of that time period right now.

We have put other post-shipment visit requests forward to the Chinese on non-computer items and they have agreed to permit those visits, and those visits have been performed successfully and favorably. So I have every expectation that they will agree to our computer requests and that they will be performed.

Senator COCHRAN. I did notice that it was advertised, after the recent visit to China by the President, that there was a computer-specific—I thought—agreement that would permit us to have access or information that we otherwise didn't have.

It says, "Press reports indicated an agreement was reached that would allow the United States to conduct computer PSVs." Does it provide for anytime, anywhere PSVs in China? Or if not, what does the agreement permit, if you know?

Mr. REINSCH. First of all, it is not exclusive to computers. It includes computers, but we insisted that it cover anything else we want to look at, because we have other problems with the Chinese besides computers, as you well know.

It sets up rules. The basic one is a question of sovereignty, and frankly, it's the same rule we would impose on countries seeking to do the same thing here; we have to get the government's permission. So we can't just show up at the factory door and say, "Surprise." We have to get the government's permission. We have to ask within a certain period of time, and then they have a certain period of time to respond and to arrange the visit and conduct the visit. Thus far I believe they've accompanied us on the visits. I believe that's their current preference.

The ministry in question that is controlling all this is undergoing a substantial reorganization, and, we're told, a reduction in staff of approximately 47 percent, which is significant, so it's a little difficult to say exactly what impact that is going to have on this.

We have some things that we would like to do to this agreement to broaden it a bit, which I would prefer to discuss with you privately and which I'm happy to do. The Joint Commission on Commerce and Trade, which is a joint meeting which happens annually between the Secretary of Commerce and his counterpart—and this is the ministry which does this in China—is meeting in Washington in late October and this issue is on the agenda. The Chinese agreed to come here for a week-long seminar on export controls in April. They did so; they appeared; they agreed to invite us for a return this fall. We will be going later in the fall. This is a relationship that is a work in progress, and we do have further agenda items we want to get from them.

Senator COCHRAN. Well, that's encouraging. I think progress is being made and we ought to continue to pursue that.

The report that we are talking about today, I think, can be summarized in this way. The GAO says that the decision that was made by the administration to decontrol high performance com-

puter exports was really subject to challenge on three grounds: First, that it was based on the Stanford study, which lacked empirical evidence or analysis to support its conclusions that HPCs were uncontrollable; second, that there would be widespread availability of foreign high performance computers; and third, that the administration did not undertake a threat analysis of providing HPCs to countries of concern.

I want to give you an opportunity, if you can, to give us your reaction to those three bases of criticism.

Mr. REINSCH. First, I guess, Mr. Chairman, empiricism is in the eye of the beholder. I am familiar with the 1995 study. I think the 1998 study is much more detailed. But I think it provided a good bit of data and information with respect to the state of the computer industry worldwide. It did not assert—and we don't assert, although we would differ somewhat with GAO—we don't assert that there is indigenous production of computers that compete successfully with American computers in China or India or in other countries that you might name.

I think we would assess the level of production of those computers in China as somewhat higher than GAO would, but I would recommend you consult with the intelligence community on that because they do have information that discusses the state of the computer industry in those two countries.

And I would urge you to keep in mind what I said previously. The issue isn't whether they compete with IBM; the issue is whether they can make a dozen of them. There were statements by some Indian officials after their nuclear tests that they were employing Indian computers to analyze those test results, which I think suggests that they have some capability—or at least they say they have some capability.

I think the study has plenty of data about the state of the art and empirical data. I think the 1998 study has more. I would point out that in fact the authors of the study have substantial proprietary data that they were not permitted to put into either study because it was provided confidentially by individual companies who gave them quite a bit of information about actual activities, sales, and competition. They were not permitted to provide it, but that information exists; the authors have some of it, and we have some of it.

On the second issue of availability and controllability, as I've made clear, I think we have a disagreement with GAO over what the relevant standard is. My judgment of their report on that point is that they've asked the wrong question; they probably provided the right answer to the wrong question. If you use the statutory standard, it is probably a fair judgment to say that availability is not there, there is not foreign indigenous production in comparable quality and sufficient quantity so as to offset the effectiveness of our controls.

Our point is a better term, and this is not 180 degrees different. This is a 40 degree difference, or maybe 50. Our term is controllability, by which we mean the ubiquity of the ingredients and the technology. As I said in my testimony, Mr. Chairman, the secret here is the chips, it's not the box. It's the ability to take a lot of these things that I have now put away, a lot of these chips, to-

gether to operate quickly and successfully as a high performance computer. What a high performance computer is, is a computer that has more processors working faster than a PC. There are a lot of ways to put those together. Chips have been effectively decontrolled, except at very high levels, since 1989, as I recall. There are lots of people in the world who make chips, not just American companies. There are a lot of American companies overseas that make chips; there are other American companies that make clone chips or clone PCs.

What you are seeing in this industry is the same thing that you have seen in the textile industry, the automobile industry, the television industry, a host of industries over the last 40 years. Developing countries come in at the low end; they make the basic chips. Maybe they stole the design, maybe they licensed it, who knows, and they make low-end products and they gradually work their way up the value added chain. And that's happening in this sector no differently than it has happened in all the other sectors I just named, and I know that there a lot of people in your State that know about moving up the value added chain in a number of those sectors.

This is no different. Part of our concern here is that we lead the world in these computers, particularly at the high end. A viable competitor is the Japanese. And we're proud of that, and we want to keep it that way. What I would say is, if you tie our guys' hands—and you have not suggested doing that—but if the Congress or our controls were to tie our producers' hands and say "You can't sell in such-and-such a market" through one means or another, what will happen, I would say, is that in 9 to 12 months you will have the Koreans, the Taiwanese, and a variety of European nations competing at the high end, because you will have opened the door and made it economically viable for them to do that. It is not economically viable for them to do that now because they don't produce products that are as good as ours at this end, and they don't have any particular economic incentive to go to the high end.

If you create the economic incentive by knocking us out of the market, then you are handing them the market, and that goes back to controllability. These things are out there. They can make these products.

So we would submit that the GAO has asked the wrong question, albeit having come up with the right answer. The studies asked the right question, and if you want empirical data, look at the marketplace, invite some of the people in the back row up to talk and tell you what's going on in the marketplace, and you will see that what Goodman said in 1995 has happened. That's the best empirical information that I can find.

Now, the last point is the most interesting one, which is the question of whether we performed a national security effects analysis. I guess I would say a couple things about that. I would make the point that Senator Levin made; the Department of Defense argues that that was taken into account, and I think that's right. I think if you want to talk to the Department of Defense, that would be a constructive thing to do. They are the agency that is most responsible for making those judgments, and they indicated that they have done so. My recollection of the interagency discussion sug-

gests that they made clear that the levels of decontrol that they were proposing—or liberalization that they were proposing—was consistent with their sense of what the security threats were. And they can elaborate on that.

Let me also say that I would disagree with the GAO in the order of events. Mr. Johnson said, "We ought to look at national security first, and then figure out what can be controlled." And I will say, I think, to the extent the administration did something differently, I would acknowledge that we did it in reverse order. We asked ourselves first, what is controllable? Then we said, let's look at the national security issues. Because I am perfectly willing to tell you—and this is not a surprise, nor is it a revelation—if you want to look at nuclear weapons design, you can do nuclear weapons design on a PC. You can do nuclear weapons design on a PC in your office. So if you ask me, is there an adverse national security impact of selling PCs, the answer is yes.

But that debate reminds me a little bit about this guy I was reading about the other day who got frustrated over all the hoopla about the movie Titanic, so he printed out 500 T-shirts that said, "It sank. Get over it." [Laughter.]

This debate is a little bit like that. This technology is out of the box. We can perform a national security analysis, for example, on computers below 2,000 MTOPS, and we can tell you that, yes, those exports are going to have an adverse national security impact here and here and here and here and here. It's kind of an arid discussion because there's not an awful lot we can do about it.

What we can do about it is not stop it for all the reasons I outlined in my testimony. What we can do about it is make sure we stay ahead of the curve, and that we're prepared to deal with the consequences of that. And GAO missed that entire point.

Senator COCHRAN. Well, you've given a very spirited defense of the liberalization of export controls——

Mr. REINSCH. This comes from the heart, Mr. Chairman.

Senator COCHRAN. I can tell you're sincere about that, and I respect that. I think it also means, though, that because we are seeing an evolution of technology in many areas, and this is just one of them, we have to be very determined in our effort to do what we can do to safeguard America's security interests, and we can't just ignore the fact that we have an obligation. I think that national security is the highest priority of our government, that the agencies that have the responsibility of enforcing our laws on this subject have the obligation to do the best they possibly can with the resources they have, to see that they faithfully carry out these laws.

For that reason, I was interested in what is being done to carry out the change in the law that the Congress approved on this subject. There are many who remain concerned that the policy is flawed and that we could do a better job of controlling the sale of these HPCs to countries that we know are going to use them to improve the capabilities of their nuclear weapons or their missile systems, particularly if we think that they can proliferate these systems to countries that are emerging as threats to our national security interests. I am thinking right now of North Korea, for example; Iran is another example, countries that have expressly prom-

ised to either destroy the United States or kill Americans or the like. This is a situation that makes this a very, very dangerous world. I know we can't pass a statute or an amendment to a law and end it or make it right or fix it, but we do have an obligation—and I know you agree with this—to continue to work as hard as we can to be sure that our policies and our export laws are consistent with that national security interest, as well as our economic interest. We are interested here in having a regulatory environment that permits our businesses to flourish, to grow, to expand, to remain the best in the world, the most advanced in the world. We're all for that; I'm certainly for that. It is good to have this interaction, I think, and this discussion of these competing interests and how we sort them out.

We will continue to work with the Department of Commerce and with you and with GAO and with the Department of Defense and others to try to do our part to help make sure we do our part to help make sure we do a good job of preventing the proliferation of weapons and the means of developing those weapons that threaten our security interests.

We thank you for your continued cooperation and we will stay in touch with you. If we have any other questions of you, we will submit them for the record.

Mr. REINSCH. Thank you, Mr. Chairman. It's always a pleasure to be here. I'll be glad to come back if you want.

Senator COCHRAN. Thank you very much. Our hearing is adjourned.

[Whereupon, at 4:15 p.m., the Subcommittee was adjourned, to reconvene at the call of the Chair.]

A P P E N D I X

STATEMENT BY SENATOR CARL LEVIN (D-MICH)

BEFORE

SENATE SUBCOMMITTEE ON INTERNATIONAL SECURITY,
PROLIFERATION AND FEDERAL SERVICES

ON

GAO REPORT ON HIGH PERFORMANCE COMPUTER EXPORTS

September 16, 1998

In the two years since the Clinton Administration modified regulatory restrictions on computer exports, American exports of high performance computers have surged. In 1996 and 1997, American companies have sold over 3600 high performance computers overseas, meaning computers that have the capability to perform 2,000 or more MTOPS, or million theoretical operations per second. 2,000 MTOPS is about the level of computing capability needed to run a hotel reservation system.

Some say these surging exports are good news for American workers, American high technology jobs and the American economy. And overall, I think they are right. But others point out that this good news must be tempered by concern about whether these computer exports may be affecting our national security. That is the subject of today's hearing, which is the second this Subcommittee has held on national security concerns associated with exporting U.S. computers to other countries.

In 1996, the Clinton Administration revamped the system we have for controlling computer exports. The previous system was a simple one: any computer capable of performing over a certain level could not be exported without an individual export license. But the level set was equivalent to the computing capability of the average desktop computer, which meant that our computer companies were battling red tape chasing an export license for each routine computer they wanted to sell abroad.

The revision, which was the product of extensive interagency efforts, substituted for the across-the-board approach a graduated system of increasingly stringent export controls focused most on countries whose possession of high performance computers might raise national security concerns. The result is a four-tier system. Tier 1, which covers our closest allies, eliminates virtually all licensing requirements for exports to the covered countries. Tier 2, which includes countries that are friendly but less close to the United States than those in the first tier, imposes limited controls on exports of more powerful computers. Tier 3, which covers countries that raise proliferation and national security concerns such as China, Russia, India and Pakistan, imposes still more stringent export controls that take into account both the computing power of the machine being exported and the nature of the end-user. Tier 4, which covers countries suspected of terrorism, imposes a ban on computer exports from the United States. In addition,

the Administration reserves the right to block any computer export involving an end-user raising proliferation concerns.

This system, which became effective in January 1996, was the subject of debate in 1997, when questions were first raised about whether it adequately protects our national security. Congress declined to make major changes, and instead fine-tuned the new system with legislation added to the DOD authorization bill. The fine-tuning, among other measures, requires the President to provide advance notice to Congress before altering the setup of the four tiers, and requires exporters to provide advance notice of certain computer exports to Tier 3 countries so that any of five agencies may object to the export and impose a formal licensing requirement.

The resulting system is complex and still fairly new. Less than a year has passed since the fine-tuning in 1997. Nevertheless, it is not too soon to begin to analyze how it is performing and whether it adequately protects our national security.

The General Accounting Office report released today provides information that tells part of the story. Statistics compiled by GAO tell us, for example, that of the 3600 high performance computers exported in 1996 and 1997, about 2800 or 72% went to our friends and allies in Tier 1. Five countries in particular were our biggest customers, Germany, the United Kingdom, Japan, South Korea and France. These countries also bought the most powerful machines from us. The statistics gathered by GAO also tell us that most of the computers we exported, about 85%, were in the lower to mid range of capability, from 2,000 to 5,000 MTOPS.

The statistics also show that about 5% of the total were exported to Tier 3 countries like China and Russia. That includes 77 high performance computers exported to China and 28 to Russia. I understand the bulk of these computers went to entities like banks, telephone companies, and railroads or to conduct oil exploration. But we've also heard reports about three instances in which computers exported to China or Russia were diverted to possible military use. The computer exported to China has since been returned to the United States, while those sent to Russia are still unreturned after more than one year of negotiation and criminal investigations into what happened. These 3 instances provide reminders of the stakes involved in exporting high performance computers to countries that raise national security concerns.

In its report, GAO recommends that the Department of Defense perform a new national security analysis of the exports that have taken place since the new controls were put in place, to determine how they are working and whether changes are needed.

I look forward to hearing from GAO and the Department of Commerce on these issues and commend the Chairman for his leadership in examining these important matters.

United States General Accounting Office

GAO

Testimony

Before the Subcommittee on International Security, Proliferation, and Federal Services, Committee on Governmental Affairs, U.S. Senate

For Release
on Delivery
Expected at
2:00 p.m., EDT
Wednesday,
September 16, 1998

EXPORT CONTROLS

Changes in Controls Applied to the Export of High Performance Computers

Statement of Harold J. Johnson, Associate Director, International Relations and Trade Issues, National Security and International Affairs Division

GAO/T-NSIAD-98-250

Mr. Chairman and Members of the Committee:

We are pleased to be here today to discuss export controls on high performance computers (HPCs). Since January 1996, when the executive branch raised the thresholds of computer performance for which exporters must obtain a license, several unlicensed HPCs were exported to Russia and China, including some sent illegally to a Russian nuclear weapons laboratory. You expressed concern about these sales, and asked us to (1) assess the basis for the executive branch's revision of HPC export controls and (2) identify changes in licensing activities and export enforcement requirements resulting from the revision. You also asked that we determine the current foreign availability of HPCs, particularly for countries of national security concern. Because the unlicensed exports to Russia and China were under investigation by Commerce, Justice and the Customs Service, we did not specifically address this matter during our assessment. Also, it is important to note that we did not determine the appropriate thresholds for controlling HPC exports, but instead, as you requested, we evaluated the process by which the executive branch made its decisions and the adequacy of the information it had available for this purpose.

Our report on the decision to revise HPC export controls is being released today,[1] as is our companion report responding to Section 1214 of the Fiscal Year 1998 National

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[1]Export Controls: Information on the Decision to Revise High Performance Computer Controls (GAO/NSIAD-98-196, Sept. 16, 1998).

Defense Authorization Act;[2]therefore, my prepared statement will summarize our principal findings. However, to facilitate an understanding of the issues, I believe that a brief background may be useful.

BACKGROUND

As we have stated in previous testimony,[3] the U.S. export control system is about managing risk; exports to some countries involve less risk than to other countries and exports of some items involve less risk than others. The President has the responsibility and authority to control and require licenses for the export of items that may pose a national security or foreign policy concern, and he may remove or revise export controls as U.S. concerns and interests change.[4] It should be noted that the law does not require that a foreign availability[5] analysis be performed when deciding to remove or relax export controls.

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[2]Export Controls: National Security Issues and Foreign Availability for High Performance Computer Exports (GAO/NSIAD-98-200, Sept. 16, 1998).

[3]Export Controls: Issues Related to Commercial Communications Satellites (GAO/T-NSIAD-98-208, June 10, 1998)

[4]In this report, revision of export controls refers to removal of licensing requirements for groups of countries based on the performance levels of HPCs.

[5]The Export Administration Act of 1979, as amended, describes foreign availability as goods or technology available without restriction to controlled destinations from sources outside the United States in sufficient quantities and comparable quality to those produced in the United States so as to render the controls ineffective in achieving their purposes.

In 1995, the executive branch conducted a review of export controls on computer exports to determine how changes in computer technology and its military applications should affect U.S. export control regulations. This review was the continuation of a process begun in the 1980s to take into account the technological advancements in the computer industry. It may be useful to note that as recently as 1993, the export of computers with a composite theoretical performance of 195 millions of theoretical operations per second (MTOPS)[6] were controlled. This was raised to 1,500 MTOPS in February 1994.

A key element of the executive branch review was a Stanford University study, jointly commissioned by the Commerce and Defense Departments.[7] Among other things, the study concluded that (1) U.S.-manufactured computer technology with a composite theoretical performance of up to 4,000 to 5,000 MTOPS were currently widely available and uncontrollable worldwide, (2) computers with a performance level of up to 7,000 MTOPS would become widely available and uncontrollable worldwide by 1997, and (3) many HPC applications used in U.S. national security programs occur at about 7,000 MTOPS and at or above 10,000 MTOPS. The study also concluded that it would be too expensive for government and industry to effectively control exports of computing

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[6]MTOPS is the composite theoretical performance of a computer measured in millions of theoretical operations per second. In principle, higher MTOPS indicates greater raw performance of a computer to solve computations quickly, but not the actual performance of a given machine for a given application.

[7]Building on the Basics: An Examination of High-Performance Computing Export Control Policy in the 1990's, Seymour Goodman, Peter Wolcott, and Grey Burkhart, (Center for International Security and Arms Control, Stanford University, November 1995)

systems with performance below 7,000 MTOPS, and that attempts to control HPC exports below this level would become increasingly ineffectual, and would unreasonably burden a vital sector of the computer industry.

In announcing its January 1996 change to HPC controls, the executive branch stated that one goal of the revised export controls was to permit the government to tailor control levels and licensing conditions to the national security or proliferation risk posed at a specific destination. The revised export control policy removed license requirements for most HPC exports with performance levels up to 2,000 MTOPS--an increase from the previous level of 1,500 MTOPS. The policy also organized countries into four "computer tiers," with each tier after tier 1 representing a successively higher level of concern to U.S. security interests. A dual-control system was established for tier 3 countries, such as Russia and China. For these countries, HPCs up to 7,000 MTOPS could be exported to civilian end users without a license, while exports at and above 2,000 MTOPS to end users of concern for military or proliferation of weapons of mass destruction reasons required a license. Exports of HPCs above 7,000 MTOPS to civilian end users also required a license.

The January 1996 regulation also made other changes. It specified that exporters would be responsible for (1) determining whether an export license is required, based on the MTOPS level of the computer; (2) screening end users and end uses for military or proliferation concerns, and (3) keeping records and reporting on exports of computers

with performance levels of 2,000 MTOPS.[8] The Fiscal Year 1998 National Defense Authorization Act (Public Law 105-85) modified the 1996 revisions by requiring exporters to notify the Commerce Department of any planned sales of computers with performance levels greater than 2,000 MTOPS to tier 3 countries. The government has 10 days to assess and object to a proposed HPC sale. The law also now requires Commerce to perform post-shipment verifications (PSV) on all HPC exports with performance levels over 2,000 MTOPS to tier 3 countries.[9]

SUMMARY

As I indicated, one focus of our work was to assess whether the empirical evidence presented in the Stanford study--a key element in the decision to revise HPC export controls-- supports its conclusions. Our analysis showed that it had 2 significant limitations. First, the study lacked empirical evidence or analysis to support its conclusion that HPCs were uncontrollable based on (1) worldwide availability and (2) insufficient resources to control them. Second, the study did not assess the capabilities of countries of concern to use HPCs for military and other national security applications, as required by its tasking. The study's principal author said that U.S. government data

[8] In addition to the standard record-keeping requirements, the regulation added requirements for the date of the shipment, the name and address of the end-user and of each intermediate consignee, and the end use of each exported computer

[9]The Commerce Department promulgated regulations implementing the law on February 3, 1998.

was insufficient to make such an assessment, and the study recommended that better data be gathered so that such an analysis could be done in the future.

Except for nuclear weapons, the executive branch has not completed an assessment of the national security risks of exporting HPCs to tier 3 countries, and the nuclear weapons assessment was completed by the Department of Energy in June 1998, more than two years after the export control policies for HPCs were revised. The executive branch has identified high performance computing as having applications in such national defense areas as nuclear weapons programs, cryptology, conventional weapons, and military operations. However, except for nuclear weapons, the executive branch has not identified how and at what performance levels specific countries of concern may use HPCs for national defense applications–an important factor in assessing risks of HPC sales.

In December 1997, the House Committee on National Security directed the Departments of Energy and Defense to assess the national security impacts of HPC sales to tier 3 countries. DOE's study on nuclear weapons shows that nuclear weapons programs in tier 3 countries, especially those of China, India, and Pakistan could benefit from the acquisition of HPC capabilities. The executive branch has not yet finished identifying how specific countries of concern would use HPCs for nonnuclear national defense applications.

Nonetheless, based on its view of the worldwide availability of computing power and the technological advancements in this area, the executive branch raised the MTOPS thresholds for HPC export controls. The 1996 revision to HPC export controls had three key consequences.

- First, by increasing the performance thresholds for computers that require a license, the 1996 revisions decreased the number of license applications from 459 in fiscal year 1995 to 125 in 1997 and of approved export license applications for HPCs from 395 in fiscal year 1995 to 42 in 1997.

- Second, the revision shifted some of the government's end use screening responsibilities from the government to the computer industry. In essence, the exporters had to decide whether a license was required since the decision is made on the basis of the end use, the end user, and the computer performance capability. This decision could be particularly difficult for exports to a tier 3 country, like China, where identifying the distinction between a civilian and military end user can be very difficult. In response to several allegations of improper sales to Russia and China, Congress partly reversed this situation by passing the Fiscal Year 1998 National Defense Authorization Act, which requires exporters to notify the Commerce Department of all HPC sales over 2,000 MTOPS to tier 3 countries prior to their export.

- Third, the regulation required HPC manufacturers to keep records of the end users of all their HPC exports over 2,000 MTOPS. Based on our review of records provided by the manufacturers to the Commerce Department from January 1996 through September 1997, we noted that China ranked first in the number of HPCs acquired by tier 3 countries, having purchased a total of 77 HPC's during this period. These exports were all made without an individual license being required. Examining how these machines are being used was beyond the scope of this review.

Responsibility for PSV checks on exports remained with the government, but information on these exports reported to the government has been incomplete. PSVs for computers generally have been of reduced value because of how this process is implemented. First, PSVs verify the physical location of an HPC, but not how it is used. Also, some governments, such as China, have not allowed the United States to conduct PSVs.

With regard to foreign availability of HPCs,[10] we found that subsidiaries of U.S. computer manufacturers dominate the overseas HPC market and they must comply with U.S. controls. Russia, China, and India have developed HPCs, but their capabilities are believed to be limited. Thus, our analysis suggests that HPCs over 2,000 MTOPS are not readily available to tier 3 countries from foreign sources without restriction.

[10]We used the description of foreign availability described in footnote 4 as our criteria.

The report contains two recommendations: one that requires action by the Secretary of Defense, and one that requires action by the Secretary of Commerce with support from Defense, Energy, State, and the Arms Control and Disarmament Agency.

First, we recommended that to complement the studies undertaken by DOD and DOE for the House Committee on National Security, the Secretary of Defense assess and report on the national security threat and proliferation impact of U.S. exports of HPCs to countries of national security and proliferation concern. This assessment, at a minimum, should address (1) how and at what performance levels countries of concern use HPCs for military modernization and proliferation activities; (2) whether such uses are a threat to U.S. national security interests; and (3) the extent to which such HPCs are controllable.

Second, upon completion of the analysis suggested in our first recommendation, we also recommended that the Secretary of Commerce, in conjunction with the other agencies I mentioned, jointly evaluate and report on options to safeguard U.S. national security interests regarding HPCs. Such options should include, but not be limited to, (1) requiring government review and control of the export of computers at their highest scalable MTOPS performance levels and (2) requiring that HPCs destined for tier 3 countries be physically modified to prevent upgrades beyond the allowed levels.

I would also like to comment just briefly on the agencies' response to our report. In addition to Commerce and Defense, the Departments of Energy and State, and the Arms Control and Disarmament Agency (ACDA) offered their views.

Commerce said that the President's decision was intended to change the computer export policy from what it referred to as "a relic of the Cold War to one more in tune with today's technology and international security environment," and was based on (1) rapid technological changes in the computer industry, (2) wide availability, (3) limited controllability, and (4) limited national security applications for HPCs. Commerce further stated that our report focused too much on how countries might use HPCs for proliferation or military purposes and on what it called an outdated Cold War concept of "foreign availability". The Department said that our analysis of foreign availability was too narrow, and that foreign availability is not an adequate measure of the problem.

We agree that rapid technological advancements in the computer industry have made the controllability of HPC exports a more difficult problem; however, we disagree that foreign availability is an outdated Cold War concept that has no relevance in today's environment. While threats to U.S. security may have changed, they have not been eliminated. Commerce itself recognized this in its March 1998 annual report to the Congress which stated that "the key to effective export controls is setting control levels above foreign availability." Moreover, the concept of foreign availability, as opposed to Commerce's

notion of "worldwide" availability, is still described in the Export Administration Act and Export Administration Regulations as a factor to be considered in export control policy.

Commerce also commented that the need to control the export of HPCs because of their importance for national security applications is limited. It stated that many national security applications can be performed satisfactorily on uncontrollable low-level technology, and that computers are not a "choke point" for military production. Commerce said that having access to HPCs alone will not improve a country's military-industrial capabilities.

Commerce offered no specific evidence to support this point of view; moreover, its view seems to be inconsistent with the requirement for DOD to identify militarily critical technologies. In assessing these militarily critical technologies, DOD has determined that high performance computing is an enabling technology for modern tactical and strategic warfare and is also important in the development, deployment, and use of weapons of mass destruction. High performance computing has also played a major role in the ability of the United States to maintain and increase the technological superiority of its war-fighting support systems. DOD has noted in its High Performance Computing Modernization Program annual plan that the use of HPC technology has led to lower costs for system deployment and improved the effectiveness of complex weapons systems. DOD further stated that as it transitions its weapons system design and test process to rely more heavily on modeling and simulation, the nation can expect many more

examples of the profound effects that the HPC capability has on both military and civilian applications.

In its comments on our report, DOD said that it had considered the threats associated with HPC exports to countries of national security and proliferation concern. In this context, DOD referred to its identification of how HPCs in the United States are used for national security applications. While our report recognized that such an assessment of domestic uses had been done, this did not address our concern. We reported that (1) the Stanford study did not assess the capabilities of countries of concern, such as China, Russia, India or Pakistan, to use HPCs for military and other national security applications, as required by its tasking, and (2) the executive branch did not undertake a threat analysis of providing HPCs to such countries of concern. As we reported, the principal author of the Stanford study noted that no assessment had been done of the national security impact of allowing HPCs to go to particular countries of concern and of what military advantages such countries could achieve. In fact, the April 1998 Stanford study on HPC export controls by the same principal author also noted that identifying which countries could use HPCs to pursue which military applications remained a critical issue on which the executive branch provided little information.

The Departments of State and Energy, and ACDA generally agreed with our report.

Mr. Chairman, that concludes our prepared testimony. My colleagues and I would be happy to respond to any questions you or other members may have.

United States General Accounting Office

GAO

Report to the Chairman, Subcommittee on International Security, Proliferation, and Federal Services, Committee on Governmental Affairs, U.S. Senate

September 1998

EXPORT CONTROLS

Information on the Decision to Revise High Performance Computer Controls

GAO/NSIAD-98-196

GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-280320

September 16, 1998

The Honorable Thad Cochran
Chairman, Subcommittee on International Security,
Proliferation, and Federal Services
Committee on Governmental Affairs
United States Senate

Dear Mr. Chairman:

In January 1996, the executive branch revised controls on the export of U.S.-manufactured high performance computers (HPC) by raising thresholds of computer performance for which exporters must obtain a license. Subsequently, several unlicensed HPCs were exported to both China and Russia, including 17 computers illegally sent to a Russian nuclear weapons lab. You expressed concerns that U.S. national security interests may have been compromised by such sales[1] and requested that we (1) assess the basis for the executive branch's revision of HPC export controls and (2) identify changes in licensing activities and the implementation of certain U.S. licensing and export enforcement requirements since the revision. You also asked us to determine the current foreign availability of HPCs, particularly for certain countries of national security concern.

We are also issuing a related report entitled, Export Controls: National Security Issues and Foreign Availability for High Performance Computers (GAO/NSIAD-98-200, Sept. 16, 1998), pursuant to section 1214 of the Fiscal Year 1998 National Defense Authorization Act (P.L. 105-85).

Background

The U.S. export control system is about managing risk; exports to some countries involve less risk than to other countries and exports of some items involve less risk than others. Under U.S. law, the President has the authority to control and require licenses for the export of items that may pose a national security or foreign policy concern. The President also has the authority to remove or revise those controls as U.S. concerns and

[1]The circumstances surrounding these specific exports are being investigated by the U.S. Departments of Justice and Commerce and the Customs Service. On July 31, 1998, the Department of Justice announced that IBM East Europe/Asia Ltd. entered a guilty plea and received the maximum allowable fine of $8.5 million for violating 17 counts of U.S. export laws.

interests change.[2] In doing so, the President is not required under U.S. law to conduct a foreign availability analysis.

In 1995, as a continuation of changes begun in the 1980s, the executive branch reviewed export controls on computer exports to determine how changes in computer technology and its military applications should affect U.S. export control regulations. In announcing its January 1996 change to HPC controls, the executive branch stated that one goal of the revised export controls was to permit the government to tailor control levels and licensing conditions to the national security or proliferation risk posed at a specific destination.

A key element of the executive branch review of HPC export controls was a Stanford University study, jointly commissioned by the Commerce and Defense Departments.[3] Among other things, the study was tasked to provide an assessment of the availability of HPCs in selected countries and the capabilities of those countries to use HPCs for military and other national security applications. The study concluded that (1) U.S.-manufactured computer technology between 4,000 and 5,000 millions of theoretical operations per second (MTOPS)[4] was widely available and uncontrollable worldwide, (2) U.S.-manufactured computer technology up to 7,000 MTOPS would become widely available and uncontrollable worldwide by 1997, and (3) many HPC applications used in U.S. national security programs occur at about 7,000 MTOPS and at or above 10,000 MTOPS. The study also concluded that it would be too expensive for government and industry to effectively control the international diffusion of computing systems with performance below 7,000 MTOPS, and that attempts to control computer exports below this level would become increasingly ineffectual, would harm the credibility of export controls, and would unreasonably burden a vital sector of the computer industry. The

[2]In this report, revision of export controls refers to removal of licensing requirements for groups of countries based on the performance levels of HPCs.

[3]Building on the Basics: An Examination of High-Performance Computing Export Control Policy in the 1990's, Seymour Goodman, Peter Wolcott, and Grey Burkhart (Center for International Security and Arms Control, Stanford University, November 1995).

[4]MTOPS is the composite theoretical performance of a computer measured in millions of theoretical operations per second. In principle, higher MTOPS indicates greater raw performance of a computer to solve computations quickly, but not the actual performance of a given machine for a given application.

study also raised concerns about the ability to control HPC exports in the future in light of advances in computing technology.[5]

The export control policy implemented in January 1996 removed license requirements for most HPC exports with performance levels up to 2,000 MTOPS—an increase from the previous level of 1,500 MTOPS. The policy also organized countries into four "computer tiers," with each tier after tier 1 representing a successively higher level of concern to U.S. security interests. The policy placed no license requirements on tier 1 countries, primarily those in Western Europe and Japan. Exports of HPCs above 10,000 MTOPS to tier 2 countries in Asia, Africa, Latin America, and Central and Eastern Europe would continue to require licenses. A dual-control system was established for tier 3 countries, such as Russia and China. For these countries, HPCs up to 7,000 MTOPS could be exported to civilian end users without a license, while exports at and above 2,000 MTOPS to end users of concern for military or proliferation of weapons of mass destruction reasons required a license. Exports of HPCs above 7,000 MTOPS to civilian end users also required a license. HPC exports to terrorist countries in tier 4 were essentially prohibited. (See appendix II for details on the four-tier system of export controls.)

The January 1996 regulation also made other changes. It specified that exporters would be responsible for (1) determining whether an export license is required, based on the MTOPS level of the computer; (2) screening end users and end uses for military or proliferation concerns;[6] and (3) keeping records and reporting on exports of computers with performance levels of 2,000 MTOPS. In addition to the standard record-keeping requirements, the regulation added requirements for the date of the shipment, the name and address of the end user and of each intermediate consignee, and the end use of each exported computer. The Fiscal Year 1998 National Defense Authorization Act (P.L. 105-85) modified the policy for determining whether an individual license is required and now requires exporters to notify the Commerce Department of any planned sales of computers with performance levels

[5]In April 1998, authors of the 1995 Stanford study published a follow-on discussion paper, High-performance Computing, National Security Applications, and Export Control Policy at the Close of the 20th Century, as a contribution to the periodic review of HPC export controls. This paper noted (1) that rapid advances in computer technology were continuing but (2) that a proposed change in licensing procedure—to review each HPC at its highest attainable level, rather than its configuration at time of export—would remove the concern of HPCs being upgraded without the knowledge of exporters or the U.S. government. We did not evaluate the adequacy of the analysis and support of the second study.

[6]End-use screening is the process exporters follow to evaluate whether a transaction involves an unacceptable risk of use in, or diversion to, a proliferator or military end user.

greater than 2,000 MTOPS to tier 3 countries. The government has 10 days to assess and object to a proposed HPC sale. The law also now requires Commerce to perform post-shipment verifications (PSV) on all HPC exports with performance levels over 2,000 MTOPS to tier 3 countries.[7] The Commerce Department promulgated regulations implementing the law on February 3, 1998.

Results in Brief

The Stanford University study was a key element in the decision to revise HPC export controls. However, our analysis of the study showed that it had two significant limitations. First, the study lacked empirical evidence or analysis to support its conclusion that HPCs were uncontrollable based on (1) worldwide availability and (2) insufficient resources to control them. Second, the study did not assess the capabilities of countries of concern to use HPCs for military and other national security applications, as required by its tasking. The study's principal author said that U.S. government data was insufficient to make such an assessment, and the study recommended that better data be gathered so that such an analysis could be done in the future. In addition, the executive branch did not undertake a threat analysis of providing HPCs to countries of concern. Nonetheless, based on its undocumented view of the worldwide availability of computing power and on the technological advancements in this area, the executive branch raised the MTOPS thresholds for HPC export controls and established the four-tier control structure. Although the Stanford study had limitations, it made some observations regarding the potential to upgrade HPCs and the export control challenge this will present in the future. For example, it noted that the technological trend toward upgrading computer performance without vendor support or knowledge is reducing the effectiveness of U.S. export controls.

The 1996 revision to HPC export controls had three key consequences. First, the number of computer export licenses issued declined from 395 in fiscal year 1995 to 42 in 1997. Second, U.S. HPC exporters were charged with responsibilities previously conducted by the government. New U.S. HPC exporters' responsibilities included screening and reporting on the end use and end user of HPCs. In essence, the exporters had to decide whether a license was required since the decision is made on the basis of the end use, the end user, and the computer performance capability. This decision could be particularly difficult for exports to tier 3 countries, such as China, where identifying the distinction between a civilian and military end user

[7]PSVs are on-site visits, generally by U.S. government officials, to locations where goods are shipped.

can be difficult without information that is sometimes available only to the U.S. government. This situation was partly reversed by the Fiscal Year 1998 National Defense Authorization Act, which requires exporters to notify the Commerce Department of all HPC sales over 2,000 MTOPS to tier 3 countries prior to their export. Third, the regulation required HPC manufacturers to keep records of the end users of all their HPC exports over 2,000 MTOPS. To date, information on these exports reported to the government has been incomplete. Responsibility for PSV checks remained with the government. However, because of how PSVs for computers are implemented, their value is reduced because they verify the physical location of an HPC, but not how it is used. Also, some governments, such as China, have not allowed the United States to conduct them.

With regard to foreign availability of HPCs,[8] we found that subsidiaries of U.S. computer manufacturers dominate the overseas HPC market and they must comply with U.S. controls. Three Japanese companies are global competitors of U.S. manufacturers, two of which told us that they had no sales to tier 3 countries. The third company did not provide data on such sales in a format that was usable for our analysis. Two of the Japanese companies primarily compete with U.S. manufacturers for sales of high-end HPCs at about 20,000 MTOPS and above. Two other manufacturers, one in Germany and one in the United Kingdom, also compete with U.S. HPC suppliers, but primarily within Europe. Only the German company has sold HPCs to tier 3 countries. Japan, Germany, and the United Kingdom each have export controls on HPCs similar to those of the United States, according to foreign government officials. Russia, China, and India have developed HPCs, but the capabilities of their computers are believed to be limited. Thus, our analysis suggests that HPCs over 2,000 MTOPS are not readily available to tier 3 countries from foreign sources without restrictions.

Key Study Used as Basis for Changing HPC Controls Had Limitations

The Stanford study, used as a key element by the executive branch in its decision to revise HPC export controls, had significant limitations. It lacked empirical evidence or analysis regarding its conclusion that HPCs were uncontrollable and, although tasked with doing so, it did not assess the capabilities of countries of concern to use HPCs for military and other national security applications. The study itself identified as a major limitation, its inability to assess capabilities of countries of concern to use HPCs for their military programs or national security applications, on the

[8]We used a description of foreign availability in the Export Administration Act (EAA) of 1979, as amended, as our criteria.

basis that such information was not available, and recommended that such an assessment be done. The study noted that trends in HPC technology development could affect U.S. security and the ability to control HPC exports in the future and need to be further studied. Despite the study's limitations, the executive branch decided to relax HPC export controls.

The Stanford Study Lacked Evidence of HPC Uncontrollability

The Stanford study accumulated information from computer companies on U.S. HPC market characteristics and concluded—without empirical evidence or analysis—that computers between 4,000 and 5,000 MTOPS were already available worldwide and uncontrollable and that computers at about 7,000 MTOPS would be widely available and uncontrollable by 1997.[9] Using the findings from the Stanford study, executive branch officials set the computer performance control thresholds for each tier. However, these officials could not explain nor provide documentation as to how the executive branch arrived at the decision to set the license requirements for exports of HPCs to tier 3 countries for military or proliferation end users at 2,000 MTOPS, even though the study concluded that computing power below 4,000 or 5,000 MTOPS was already "uncontrollable."

The study identified the following six factors as affecting controllability of HPCs: computer power, ease of upgrading, physical size, numbers of units manufactured and sold, sources of sales (direct sales or through resellers), and the cost of entry level systems. It described uncontrollability as the relationship between the difficulty of controlling computers and the willingness of government and industry to meet the costs of tracking and controlling them. The study asserted that as U.S. HPCs were sold openly for 2 years, their export would become uncontrollable. Part of the study's rationale was that, as older HPCs are replaced by newer models 2 years after product introduction, original vendors may no longer have information on where replaced HPCs are relocated. The study also presumed a level of "leakage" of computers to countries of concern from U.S. HPC sources and asserted that costs of controlling such leakage were no longer tolerable. However, the study did not attempt to calculate or specify those costs. In addition, the study suggested only vague thresholds for these six factors to determine "uncontrollability." For example, it noted that the threshold at which it becomes difficult to track numbers of units could vary from 200 to several thousand. The study did not provide analysis or empirical evidence to support its assumptions or conclusions.

[9]The Commerce Department stated that Department of Defense (DOD) information, which showed that a number of significant military applications are run at performance levels above 7,000 MTOPS, also supported the Stanford study's conclusion that an HPC control threshold at this level could be justifiable.

National Security and Proliferation Risks of HPCs Not Assessed

Although the Stanford study was tasked with assessing the capabilities of countries of concern to use HPCs for military and other national security applications, it did not do so. The study discussed only U.S. applications of HPCs for military purposes. According to the study's principal author, data on other countries' use of HPCs for military and other national security purposes was insufficient to make such assessments because the U.S. government does not gather such data in a systematic fashion. The report recommended that such an analysis be done.

Despite the study's limitations and recommendations to gather better data in the future on other countries' use of HPCs for military and other national security purposes, the executive branch raised the MTOPS thresholds for HPC export controls and established the four-tier export control structure. The former Deputy Assistant Secretary of Defense for Counterproliferation Policy explained that because DOD was not tasked to conduct a threat assessment, it did not do so. Instead, the executive branch assessed countries on the basis of six criteria and assigned them to a particular tier. The six criteria were (1) evidence of on-going programs of national security concern, including proliferation of weapons of mass destruction with associated delivery systems and regional stability and conventional threats; (2) membership in or adherence to non-proliferation and export control regimes; (3) an effective export control system, including enforcement and compliance programs and an associated assessment of diversion risks; (4) overall relations with the United States; (5) whether U.N. sanctions had been imposed; and (6) prior licensing history.

Prior to the executive branch's decision to change computer thresholds, scientists at Department of Energy (DOE) national laboratories and other U.S. government officials had accumulated information to show how countries of concern could use HPCs to facilitate the design of nuclear weapons and to improve advanced nuclear weapons in the absence of tests of nuclear explosives. However, this information was not used as part of the decisionmaking process for revising HPC export controls, according to the Commerce Department. In December 1997 the House Committee on National Security directed the DOE and DOD to assess the national security impacts of exporting HPCs with performance levels between 2,000 and 7,000 MTOPS to tier 3 countries. In June 1998, 2 and 1/2 years after the executive branch revised HPC export controls, DOE concluded its study on how countries like China, India, and Pakistan can use HPCs to improve their nuclear programs.

According to the DOE study, the impact of HPC acquisition depends on the complexity of the weapon being developed and, even more importantly, on the availability of high-quality, relevant test data. The study concluded that "the acquisition and application of HPCs to nuclear weapons development would have the greatest potential impact on the Chinese nuclear program—particularly in the event of a ban on all nuclear weapons testing." Also, the study indicated that India and Pakistan may now be able to make better use of HPCs in the 1,000 to 4,000 MTOPS range for their nuclear weapons programs because of the testing data they acquired in May 1998 from underground detonations of nuclear devices. The potential contribution to the Russian nuclear program is less significant because of its robust nuclear testing experience, but HPCs can make a contribution to Russia's confidence in the reliability of its nuclear stockpile. An emerging nuclear state is likely to be able to produce only rudimentary nuclear weapons of comparatively simple designs, for which personal computers are adequate. We were told that DOD's study of national security impacts had not been completed as of September 1, 1998, in part because the Department had not received requested information from the Commerce Department until after July 1.

Advances in Computing Technology May Pose Long-Term Security Challenges

The Stanford study noted that trends in HPC technology development may pose security and export control challenges and recommended further study to determine their implications for national security and export controls.

The technology trends of concern include other countries' ability (1) to upgrade the performance of individual computers and (2) to link individual computers to achieve higher performance levels. The Stanford study team reviewed the computer industry's technological advances in parallel processing and concluded that such advances as "scalability" and "clustering" contributed to the uncontrollability of high performance computing worldwide and are inevitably reducing the effectiveness of U.S. export controls.[10] "Scalability" refers to the capability to increase computer performance levels of a system by adding processor boards or by acquiring increasingly powerful microprocessors. "Clustering" refers to connecting many personal computers or workstations to achieve higher computing performance in a network of interconnected systems, working cooperatively and concurrently on one or several tasks.

[10]Parallel processing means breaking computational problems into many separate parts and having a large number of processors tackle those parts simultaneously. Greatly increased processing speed is achieved largely through the sheer number of processors operating simultaneously, rather than through any exceptional power in each processor.

Scalability and clustering offer opportunities to increase computer power without the need to develop custom-built single processors traditionally used in HPCs. Some types of HPCs are designed today to allow scalability without the need for vendor support or even knowledge.[11] As a result, some HPCs could be exported below MTOPS thresholds without an individual license, and, in theory, later covertly scaled up to levels that exceed the threshold. We asked government agencies for information about diversions and violations of U.S. HPC export controls, but they provided no evidence that countries of concern have increased the computing power of U.S. exported machines in violation of export restrictions.

We found no U.S. government reviews of alternatives to address these security concerns, although authors of the Stanford study and others with whom we spoke identified various options that could be assessed. These include (1) requiring government review and consideration of machines at their highest scalable MTOPS performance levels and (2) requiring that HPCs exported to tier 3 countries be physically modified to prevent upgrades beyond the allowed levels.

Changes in U.S. Licensing and Export Enforcement Since the Revision

The executive branch's January 1996 export control revision (1) increased thresholds for requiring licenses, which resulted in a reduction in the numbers of licensed HPCs; (2) shifted some of the government's end-use screening responsibility from the government to the computer industry, until this policy was revised in 1998; and (3) required HPC manufacturers to keep records of the end users of their HPC exports. The government continued to have responsibility for post-shipment verifications for HPCs, which have reduced value as traditionally conducted.

License Applications Have Decreased Since Revision

Since the export controls for computers were revised in 1996, HPC export license applications have declined from 459 applications in fiscal year 1995 to 125 applications in fiscal year 1997. In fiscal year 1995, the Commerce Department approved 395 license applications for HPC exports, and denied 1. In fiscal year 1997, Commerce approved 42 license applications for HPC exports, and denied 6. The remainder of the applications in each year were withdrawn without action. Changes in the numbers of both licensed and unlicensed exports might not be attributed entirely to the change in export controls. However, we did note some characteristics of U.S. HPC exports

[11] Many HPC designs use commercial, off-the-shelf processors, such as those found in personal computers or scientific workstations, and may include hundreds or even thousands of processors.

since the revision. For example, while HPC exports increased to each tier from January 1996 through September 1997, 72 percent of machines were sold to tier 1 countries. Also during this period, 77 HPCs were exported to China and 19 were exported to India, all without individual licenses. Most U.S. HPCs exported in this period (about 85 percent) had performance levels between 2,000 and 5,000 MTOPS. (See appendix III for details on HPC exports.)

End-Use Screening Responsibility Shifted to Computer Industry

The executive branch shifted some government oversight responsibility to the computer industry, especially for tier 3 countries. Exporters became responsible for determining whether exports required a license by screening end users and end uses for military or proliferation concerns (end-use screening).[12] However, some industry and government officials concluded that the computer industry lacked the necessary information to distinguish between military and civilian end users in some tier 3 countries—particularly China.

Because of concerns about U.S. HPCs being obtained by countries of proliferation concern for possible use in weapons-related activities, the Congress enacted a provision in Public Law 105-85 that required exporters to notify the Commerce Department of all proposed HPC sales over 2,000 MTOPS to tier 3 countries. The law gives the government an opportunity to assess these exports within 10 days to determine the need for a license and it can use information that may not be available to the exporter.

U.S. Companies' Records on Resales of HPCs Are Incomplete

Pursuant to the Export Administration Regulations, exporters are required to keep accurate records of each licensed and unlicensed export of a computer over 2,000 MTOPS to any destination. These records are to include names and addresses of each end user and each "intermediate consignee" (resellers or distributors). Exporters must also provide quarterly reports to Commerce on license-exempt exports—almost 96 percent of the total HPC exports in the past 2 years.

The government relies on the exporters' data for end-use information, but we found that companies had reported inconsistent and incomplete data

[12]To aid exporters in making end user determinations, Commerce created specific guidance to educate exporters about signs they need to be aware of that can be of concern to the government. Companies also were urged to contact the Commerce Department when in doubt about an end user's activities. According to Commerce, the end user could then be researched by the government and the exporter advised to seek a license if any strategic concerns were present.

for intermediate consignees (resellers or distributors) as end users. For example, one company reported data for only one intermediate consignee, even though company officials told us that the company uses multiple resellers. Company officials noted that the company sells computers to companies in other countries, which then sell the computers to other, unknown end users. A second company provided "end-use statements" from its resellers, rather than the actual end users, and identified computers' end use for several overseas sales as "resale." In contrast, a third company shows its resellers as resellers, rather than as end users. Company officials said that the company contractually requires its resellers to identify and provide end-use statements from the ultimate end-users.

Safeguards Procedures for Verifying the End Use of HPCs Are Limited

The revision of HPC export controls did not reduce the government's responsibility for certain safeguards procedures, notably conducting PSVs. Under current law, Commerce is required to conduct PSVs for all HPC exports over 2,000 MTOPS to tier 3 countries. While PSVs are important for detecting and deterring physical diversions of HPCs, PSVs, as traditionally conducted, do not verify computer end use. Also, some countries do not allow the United States to conduct them. China, for example, had not allowed PSVs,[13] but in June 1998, it reportedly agreed to do so.

U.S. government officials agreed that the way PSVs of computers have been traditionally conducted have reduced their value because such PSVs establish only the physical presence of an HPC. However, this step assures the U.S. government that the computer has not been physically diverted. According to DOE laboratory officials, it is easy to conceal how a computer is being used. They believed that the U.S. government officials performing the verifications cannot make such a determination, partly because they have received no computer-specific training. Although it is possible to verify how an HPC is being used through such actions as reviewing internal computer data, this would be costly and intrusive, and require experts' sophisticated computer analysis.

Another limitation of PSVs concerns sovereignty issues. Host governments in some countries of greatest concern, notably China, have precluded or restricted the U.S. government's ability to conduct PSVs. Three European countries that we visited—United Kingdom, Germany, and France—also

[13]In the last 3 calendar years, U.S embassy officials conducted 20 PSVs of digital computers. In addition, during 1997, Commerce officials on special teams from headquarters also conducted 19 visits to HPC locations.

do not allow U.S. government officials to do PSVs. However, they perform the checks themselves and provide the results to the U.S. government.

The government makes limited efforts to monitor exporters' and end users' compliance with explicit conditions attached to export licenses. It relies largely on HPC exporters for end use monitoring and may require them or the end users to safeguard the exports by limiting access to the computers or inspecting computer logs and outputs. The end user may also be required to agree to on-site inspections, even on short notice, by U.S. government or exporting company officials, who would review programs and software used on the computer, or to remote electronic monitoring of the computer. Commerce officials stated that they may have reviewed computer logs in the past, but do not do so anymore, and said that they have not conducted any short notice visits, and that they do not do remote monitoring. They said that, ultimately, monitoring safeguards plans is the exporter's responsibility.

Current Foreign Availability of HPCs

As requested, we evaluated the current foreign availability of HPCs. Using the EAA's general description of foreign availability as our criteria, our analysis showed that subsidiaries of U.S. companies dominate the overseas sales of HPCs. These companies primarily compete against one another with limited competition from foreign suppliers in Japan and Germany. We also obtained information on the capability of certain tier 3 countries to build their own HPCs and found it to be limited in the capability to produce machines in comparable quantity, quality, and power as the major HPC-supplier countries.

The EAA describes foreign availability as goods or technology available without restriction to controlled destinations from sources outside the United States in sufficient quantities and comparable quality to those produced in the United States so as to render the controls ineffective in achieving their purposes. We found that the only global competitors for general computer technology are three Japanese companies, two of which compete primarily for sales of high-end computers—systems sold in small volumes and performing at advanced levels. Two of the companies reported no HPC exports to tier 3 countries, while the third company reported some exports on a regional, rather than country, basis. One German company sells HPCs primarily in Europe and has reported several sales of its HPCs over 2,000 MTOPS to tier 3 countries. One British company said it is capable of producing HPCs above 2,000 MTOPS, but company officials said it has never sold a system outside the European Union.

A 1995 Commerce Department study of the HPC global market showed that American dominance had prevailed at that time, as well. The study observed that American HPC manufacturers controlled the market worldwide, followed by Japanese companies. It also found that European companies controlled about 30 percent of the European market and were not competitive outside Europe.

The other countries that are HPC suppliers to countries outside Europe also restrict their exports. The United States and Japan since 1984 have been parties to a bilateral arrangement, referred to as the "Supercomputer Regime," to coordinate their export controls on HPCs. Also, both Japan[14] and Germany, like the United States, are signatories to the Wassenaar Arrangement, which has membership criteria of adherence to non-proliferation regimes and effective export controls.[15] Each country also has national regulations that generally appear to afford levels of protection similar to U.S. regulations for their own and for U.S.-licensed HPCs. For example, both countries place export controls on sales of computers over 2,000 MTOPS to specified destinations, according to German and Japanese government officials. However, foreign government officials said that they do not enforce U.S. reexport controls on unlicensed U.S. HPCs. In fact, a study of German export controls noted that regulatory provisions specify that Germany has no special provisions on reexport of U.S.-origin goods. According to German government officials, the exporter is responsible for knowing the reexport requirements of the HPC's country of origin. We could not ascertain whether improper reexports of HPCs occurred from tier 1 countries.

Because some U.S. government and HPC industry officials consider indigenous capability to build HPCs a form of foreign availability, we examined such capabilities for tier 3 countries. Available information indicates that the capabilities of China, India, and Russia to build their own HPCs still lag well behind that of the United States, Japan, and European countries. Although details are not well-known about HPC developments in each of these tier 3 countries, most officials and studies showed that each country still produces machines in small quantities and of lower quality and power compared to U.S., Japanese, and European computers. For example,

[14]We also obtained information from the Japanese government and HPC vendors. We identified controls in force, but did not assess their implementation.

[15]The 1996 Wassenaar Arrangement of Export Controls for Conventional Arms and Dual-Use Goods and Technologies is an arrangement to exchange export information between 33 states with the purpose of contributing to regional and international security by enhancing cooperation among export control systems and international regimes.

- China has produced at least two different types of HPCs, called the Galaxy and Dawning series, based on U.S. technology and they are believed to have a performance level of about 2,500 MTOPS. Although China has announced its latest Galaxy at 13,000 MTOPS, U.S. government officials have no confirmation of this report.
- India has produced a series of computers called Param, which are based on U.S. microprocessors and are believed by U.S. DOE officials to be rated at about 2,000 MTOPS. These officials were denied access to test the computer's performance.
- Russia's efforts over the past three decades to develop commercially viable HPCs have used both indigenously-developed and U.S. microprocessors, but have suffered from economic problems and a lack of customers. According to one DOE official, Russia has never built a computer running better than 2,000 MTOPS, and various observers believe Russia to be 3 to 10 years behind the West in developing computers.

Conclusions

A key element in the 1996 decision to revise HPC export controls was the findings of the Stanford study which did not have adequate analyses of critical issues. In particular, the study used to justify the decision did not assemble empirical data or analysis to support the conclusion that HPCs below specific performance levels were uncontrollable and widely available worldwide. Moreover, the study did not analyze the capabilities of countries of concern to use HPCs to further their military programs or engage in nuclear proliferation, but rather recommended that such data be gathered and such analysis be made. Despite the limitations of the study, the executive branch revised the HPC export controls. Since the executive branch's stated goals for the revised HPC export controls included tailoring control levels to security and proliferation risks of specific destinations, it becomes a vital factor to determine how and at what performance levels specific countries would use HPCs for military and other national security applications and how such uses would threaten U.S. national security interests in specific areas. In addition, the Stanford study identified trends in HPC technology development which may pose security and export control challenges for national security and export controls. Some alternatives to address these security challenges have been identified by authors of the Stanford study and others with whom we spoke, and could be assessed.

Recommendations

To complement the studies undertaken by DOD and DOE for the House Committee on National Security, we recommend that the Secretary of

Defense assess and report on the national security threat and proliferation impact of U.S. exports of HPCs to countries of national security and proliferation concern. This assessment, at a minimum, should address (1) how and at what performance levels countries of concern use HPCs for military modernization and proliferation activities; (2) the threat of such uses to U.S. national security interests; and (3) the extent to which such HPCs are controllable.

We also recommend that the Secretary of Commerce, with the support of the Secretaries of Defense, Energy, and State, and the Director of the U.S. Arms Control and Disarmament Agency, jointly evaluate and report on options to safeguard U.S. national security interests regarding HPCs. Such options should include, but not be limited to, (1) requiring government review and control of the export of computers at their highest scalable MTOPS performance levels and (2) requiring that HPCs destined for tier 3 countries be physically modified to prevent upgrades beyond the allowed levels.

Agency Comments and Our Evaluation

Commerce and DOD each provided one set of general written comments on a draft of this and a companion report[16] and the Departments of State and Energy and the Arms Control and Disarmament Agency provided oral comments. Commerce, Defense, and State raised issues about various matters discussed in the report. The Department of Energy had no comments on the report but said it deferred to Commerce and Defense to comment on the Stanford study. The Arms Control and Disarmament Agency agreed with the substance of the report. Commerce, State, Energy, and the Arms Control and Disarmament Agency did not comment on our recommendations, but Defense did. Defense said that our recommendation concerning the assessment of national security threats and proliferation impact of U.S. exports to countries of concern was done in connection with the 1995 decision to revise HPC export controls, and that it would consider additional options to safeguard exports of HPCs as part of its ongoing review of export controls. As noted below, we believe the question of how countries of concern could use HPCs to further their military and nuclear programs was not addressed as part of the executive branch's 1995 decision.

Commerce commented that the President's decision was intended to change the computer export policy from what it referred to as "a relic of

[16]Export Controls: National Security Issues and Foreign Availability for High Performance Computer Exports (GAO/NSIAD-98-200, September 1998)

the Cold War to one more in tune with today's technology and international security environment." Commerce said the decision was based on (1) rapid technological changes in the computer industry, (2) wide availability, (3) limited controllability, and (4) limited national security applications for HPCs. Commerce provided additional views about each of these factors. Commerce commented that our report focused on how countries might use HPCs for proliferation or military purposes and on what it called an outdated Cold War concept of "foreign availability," rather than these factors.

Our report specifically addresses the four factors Commerce said it considered in 1995. These four factors are considered in the Stanford University study upon which the executive branch heavily relied in making its decision to revise HPC export controls. Our report agreed with the study's treatment of technological changes in the computing industry and that advances in computing technology may pose long-term security and controllability challenges.

Commerce commented that our analysis of foreign availability as an element of the controllability of HPCs was too narrow, stating that foreign availability is not an adequate measure of the problem. Commerce stated that this "Cold War concept" makes little sense today, given the permeability and increased globalization of markets. We agree that rapid technological advancements in the computer industry have made the controllability of HPC exports a more difficult problem; however, we disagree that foreign availability is an outdated Cold War concept that has no relevance in today's environment. While threats to U.S. security may have changed, they have not been eliminated. Commerce itself recognized this in its March 1998 annual report to the Congress which stated that "the key to effective export controls is setting control levels above foreign availability." Moreover, the concept of foreign availability, as opposed to Commerce's notion of "worldwide" availability, is still described in EAA and the Export Administration Regulations as a factor to be considered in export control policy.

Commerce also commented that the need to control the export of HPCs because of their importance for national security applications is limited. It stated that many national security applications can be performed satisfactorily on uncontrollable low-level technology, and that computers are not a "choke point" for military production. Commerce said that having access to HPCs alone will not improve a country's military-industrial capabilities. Commerce asserted that the 1995 decision was based on

research leading to the conclusion that computing power is a secondary consideration for many applications of national security concern. We asked Commerce for its research evidence, but none was forthcoming. The only evidence that Commerce cited was contained in the Stanford study.

Moreover, Commerce's position on this matter is not consistent with that of DOD. DOD, in its Militarily Critical Technologies List,[17] has determined that high performance computing is an enabling technology for modern tactical and strategic warfare and is also important in the development, deployment, and use of weapons of mass destruction. High performance computing has also played a major role in the ability of the United States to maintain and increase the technological superiority of its war-fighting support systems. DOD has noted in its High Performance Computing Modernization Program[18] annual plan that the use of HPC technology has led to lower costs for system deployment and improved the effectiveness of complex weapons systems. DOD further stated that as it transitions its weapons system design and test process to rely more heavily on modeling and simulation, the nation can expect many more examples of the profound effects that the HPC capability has on both military and civilian applications. Furthermore, we note that the concept of "choke point" is not a standard established in U.S. law or regulation for reviewing dual-use exports to sensitive end users for proliferation reasons.

In its comments, DOD said that the Stanford study was just one of many sources of information and analysis used in the 1996 executive branch decision. We reviewed all of the four sources of information identified to us by DOD, DOE, State, Commerce, and Arms Control and Disarmament Agency (ACDA) officials as contributing to their assessment of computer export controls. However, the Stanford study was a key analytical study used in the decision-making process and the only source whose findings were consistently and repeatedly cited by the executive branch in official announcements, briefings, congressional testimony, and discussions with us in support of the HPC export control revision.

[17]The Militarily Critical Technologies List, required by EAA, is a compendium of the technologies DOD assesses as critical to maintaining superior U.S. military capabilities. According to DOD, it should be used as a reference for evaluating potential technology transfers and to determine if the proposed transaction would permit potential adversaries access to technologies with specific performance levels at or above the characteristics identified as militarily critical.

[18]The High Performance Computing Modernization Program is the major force designed to improve DOD's ability to exploit the computation necessary to sustain technological superiority on the battlefield. Managed by the Director, Defense Research and Engineering, the program is intended to establish a nationwide integrated infrastructure to support the defense research, development, test, and evaluation communities.

In its comments, DOD stated that our report inaccurately characterized DOD as not considering the threats associated with HPC exports. DOD said that in 1995 it "considered" the security risks associated with the export of HPCs to countries of national security and proliferation concern. What our report actually states is that (1) the Stanford study did not assess the capabilities of countries of concern to use HPCs for military and other national security applications, as required by its tasking and (2) the executive branch did not undertake a threat analysis of providing HPCs to countries of concern. DOD provided no new documentation to demonstrate how it "considered" these risks. As the principal author of the Stanford study and DOD officials stated during our review, no threat assessment or assessment of the national security impact of allowing HPCs to go to particular countries of concern and of what military advantages such countries could achieve had been done in 1995. In fact, the April 1998 Stanford study on HPC export controls by the same principal author also noted that identifying which countries could use HPCs to pursue which military applications remained a critical issue on which the executive branch provided little information.

In its comments, the Department of State disagreed with our presenting combined data on HPC exports to China and Hong Kong in appendix III because the U.S.-Hong Kong Policy Act of 1992 calls for the U.S. government to treat Hong Kong as a separate territory regarding economic and trade matters. While, in principle, we do not disagree with State, it should be noted that we reported in May 1997 that given the decision to continue current U.S. policy toward Hong Kong, monitoring various indicators of Hong Kong's continued autonomy in export controls becomes critical to assessing the risk to U.S. nonproliferation interests.[19] Our presentation of the combined HPC export data for China and Hong Kong is intended to help illustrate a potential risk to U.S. nonproliferation interests regarding HPCs should Hong Kong's continued autonomy in export controls be weakened. We believe that monitoring data on HPC exports to Hong Kong becomes all the more important since Hong Kong is treated as a tier 2 country, whereas China is a tier 3 country.

Commerce also provided technical comments which we have incorporated as appropriate. Commerce and DOD written comments are reprinted in appendixes IV and V, respectively, along with our evaluation of them.

[19]Hong Kong's Reversion To China: Effective Monitoring Critical to Assess U.S. Nonproliferation Risks (GAO/NSIAD-97-149, May 1997).

ACDA provided oral comments on this report and generally agreed with it. However, it disagreed with the statement that "according to the Commerce Department, the key to effective export controls is setting control levels above the level of foreign availability of materials of concern." ACDA stressed that this is Commerce's position only and not the view of the entire executive branch. ACDA said that in its view (1) it is difficult to determine the foreign availability of HPCs and (2) the United States helps create foreign availability through the transfer of computers and computer parts.

Our scope and methodology are in appendix I. Appendix II contains details on the four-tier system of export controls and appendix III shows characteristics of HPC exports since the revision.

We conducted our review between August 1997 and June 1998 in accordance with generally accepted government auditing standards.

We will provide copies of this report to other congressional committees; the Secretaries of Commerce, Defense, Energy, and State; the Director, U.S. Arms Control and Disarmament Agency; and the Director, Office of Management and Budget. Copies will be provided to others upon request.

Please contact me on (202) 512-4128 if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix IV.

Sincerely yours,

Harold J. Johnson, Associate Director
International Relations and Trade Issues

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Tables

Figures

Abbreviations

ACDA	Arms Control and Disarmament Agency
DOD	Department of Defense
DOE	Department of Energy
EAA	Export Administration Act
HPC	high performance computer
MTOPS	millions theoretical operations per second
PSV	post-shipment verification

Appendix I

Scope and Methodology

To assess the basis for the U.S. government's 1996 decision to change HPC controls, we reviewed a 1995 Stanford University study on high performance computing and export control policy commissioned by the Commerce and Defense Departments and evaluated the executive branch's assessment of national security risks of HPCs. We reviewed several classified charts and briefing slides prepared by the intelligence community and DOD that were identified as important support for the revision of controls. We also talked with the Stanford study's principal authors to discuss their methodology, evidence, conclusions, and recommendations. In addition, we met with the Department of Defense (DOD), the Department of Energy (DOE), State and Commerce Department officials to discuss the interagency process used leading up to the decision to revise controls on HPCs. We also requested, but were denied access to, information from the National Security Council on data and analyses that were used in the interagency forum to reach the final decision to revise controls.

To determine how the government assessed the national security risks of allowing the high performance computers (HPC) to be provided to countries of proliferation and military concern as part of the basis for the decision to revise the controls, we reviewed DOD and DOE documents on how HPCs are being used for nuclear and military applications. We discussed high performance computing for both U.S. and foreign nuclear weapons programs with DOE officials in Washington, D.C., and at the Lawrence Livermore, Los Alamos, and Sandia National Laboratories. We also met with officials of the DOD HPC Modernization Office and other officials within the Under Secretary of Defense Acquisition and Technology, Office of the Secretary of Defense, the Joint Chiefs of Staff, and the intelligence community to discuss how HPCs are being utilized for weapons design, testing and evaluation and other military applications. Furthermore, to understand the trends occurring in computer technology, we analyzed HPC model descriptions and technical means for increasing computing performance.

To identify changes in licensing activities and the implementation of certain U.S. licensing and export enforcement requirements since the revision:

- We reviewed two sets of data from the Commerce Department, as noted above, in order to determine trends in American HPC exports since the 1996 revision of controls. We examined all U.S. high performance computer-related license applications worldwide. We analyzed the data for

trends and changes in MTOPS levels of HPC exports before and after revision of controls, numbers of licenses approved, denied, and withdrawn without action, and HPC exports by countries and country tiers. We did not review the data for completeness, accuracy, and consistency.

- We reviewed the end user and end-use screening systems of major American HPC manufacturers, Commerce Department implementation of the revised regulations, and selected foreign government export controls in order to determine licensing changes affecting U.S. HPC exporters since the revision of controls. We also reviewed applicable U.S. laws and regulations governing HPC export licensing and enforcement and discussed these laws and regulations with Commerce Department officials. We obtained Commerce Department procedures on end use and end user determinations as well as records on HPC vendor inquiries to Commerce on end users. In addition, we reviewed information on intelligence community assessments of foreign end users receiving HPC exports. We also discussed end user and end use screening procedures with officials from major U.S. HPC manufacturers—Digital Equipment Corporation, Hewlett Packard/Convex, International Business Machines, and Sun Microsystems—at their corporate offices in the United States and sales offices overseas. We also visited representatives of these companies' foreign subsidiary offices from China, Germany, Russia, Singapore, South Korea, and the United Kingdom to review end use screening procedures and documentation for selected exports. In addition, we visited selected HPC sites in China and Russia. However, the Chinese government refused us permission to visit one of three requested sites in Beijing. The Russian government, while not denying us permission to visit one site in-country, required an extended period of notification that went beyond our timeframes. Silicon Graphics, Inc./Cray refused to meet with us pending the outcome of an ongoing criminal investigation.
- We reviewed Commerce Department data on pre-license and post-shipment verification (PSV) checks on HPCs and related technology and safeguards security plans associated with HPC export licenses in order to examine affects of licensing changes on government oversight. We discussed the implementation and utility of these checks with officials of the U.S. government, American computer companies, and host governments in the countries we visited.

To determine foreign availability of HPCs, we reviewed the Export Administration Act (EAA) and Export Administration Regulations for criteria and a description of the meaning of the term. We then reviewed market research data from an independent computer research organization. We also reviewed lists, brochures, and marketing

information from major U.S. and foreign HPC manufacturers in France (Bull, SA), Germany (Siemens Nixdorf Informationssysteme AG and Parsytec Computer GmbH), and the United Kingdom (Quadrics Supercomputers World, Limited) and met with them to discuss their existing and projected product lines. We also obtained market data, as available, from three Japanese HPC manufacturers. Furthermore, we met with government officials in China, France, Germany, Singapore, South Korea, and the United Kingdom to discuss each country's indigenous capability to produce HPCs. We also obtained information from the Japanese government on its export control policies. In addition, we obtained and analyzed from two Commerce Department databases (1) worldwide export licensing application data for fiscal years 1994-97 and (2) export data from computer exporters provided to the Department for all American HPC exports between January 1996 and October 1997. We also reviewed a 1995 Commerce Department study on the worldwide computer market to identify foreign competition in the HPC market prior to the export control revision.[1] To identify similarities and differences between U.S. and foreign government HPC export controls, we discussed with officials of the U.S. embassies and host governments information on foreign government export controls for HPCs and the extent of cooperation between U.S. and host government authorities on investigations of export control violations and any HPC diversions of HPCs to sensitive end users. We also reviewed foreign government regulations, where available, and both foreign government and independent reports on each country's export control system.

[1]Part III, Global Supercomputer Industry and Market Assessment, June 2, 1995, Department of Commerce, Bureau of Export Administration, Office of Strategic Industries and Economic Security, Economic Analysis Division

Appendix II

Current Export Licensing Requirements for High Performance Computers

Table II.1 and the description that follows summarize the terms of the revised export controls for HPCs and according to their MTOPS levels and destinations.

Table II.1: Current Export Licensing Requirements for High Performance Computers[a]

MTOPS	Tier 1	Tier 2	Tier 3	Tier 4
20,000 and up	No license required under license exception[b]	License and additional safeguards may be required	License required	License required Presumption of denial Various terrorist and boycott restrictions apply
10,000 to 20,000		License required		
up to 10, 000		No license required under license exception		
2,000 to 7,000			License required for military or proliferation end users or end use No license required for civilian end user under license exception Ten-day review period for government review	
Up to 2,000			No license required under license exception	License required to Sudan & Syria at or over 6 MTOPS and for any MTOPS to rest of tier

[a] For each tier, exporters must maintain and provide records to the Commerce Department and reexport and retransfer restrictions apply.

[b] A license exception for HPCs is a regulatory authorization that allows exporters to export or reexport, based on MTOPS levels and destination, computers that otherwise would require a license.

The Revised Controls

The revised controls announced by the President divide into four country groups, as follows:

- Tier 1 (28 countries: Western Europe, Japan, Canada, Mexico, Australia, New Zealand). No prior government review (license exception) for all computers, but companies must keep records on higher performance shipments that will be provided to the U.S. government, as directed.

- Tier 2 (106 countries: Latin America, South Korea, Association of Southeast Asian Nations or ASEAN, Hungary, Poland, Czech Republic, Slovak Republic, Slovenia, South Africa). No prior government review (license exception) up to 10,000 MTOPS with record-keeping and reporting, as directed; individual license (requiring prior government review) above 10,000 MTOPS. Above 20,000 MTOPS, the government may require certain safeguards at the end-user location.
- Tier 3 (50 countries: India, Pakistan, all Middle East/Maghreb, the former Soviet Union, China, Vietnam, rest of Eastern Europe). No prior government review (license exception) up to 2,000 MTOPS. Individual license for military and proliferation-related end uses and end users and license exception for civil end users between 2,000 MTOPS and 7,000 MTOPS, with exporter record-keeping and reporting, as directed. Individual license for all end users above 7,000 MTOPS. Above 10,000 MTOPS, additional safeguards may be required at the end-user location.
- Tier 4 (7 countries: Iraq, Iran, Libya, North Korea, Cuba, Sudan, and Syria). Current policies continue to apply (i.e., virtual embargo on computer exports).

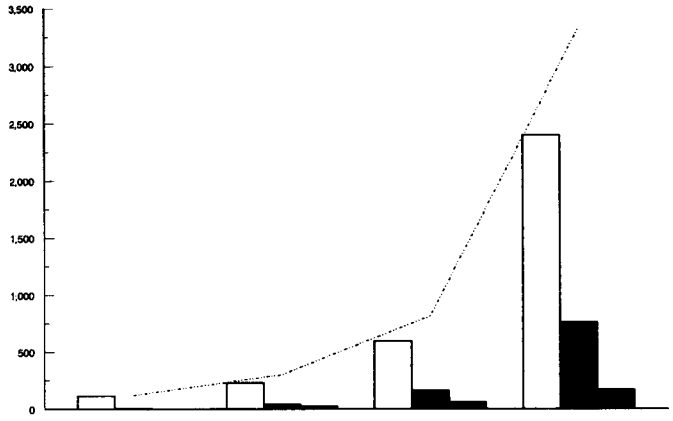
For all these groups, reexport and retransfer provisions continue to apply. The government continues to implement the Enhanced Proliferation Control Initiative, which provides authority for the government to block exports of computers of any level in cases involving exports to end uses or end users of proliferation concern or risks of diversion to proliferation activities. Criminal as well as civil penalties apply to violators of the Initiative.

Appendix III

U.S. High Performance Computer Exports Since the 1996 Export Control Revision

HPC exports have increased significantly since the 1996 export control revision. Figure III.1 shows the numbers of U.S. HPCs exported to all tiers from fiscal year 1994 through fiscal year 1997. In fiscal year 1996, U.S. computer vendors exported almost twice as many HPCs as they had in fiscal years 1994 and 1995 together. In fiscal year 1997, U.S. exports of HPCs more than quadrupled the fiscal year 1996 level. Figure III.1 also shows that growth in export volume was strong for tier 1 countries. Although tier 2 growth remained ahead of tier 1 for the whole period, the greatest volume of U.S. exports has been with the tier 1 countries. Table III.1 shows the largest importers of U.S. HPCs. U.S. allies and friends remained the largest market for U.S. HPC exports, but tier 2 countries were the fastest growing market. Figure III.2 summarizes the share of U.S. HPC exports that each tier took in this period. Figure III.3 shows the top five customers for U.S. HPCs and the portion of the exports they received. Finally figure III.4 shows that most HPCs exported in the past 2 years were rated between 2,000 and 3,000 MTOPS.

Figure III.1: Numbers of U.S. High Performance Computers Exported to All Tiers, Fiscal Years 1994 Through 1997



	FY94	FY95	FY96	FY97
Tier 1	115	231	594	2,398
Tier 2	7	45	161	761
Tier 3	1	25	60	171
Annual Total	123	301	815	3,330

Note: This shows the number of items licensed for export rated at above 1,500 MTOPS for fiscal years 1994 and 1995, as well as the number of items at or above 2,000 MTOPS for fiscal years 1996 and 1997 reported as exported. The regulations changed in January 1996, so that first quarter fiscal year 1996 data includes HPCs at above 1,500 MTOPS and the second quarter includes 18 machines rated at between 1,500 and 2,000 MTOPS licensed for export in January 1996.

Since the January 1996 revision, 68 countries worldwide, out of 193 in the tier system, purchased 3,967 U.S. HPCs,[2] as of September 1997. These machines represent a total HPC computing power, as calculated in MTOPS, of over 15 million MTOPS. Twenty-six countries lead the world as the dominant customers for U.S. HPCs. These countries purchased 91 percent of all HPCs sold worldwide. Together they purchased over 14 million MTOPS, representing 93 percent of the HPC computing power exported from the U.S. in the period. Table III.1 ranks the countries by the quantities of MTOPS they purchased. It also shows the number of HPCs they purchased. The countries that purchased the most machines also purchased relatively more powerful machines as rated by MTOPS. (See table III.1.)

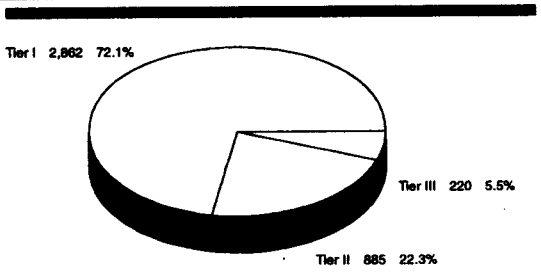
[2]Depending on a personal computer's configuration, a PC with an Intel Pentium II 350 megahertz chip is rated at 408.33 MTOPS. Each of the 3,967 HPC machines is rated at least 2,000 MTOPS. The 3,967 HPCs shipped from the United States are equivalent to about 37,000 Pentium II computers in terms of MTOPs.

Table III.1: Largest Importers of U.S. HPCs, Fiscal Years 1996 - 1997, Ranked by Total MTOPS Exported

Country	FY96 Machines	FY97 Machines	Total Machines for FY96-97	Total MTOPS Exported to Country FY96-97	Tier
Germany	111	488	599	2,600,949	1
United Kingdom	87	489	576	2,359,761	1
Japan	74	233	307	1,667,745	1
South Korea	62	269	331	1,128,945	2
France	29	229	258	1,070,385	1
Italy	16	142	158	601,979	1
Switzerland	23	147	170	500,327	1
Spain	10	123	133	484,862	1
Sweden	20	77	97	441,541	1
Australia	32	88	120	398,198	1
Netherlands	10	95	105	321,352	1
Belgium	12	88	100	288,194	1
Hong Kong	9	73	82	259,072	2
China	23	54	77	239,037	3
Brazil	2	68	70	214,350	2
Israel	7	41	48	200,177	3
Mexico	12	45	57	199,133	1
Malaysia	23	53	76	194,805	2
Singapore	5	60	65	189,729	2
South Africa	8	28	36	132,675	2
Thailand	2	35	37	110,536	2
Austria	6	25	31	108,449	1
Norway	1	15	16	107,388	1
Indonesia	0	27	27	91,561	2
Russia	7	21	28	84,961	3
Finland	1	23	24	81,571	1
Total	**588**	**3,040**	**3,628**	**14,077,682**	

As table III.1 shows, tier 1 countries, mainly U.S. friends and allies, were by far the largest market for U.S. HPCs. Figure III.2 summarizes the share of U.S. HPC exports that each tier received in the past 2 years.

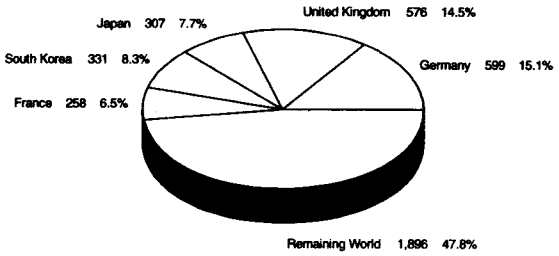
Figure III.2: Quantity and Percent of U.S. HPC Exports to Each Tier, January 1996 -September 1997



Source: Department of Commerce and GAO Analysis.

Since the export controls were revised, HPCs have been sold to more countries, but 26 countries account for 91 percent of all U.S. HPCs sold worldwide. Not only have the Tier 1 countries dominated as U.S. HPC customers, five U.S. allies were the largest customers for U.S. HPCs: Germany, the United Kingdom, Japan, South Korea, and France. As figure III.3 shows, these five countries together received over 52 percent of the machines exported. These countries also bought the most powerful machines, purchasing 58.36 percent of the MTOPS exported in HPCs.

Figure III.3: Quantity and Percent of Total Machines Purchased by Five Largest Customers for U.S. HPCs, From January 1996 - September 1997



Source: U.S. Department of Commerce and GAO Analysis.

The large majority of U.S. HPCs exported since the revision and the largest number of most powerful computers were sent to tier 1 and 2 countries. For example, 50, 5, and 1 HPCs with computing power greater than 13,000 MTOPS went to tiers 1, 2, and 3, respectively. Of the 50 countries in tier 3, five—China, Israel, Russia, India, and Saudi Arabia—account for about 84 percent of the computers exported to tier 3. Table III.2 shows the numbers of computers each country has received.

Table III.2: Numbers of Machines Exported to Top Five Tier 3 Recipients, January 1996-September 1997[a]

Country	1996	1997	Total	Percent of total
China	23	54	77	35.0
Israel	7	41	48	21.8
Russia	7	21	28	12.7
India	6	13	19	8.6
Saudi Arabia	2	11	13	5.9
Other Tier 3	4	31	35	15.9
Total	**49**	**171**	**220**	**100**

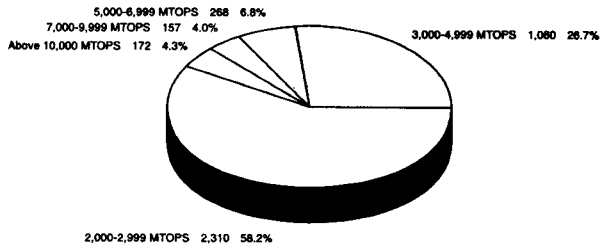
[a]HPCs to China and India were exported with no individual licenses. Russia and Saudi Arabia received 1 licensed HPC each, while Israel received 18 licensed machines.

China, which ranks first in the number of HPCs received by a tier 3 country, would have received even higher numbers of HPCs if its HPC totals were combined with those of its Hong Kong Special Administrative Region. Hong Kong and China rank 13th and 14th, respectively, on the HPC purchasers' list. (See table III.1) If Hong Kong and China were treated as one for purposes of U.S. export controls and statistics[3], the combined region would have purchased more machines than Italy, which ranked seventh in U.S. machines exported, and almost as many machines as Switzerland, which ranked sixth.

The largest numbers of U.S. HPCs exported were less powerful HPCs. HPCs at the 2,000 to 3,000 MTOPS level made up the bulk of machines exported, about 58 percent of all HPC exports. HPCs at the 2,000 to 7,000 MTOPS level constitute the large majority of U.S. HPC exports, about 92 percent of all U.S. HPC exports, or 3,638 machines exported. The remaining 8 percent of HPC exports, 329 machines, were above 7,000 MTOPS. Figure III.4 shows these relationships. (See fig. III.4.)

[3]In our report Hong Kong's Reversion To China: Effective Monitoring Critical to Assess U.S. Nonproliferation Risks (GAO/NSIAD-97-149, May 1997), we emphasized the need to monitor the continuation of Hong Kong's separate and autonomous export controls. U.S. officials agreed that monitoring Hong Kong's autonomy in the conduct of export controls is necessary, given the potential risks involved and the U.S. policy commitment to ensure that exports of sensitive technology to Hong Kong are protected.

Figure III.4: Quantity and Percentage of U.S. HPC Exports by MTOPS Levels, January 1996-September 1997



Source: U.S. Department of Commerce and GAO analysis.

Appendix IV

Comments From the Department of Commerce

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

THE SECRETARY OF COMMERCE
Washington, D.C. 20230

AUG - 7 1998

Mr. Harold J. Johnson
Associate Director
International Relations and Trade Issues
General Accounting Office
Washington, D.C. 20548

Dear Mr. Johnson:

Thank you for the opportunity to comment on the draft GAO reports on the 1995 decision to revise export controls for high performance computers (HPCs). My general view is that the reports are too limited in their scope and should be expanded to reflect better the rationale that led to the President's decision to change computer export policy from a relic of the Cold War to one more in tune with today's technology and international security environment. The President based his decision on several factors -- rapid technological change, wide availability, limited controllability, and limited national security application -- that played critical roles in the Administration's decision to create an effective export policy for computers at various performance levels. Instead of analyzing this rationale, the reports focus on an outdated, Cold War concept of "foreign availability."

The United States currently dominates the high performance computer market, in part because of the computer export policy adopted by this Administration in 1995. That policy was carefully crafted and was realistic in designating what could be controlled. The 1995 computer review was a model for how export controls should be approached and adjusted in the Post-Cold War security environment. I have provided recommendations to expand the reports and make them more reflective of this discussion. I ask that you include the following comments in your reports and that you consider our recommended changes to the text.

Thank you again for soliciting the Department's views on the draft reports.

Sincerely,

William M. Daley

Enclosures

Comments and Recommended Changes
GAO Draft Report
"More Information Needed for Decision to Revise High Performance Computer Controls"

General Comment

While many factors contributed to the decision to liberalize export controls on computers, four major factors stand out -- technological progress, availability, controllability, and the strategic applications of high performance computers (HPCs). Each of these factors plays a critical role in determining the viability of imposing export controls on computers at various computing levels. The principal flaw in this study, and its conclusions, is its narrow and selective focus on computer applications and foreign availability.

Rapid Technological Change

Four years ago, the United Sates controlled as "supercomputers" machines with a performance of 195 millions of theoretical operations per second (MTOPS). Today, the average personal computer on a desk is more powerful. We could not afford in 1995 to ignore market trends and technology advancements that were affecting the development of computers. Rapid progress in microprocessor architecture was a critical element. Improvements in microprocessor design made HPCs smaller, cheaper, and faster. Computer chips are produced in the millions in plants in the United States and overseas. A 1995 report prepared by the Institute for Defense Analysis for the Defense Department projected correctly, based on reliable historical trends and industry projections, that microprocessor performance would double by 1997. Performance increases were the result of both improved design and improved manufacturing techniques that continue to drive down the prices of computers, making them more affordable and more practical for an ever-increasing variety of uses. By 1995, rapid advances in microprocessors and software meant that the performance levels once associated with giant machines could be obtained by smaller and relatively inexpensive computers marketed around the world by the tens-of-thousands. HPCs are smaller, cheaper, simpler to install and maintain, and more reliable. These attributes, desirable in the marketplace, constrain our ability to control the export of many HPCs.

Availability of HPCs

The GAO report focuses primarily on foreign availability as it relates to the indigenous production capabilities of foreign producers. This is not an adequate measure of the problem. Foreign availability -- the availability of high performance computers built by foreign manufacturers with foreign parts and technology -- was a key determinant of our export policy during the Cold War. A Cold War concept of foreign availability makes little sense today in determining policy for commodities like computers, given the permeability and increased globalization of markets. Assessments of the global market for computers in 1995 indicated that roughly 25 percent of HPCs were sold outside the United States, primarily to Japan and Europe, with a smaller percentage of exports targeted at East European, Asian, and Latin American markets. In 1994 alone, over a half million HPCs, as they were then defined, were sold worldwide. Considering a huge installed base of computers, we realized early in our analysis that requiring a license for thousands of HPCs would not prevent their spread.

Controllability

The feasibility of effectively controlling items is an important consideration in the development of export control policy. To set controls in 1995 at a level that could not realistically be enforced would have been irresponsible and hurt U.S. industry when foreign suppliers make comparable products. This is particularly true for systems below 4,000 MTOPS, where European and Japanese manufacturers produce quality systems that can compete with U.S. companies. The Internet has also complicated computer controllability by facilitating the market in used HPCs and making remote access easy. Many Internet sites offer powerful HPCs for resale. This market is accessible to anyone throughout the world. Many of our European allies do not enforce U.S. reexport controls, as they consider them to be extraterritorial. In light of this, we cannot realistically expect to keep the organizations responsible for weapons development in states of concern, organizations that are technically sophisticated, well-funded and which enjoy strong government support, from clandestinely, or even openly, obtaining HPCs with performance levels up to 7,000 MTOPS.

The nature of the computer market has strong implications for export controls, and the Administration took into account the global availability of HPCs and their components in our assessment of those controls. The old style HPC, with its extensive requirements for support equipment and for maintenance, was easily controllable. This is, however, not the case for modern HPCs. We concluded in 1995 that given the computers that were then available worldwide (taking into account computing power, scalability, size, production levels, availability of basic technologies and the number and form of distribution channels), governments could not effectively control the international diffusion of computing systems at the licensing thresholds then in effect. Those thresholds were far too low. The 1995 decision to raise control thresholds, and the thresholds associated with that decision, were thus based on a realistic assessment of the ability to control the global distribution of computers.

Applications

In 1995, the Administration concluded, based on a variety of research, that computer power is a secondary consideration for many applications of national security concern. Many national security applications can be performed in a satisfactory manner based on uncontrollable, low level technology. In our analysis, countries of national security concern cannot threaten U.S. military superiority by gaining access to HPCs below the levels defined by the Administration's 1995 policy. The military services identified only a few high end applications of concern in developing the new policy. Information provided by the Department of Defense as part of the 1995 policy review confirmed the conclusion that most military research and development applications require fewer than 1,000 MTOPS of computational power. Performance levels around 1,000 MTOPS can be achieved with affordable computer systems widely available today.

Computers are not a choke point for military production. The weapon systems found in the U.S. arsenal today -- the tanks, airplanes, weapons, missiles and ships -- were designed and built with

computers whose performance was below 1,000 MTOPS -- in many cases with only 500 MTOPS. These were supercomputers in the 1980's, but by 1995 one could find single microprocessors that were more powerful, such as the 64-bit Alpha EV5, individually capable of more than 700 MTOPS of processing power.

Having access to high performance computers alone will not provide improved military-industrial capabilities. The amount of computing power needed to design and manufacture modern weapons, once one exceeds a few hundred MTOPS, is not significant. Other factors -- skill in software design, access to sophisticated manufacturing techniques, experience and test data in weapons design -- are much more important than computer performance. The level of computational power used to develop all the bombs in the current U.S. nuclear arsenal, for example, is less than that found today in many workstations. An HPC is only one piece of the puzzle to create a strategic weapon. There are many other pieces (e.g., knowledge, skill, equipment, etc.) that are essential in the manufacturing process.

Specific Comments

See comment 1.
Now on p. 3.

Page 4, line 15. Amend to read: "...(3) keeping records and reporting on exports of computers with performance levels of 2,000 MTOPS. In addition to the standard record keeping requirements, the regulation added record keeping requirements for the date of shipment, the name and address of the end-user and of each intermediate consignee, and the end use of each exported computer."

Rationale: Factual.

See Comment 1.
Now on p. 4.

Page 6, line 1. Amend to read: "Nonetheless, based on the worldwide availability of computing power and in consideration of the technological advancements in this area, the executive branch raised the MTOPS thresholds for HPC export controls and established the four-tier control structure."

Rationale: The U.S. Government had consistently referred to the effects of technological trends as being a predominant factor in the decision to decontrol computers.

See comment 1.
Now on p. 4.

Page 6, line 10. Amend to read: "First, the number of computer export licenses issued declined from 395 in fiscal year...."

Rationale: Information about licensing statistics provided on page 15 indicates that 395 refers to licenses approved and not applications processed.

See comment 1.
Now on p. 4.

Page 6, line 15. Amend to read: "... decision is made on the basis of the end use, the end user, and the computer performance capability."

Rationale: Factual.

See comment 1.
Now on p. 10.

Page 6, line 18. Prior to "This situation...", add new sentences: "To aid exporters in making end user determinations, the Department of Commerce created a specific list of "red flags" and "know your customer" guidance to educate exporters about signs they need to be aware of that can be of concern to the government. This guidance has been taught in seminars for several years and made available on the Bureau of Export Administration web site. Companies were also urged to contact the Commerce Department when in doubt about an end user's activities. The end user could then be researched by the government and the exporter advised to seek a license if any strategic concerns were present."

Rationale: Although some of the screening burden was placed on the exporter, it was done while simultaneously educating the public on screening procedures and signs to be aware of. This was a tremendous effort by the Bureau of Export Administration that should not be overlooked.

See comment 1.
Now on p. 5.

Page 7, footnote 8. Add "of 1979" after "the Export Administration Act" and add the following second sentence to the footnote: "Department of Commerce officials believe that this determination is an outdated Cold War concept that has little applicability in the current world environment.

See comment 2.

Page 7, line 6. Replace the first sentence of the 2nd paragraph with the following: "With regard to foreign availability of HPCs, a number of computer manufacturers exist outside the United States. In addition to subsidiaries of U.S. computer manufacturers, other manufacturers are located in Canada, Japan, Europe, and Asia. In Europe, Germany, France, the United Kingdom and Switzerland, indigenously manufacture computers that compete with those of the United States. In Asia, India is a significant producer and capabilities also exist in Taiwan and Singapore, where export controls resembling those of the United States do not exist.

It is important to note, however, that for proliferators, the issue is not a mass market capability to compete with U.S. producers but rather the capacity to make a small number of HPCs, regardless of the costs, to meet national needs. India is a prime example of this situation. In the late 1980's, India sought a HPC from the United States but was denied an export license. Bent on proving that it could still satisfy computing desires despite our refusals, India invested millions of dollars in the creation of the Param computer. Although the Param is not as sophisticated as U.S. computers, it can provide the processing capability needed for weapons of mass destruction applications. After the introduction of the Param, India publicly stated that it created this capability only after we refused to sell the country an HPC and in order to evade our controls.

Most of the systems indigenously produced in Europe and Asia have computing powers that are less than 5,000 MTOPS to target a portion of the HPC market that is large and affordable. The Japanese have concentrated on manufacturing higher end HPCs that compete directly with those of the United States. Yet, for more powerful HPCs over 5,000 MTOPS, the United States dominates the world market. However, the threat of competition is strong for lower end systems below 5,000 MTOPS, which provides some insight to the types of systems for which the United

States is most vulnerable to lose market share if it is unable to compete in the world market. The evidence supports the conclusion that the United States is not a monopolist in this industry. Others have the capability to produce, and will likely improve on this capability if afforded the opportunity to do so. This supports the findings of the 1995 Stanford University study."

Rationale: Not enough attention is given to the existence of foreign producers that have the ability to produce high level computers indigenously. These systems are typically not captured by U.S. controls. It is also important to realize that the computer market is driven largely by demand. If the United States does not supply computers at satisfactory levels, foreign producers will pick up the slack.

See comment 1.
Now on p. 6.

Page 5, line 19. Delete the first sentence of the 2nd paragraph and replace with the following: "The Stanford study accumulated information from computer companies on U.S. HPC market characteristics and information from the Defense Department regarding national security applications. This data supported the study's conclusion that a CTP threshold of 7,000 MTOPS could be justifiable as a point above which a number of significant strategic applications exist."

Rationale: Factual. The Stanford University study did not say that computers at 7,000 MTOPS were uncontrollable. It reported that computers at 4,000 - 5,000 MTOPS were uncontrollable based on evidence of availability throughout the world.

See comment 3.

Page 11, line 15. At the end of first paragraph, add the following: "This information obtained by DOE laboratories and other U.S. Government officials was never provided to policy makers for consideration. Some parts of DOE, however, are not in agreement regarding the contribution that HPCs make to nuclear programs in countries of concern. This issue is still under dispute within DOE. The Stanford University study indicated that first-generation nuclear weapons can successfully be designed using less than 1,500 MTOPS. Although second- and later-generation nuclear weapon design requires more than 1,500 MTOPS of computing power, evidence has proven that systems at this level and higher are available from foreign countries that do not implement export controls similar to those of the United States."

Rationale: Additional facts regarding this issue need to be revealed to reflect this situation accurately.

See comment 4.

Page 19, line 15. Add a new 2nd paragraph as follows: "Worldwide availability of computers, however, indicates there is a large installed base of systems with availability in the tens of thousands and even millions for smaller systems. This complicates and severely limits the ability of the U.S. Government to control the export of all computers effectively. License requirements will not prevent diversion of HPCs unless realistic controls levels are set that can be enforced effectively."

Rationale: The installed base of computers worldwide also plays an important role in the consideration of the availability of computers outside the United States.

See comment 5.

Page 21, line 4. Following "U.S.-origin goods." insert, "The United Kingdom Government's authorities instruct their exporters to ignore U.S. reexport controls. The European Union believes our reexport controls are extraterritorial and therefore most EU countries will not enforce them. These facts support the findings of the Stanford University study with regard to the difficulty of controlling computers effectively throughout the life of the product."

Rationale: Factual.

See comment 2.

Page 22, line 4. Insert at end of 1st paragraph the following: "Research and information from other U.S. Government sources and U.S. computer manufacturers indicate that Param computing capabilities range from 4,000 MTOPS to 10,000 MTOPS."

Rationale: Additional factual evidence. The Param system has been reported to be more powerful than the GAO report reveals.

The following are GAO's comments on the Department of Commerce letter dated August 7, 1998. Commerce provided one set of written comments for this report. We addressed Commerce's general comments relevant to this report on page 15 and its specific comments below.

GAO Comments

1. We have made the suggested changes, as appropriate.

2. Commerce also commented that a number of foreign manufacturers indigenously produce HPCs that compete with those of the United States. Evidence cited by Commerce concerning particular countries with HPC manufacturing capabilities came from studies that were conducted in 1995 and that did not address or use criteria related to "foreign availability." As stated in our report, we gathered data from multiple government and computer industry sources to find companies in other countries that met the terms of foreign availability. We met with major U.S. HPC companies in the United States, as well as with their overseas subsidiaries in a number of countries we visited in 1998, to discuss foreign HPC manufacturers that the U.S. companies considered as providing foreign availability and competition. We found few. Throughout Europe and Asia, U.S. computer subsidiary officials stated that their competition is primarily other U.S. computer subsidiaries and, to a lesser extent, Japanese companies. Our information does not support Commerce's position on all of these manufacturers. For example, our visit to government and commercial sources in Singapore indicated that the country does not now have the capabilities to produce HPCs. We asked Commerce to provide data to support its assertion on foreign manufacturers, but we received no documentary support. In addition, although requested, Commerce did not provide documentary evidence to confirm its asserted capabilities of India's HPCs and uses.

3. Commerce stated that policy makers did not receive DOE information prior to the revision of the HPC controls in 1995 and, further, there is current disagreement within DOE over the contribution that HPCs make to nuclear programs in countries of concern. We agree that Commerce did not obtain available information on this issue from DOE laboratories, although such information was available and provided to us upon request. In addition, we found no dissent or qualification of views identified in DOE's official study on this matter.

4. Commerce stated that worldwide availability of computers indicates that there is a large installed base of systems in the tens of thousands or

even millions. Commerce further stated that license requirements will not prevent diversion of HPCs unless realistic control levels are set that can be enforced effectively. While we agree, in principle, that increasing numbers of HPCs makes controllability more difficult, a realistic assessment of when an item is "uncontrollable" would require an analysis of (1) actual data, (2) estimated costs of enforcing controls, and (3) pros and cons of alternatives—such as revised regulatory procedures—that might be considered to extend controls. Such an analysis was not done by the executive branch before its 1995 decision. In addition, Commerce provided no documentary evidence for its statement that there is a large installed base of HPCs in the millions.

5. Commerce stated that most European governments do not enforce U.S. export control restrictions on reexport of U.S.-supplied HPCs. We agree that at least those European governments that we visited (Germany and United Kingdom) hold this position. However, although requested, Commerce provided no evidence to support its statement that the government of the United Kingdom has instructed its exporters to ignore U.S. reexport controls.

Appendix V

Comments From the Department of Defense

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

DEFENSE TECHNOLOGY SECURITY ADMINISTRATION
400 ARMY NAVY DRIVE, SUITE 300
ARLINGTON, VA 22202-2884

Mr. Benjamin D. Nelson
Director, International Relations and Trade Issues
National Security and International Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Nelson:

Thank you for the opportunity to comment on the General Accounting Office (GAO) draft reports, "More Information Needed for Decision to Revise High Performance Computer Controls" and "National Security Issues and Foreign Availability for High Performance Computer Exports," dated July 1998 (GAO/NSIAD-98-196 and 200/OSD Case # 1648/1648-A). The Department of Defense has reviewed the reports and has the following comments:

See comment 1.

- The Stanford University study referred to in the GAO report was just one of many inputs considered by the Executive Branch in its 1995 assessment of computer export controls. Information and analysis was also provided by various Defense components as well as other USG agencies, including the Intelligence Community.

See comment 2.

- The GAO draft report inaccurately states that DoD did not consider the threats associated with high performance computer (HPC) exports. DoD did take into account the security risks associated with the export of HPCs to countries of national security and proliferation concern. DoD identified numerous national security applications that require various levels of computing power, which helped to determine licensing policies for the various country groups and to establish specific safeguards on computer exports. Countries of greatest national security and proliferation concern are subject to the most stringent licensing and safeguard requirements.

See comment 3.

- The GAO recommends that the Secretary of Defense assess how and at what performance levels countries of concern use HPCs for military modernization and proliferation activities. These factors were taken into account by DoD and the interagency process in the 1995 review of computer export controls, and will be part of any future review. As pointed out in the Stanford University study, there are a wide

variety of national security applications that can benefit in one form or another from computers with performance levels well below current thresholds for export licensing. For example, the F-117 military aircraft was designed, developed, and produced using computers well below 500 million theoretical operations per second. However, it is equally important to assess the degree of controllability of computers. In the 1995 computer export control review, we determined that computers with performance below the current license threshold for Tier III countries are widely available globally and are easily scalable so that attempts to control them would be ineffective. In short, the President decided in 1995 on a system of graduated controls that reflects both the controllability of computers at various thresholds and the national security/proliferation risks for each destination.

- The GAO recommends that the USG consider certain additional options to safeguard exports of high performance computers. The Administration will be conducting a review of computer controls and these suggestions will be considered in the course of that review.

If you have any questions, please contact Dr. Oksana Nesterczuk or Mr. Richard Soskin of my staff at (703) 604-8038.

Sincerely,

Dave Tarbell
Director

The following are GAO's comments on the Department of Defense letter dated July 16, 1998. DOD provided one set of written comments for this report. We addressed DOD's general comments relevant to this report on page 17. We address DOD's specific comments below.

GAO Comments

1. DOD stated that the Stanford study was only one of many inputs considered by the executive branch in its 1995 assessment of computer export controls. We agree, and our report states, that there were other inputs to the decision. However, officials at Commerce, DOD, State, DOE, and ACDA referred us to the Stanford study in explaining the basis for the executive branch decision to revise the controls. Moreover, in announcing the 1996 HPC export control changes, the executive branch highlighted two conclusions of its review: (1) U.S.-manufactured computer technology up to 7,000 MTOPS would become widely available worldwide by 1997 and (2) many HPC applications used in U.S. national security programs occur at or above 10,000 MTOPS. Both conclusions were based on information provided only in the Stanford study. Also, DOD provided briefing slides on the HPC export control revision to the House Committee on National Security dated October 17, 1995, using information drawn almost exclusively from the Stanford study. Finally, a March 1998 Commerce Department report on foreign policy export controls noted only one source—a new Stanford study—as part of a 1998 review of HPC export controls.

2. DOD stated that it identified numerous national security applications used by the United States that require various levels of computing power, which helped to establish the revised licensing policies. We agree, and our report discusses the fact that DOD identified how the U.S. government uses HPCs for national security applications. However, this misses the point because these applications did not refer to particular countries of concern. As we noted in our report, the principal author of the Stanford study and DOD officials said that they had not performed a threat assessment or analysis of other countries' use of HPCs for military and other national security purposes. The current DOD analysis of how countries of concern can use HPCs is being done at the request of the House National Security Committee and might provide the information needed to perform our recommended assessment.

3. We disagree that the executive branch fulfilled the intent of our recommendations. Specifically, it did not have information on how and at what performance levels countries of concern, such as China, India, and

Pakistan, use HPCs for military modernization and nonnuclear proliferation activities. Regarding the degree of controllability of computers, neither the Stanford study nor any of the other inputs used in the 1995 computer export control review provided any empirical evidence or analysis to support assertions that HPCs with certain performance levels are widely available and uncontrollable. In fact, the 1998 Stanford study recommends procedural export licensing changes that would make such HPCs controllable again.

Appendix VI

Major Contributors to This Report

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PRINTED ON RECYCLED PAPER

GAO RESPONSE TO THE COMMENTS OF THE STANFORD STUDY AUTHORS TO GAO REPORT TITLED EXPORT CONTROLS: INFORMATION ON THE DECISION TO REVISE HIGH PERFORMANCE COMPUTER CONTROLS (GAO/NSIAD-98-196)

The authors of the 1995 Stanford study state that GAO's criticism of their study and of the administration's decision to relax controls in 1996 was flawed, first, because the GAO criticism was based on unrealistic presumptions regarding market controllability and, second, because GAO presumed that a comprehensive, detailed analysis of how foreign organizations of national security concern may use HPC technologies is a strong prerequisite for relaxing export control thresholds. With regard to market controllability, the authors of the Stanford study hypothesized that the controllability of HPC technologies today are more strongly determined by the quantities and qualities of systems of U.S. origin than by systems of foreign origin. They said that at a certain point (between 4,000 to 5,000 MTOPS) the volume of computer sales, including sales from the secondary market and scalable computers (those that can be easily upgraded by a user) make the costs of controlling their export too high. The authors of the study also stated that the implicit mirror-image analysis they conducted across a broad spectrum of U.S. practices to estimate a foreign country's ability to use HPCs is a viable alternative to comprehensive, in-depth analysis of foreign uses of HPCs.

GAO COMMENTS

With regard to the Stanford study's hypothesis concerning market controllability, the authors' assertions about GAO's criticisms do not accurately reflect what GAO reported or concluded. While we agree, in principle, that the study's hypothesis may have merit, an assessment of whether an item is actually "uncontrollable" would require an analysis of (1) actual data, (2) estimated costs of enforcing controls, and (3) pros and cons of alternatives--such as revised regulatory procedures--that might be considered to extend controls. It was the lack of actual data or analysis showing that resources available to the government and computer industry would be inadequate to track or control HPC sales that presented a problem. In this regard, the study's authors told us that they did not attempt to analyze the costs of controlling HPC technology at or below performance levels of 4,000 to 5,000 MTOPS. Moreover, the authors provided no data or analysis concerning the actual size of the HPC market, the amount of alleged market "leakage," or

the volume of the HPC secondary market. Also, it should be noted that, with regard to scalability, a follow-on 1998 Stanford study acknowledged and recommended a possible alternative for applying export controls to address this technological development.

Regarding U.S. national security, GAO's report did indicate that the executive branch should have conducted an analysis of how foreign countries of concern may use HPC technologies for military or proliferation purposes prior to relaxing export control thresholds. Since the executive branch's stated goals for HPC export control revision included tailoring control levels to security and proliferation risks of specific destinations, it became vital to determine how and at what performance levels specific countries would use HPCs for military and other national security applications and how such uses could threaten U.S. national security interests. Because of data and time limitations, the authors were unable to perform this analysis. Instead, they looked at how the U.S. military uses HPCs--referred to as mirror-image analysis. Although they state that a mirror-image analysis is a viable alternative to comprehensive, in-depth analysis of foreign uses of HPCs, the authors recommended significantly enhancing the analysis of HPC applications to countries of national security concern, including providing a more focused evaluation of the capabilities of target countries. Mirror-image analysis may provide some useful general information, but in this case, there is a need for more specific data to meet the goals set by the administration. DOD has since completed an analysis of how countries of concern could use HPCs for military and proliferation purposes, but this analysis was not completed until November 1998, nearly three years after the decision to relax HPC export controls.

Response to *Information on the Decision to Revise High Performance Computer Controls*, GAO/NSIAD-98-196

By

Seymour Goodman
Peter Wolcott
Patrick Homer
Grey Burkhart

November 6, 1998

Introduction

On September 16, 1998, the U.S. General Accounting Office released a report, GAO/NSIAD-98-196, entitled *Information on the Decision to Revise High Performance Computer Controls* [1]. This report was the culmination of an approximately year-long investigation to (1) assess the basis for the executive branch's revision of high performance computing (HPC) export controls, (2) identify changes in licensing activities and the implementation of certain U.S. licensing and export enforcement requirements since the revision, and (3) determine the current foreign availability of HPCs, particularly for certain countries of national security concern. A prominent part of their report was a critique of a 1995 Stanford study: *Building on the Basics: An Examination of High-Performance Computing Export Control Policy in the 1990s* [2].

This document is a reply to the GAO report. It provides a rebuttal to the two main criticisms leveled at the 1995 Stanford study. It further suggests that the GAO report was preordained to conclude that no significant relaxation of export controls should have been made because they started with unrealistic premises regarding the role of foreign availability and the grounds on which foreign use of HPC can effectively be assessed.

The GAO's criticism of a 1995 Stanford study and the Administration's decision to relax export controls in 1996 is flawed. It is based on highly unrealistic presumptions that disregard the reality of high-performance computing technologies, markets, and applications in the 1990s:

- That the 1979 concept of "foreign availability" adequately reflects the controllability of HPC technologies in the late 1990s.
- That comprehensive, detailed analysis of how foreign organizations of national security concern may use HPC technologies is a strong prerequisite for any form of relaxation of export control thresholds.

Response to Criticism of the 1995 Stanford Study

The GAO report made two primary criticisms of the 1995 Stanford study. The following two sections address each of these criticisms.

LACK OF ASSESSMENT OF FOREIGN CAPABILITY TO USE HPC FOR NATIONAL SECURITY PURPOSES

Response to critique

The GAO report makes the following claims regarding the Stanford study's assessment of the application of HPC for national security purposes [3]:

> Although the Stanford study was tasked with assessing the capabilities of countries of concern to use HPCs for military and other national security applications, it did not do so. The study discussed only U.S. applications of HPCs for military purposes.

There are two implications in this statement. First, that we ignored foreign countries' capabilities. Second, that mirror-image analysis – which tries to estimate a foreign country's ability to use HPC systems based on a study of the kinds of problems U.S. practitioners are solving, and what computing support is deemed necessary – is fundamentally flawed for the purposes of formulating export control policy. Both implications are incorrect.

> The GAO report claims that the 1995 Stanford study failed to consider the ability of countries of national security concern to use HPC systems for national security applications. This is untrue.

While it is true that the 1995 Stanford study did not identify in detail the current capability of each country of the world to apply HPC to each category of national security of application, it did not ignore the issue. The country/application matrix (Table 16, [4]) is an unclassified, significantly condensed version of a classified assessment produced by the Defense Technology Security Administration. It does indicate some of the countries that could use HPC productively in a number of advanced conventional weapons and operational applications. The eventual division of countries into four tiers reflects a number of criteria that include, but are not limited to, foreign countries' abilities to apply the HPC technologies effectively to problems of national security concern.

The more fundamental problem is that detailed analysis of many HPC applications that may be pursued in highly sensitive installations in countries of national security concern to the U.S. is extraordinarily difficult and expensive to do. It is rare that it can be done even in a few isolated cases, and even when conducted is usually significantly based on at least some substantial, implicit mirror image analysis. During the long history of export controls very little such analysis has been done. The entire U.S. intelligence community has been unable to pursue such analysis in a comprehensive fashion. Insisting that a great deal of such analysis be done as a prerequisite for any relaxation of controls in the face of such great technological change is unrealistic and unfair to U.S. industry. The 1995 Stanford study did what was possible given the constraints of a three-month study period, the information available from the U.S. government, and the security restrictions placed on that information

What we did do was conduct an implicit mirror image analysis across a broad spectrum of applications. This analysis was substantially elaborated in the 1998 Stanford study [5], which supported the essential conclusions of the 1995 study. Together, the two reports constitute by far the most extensive unclassified survey of possible HPC applications of national security concern yet done for export control purposes.

Few would argue that such mirror image analysis gives a precise picture of how foreign countries may use the HPC technologies they acquire. However, *the real question is whether mirror imaging is sufficiently accurate that it can be usefully employed by policy-makers who must make decisions even when time and resources are limited.*

> Mirror-image analysis tries to estimate a foreign country's ability to use HPC systems based on a study of the kinds of problems U.S. practitioners are solving, and what computing support is deemed necessary. While imperfect, such analysis is a viable alternative to comprehensive, in-depth analysis of foreign uses of HPC. It does allow policy-makers with finite time and resources to make decisions with some confidence that the conclusions are not ill founded.
>
> The GAO report fails to demonstrate that mirror-image analysis is sufficiently inaccurate that the 1995 Stanford study's conclusions should be called into question.

An asymmetry between U.S. and foreign pursuits is significant only if a) a foreign country pursues applications not pursued by the U.S., or b) if foreign entities are able to use lower levels of HPC technology far more effectively than their U.S. counterparts. Given the great depth and breadth of experience and support of the U.S. national security HPC community, the first point is unlikely. There appear to be very few specific and substantial examples of the second point for computing during the long history of HPC export controls. Some of the few examples that were of concern at certain times – Soviet parallel computing systems during the 1960s and Soviet residue arithmetic machines during the late 1970s – were essentially failures.

The GAO report fails to demonstrate that the mirror-image approach is sufficiently inaccurate that the fundamental findings of the 1995 Stanford study should be called into question. The GAO report's one reference to a detailed study of foreign capabilities in a narrow application domain, the 1998 DOE study on the benefit of HPC to tier 3 countries' nuclear programs, hardly invalidates mirror-image analysis. For example, the GAO report states that [6],

> [a]ccording to the DOE study, the impact of HPC acquisition depends on the complexity of the weapon being developed and, even more importantly, on the availability of high-quality, relevant test data. The study concluded that 'the acquisition and application of HPCs to nuclear weapons development would have the greatest potential impact on the Chinese nuclear program – particularly in the event of a ban on all nuclear weapons testing.' Also, the

> study indicated that India and Pakistan may now be able to make better use of HPCs in the 1,000 to 4,000 Mtops range for their nuclear weapons program because of the testing data they acquired in May 1998 from underground detonations of nuclear devices.

Compare these conclusions with the conclusions of the 1995 Stanford study [7]:

> Control of HPC exports to countries known to possess nuclear weapons, by limiting those exports or imposing appropriate safeguards, will impede their development of improved weapons and reduce their confidence in their existing stockpile by limiting the opportunity to conduct simulations in lieu of live tests. Similar or more rigorous controls on HPC exports to countries with nuclear weapons development programs could impede their development of second-generation weapons... Live testing has been critical to the U.S. nuclear weapons program, and vast amounts of data have been collected. In fact, the availability of data from full- and limited-scale nuclear tests is more crucial than the availability of HPC. Computer models were partially based on test data, and as more data from nuclear detonation tests was acquired they were refined and expanded... The advancement of a nuclear weapons program beyond basic weapons design requires both computational horsepower and empirical test data... Second-and later-generation nuclear weapons design requires using computers of at least 1,500 Mtops and conducting tests to provide data for empirical model development. [W]ithout nuclear test data and the resulting empirical models, computers at [4-5,000 Mtops]–indeed, at any currently available level of performance–are likely to be insufficient to design such weapons.

The DOE study is consistent with the 1995 Stanford study. Moreover, the DOE study itself contains substantial mirror image analysis. This is not to say that studies like that done by the DOE should not be carried out, when feasible. We recommended that they be done because of their potential contribution to our understanding of the actual state of practice of HPC applications throughout the world. Furthermore, when such information becomes available, the analytic framework developed in the Stanford studies can easily accommodate it. But in the absence of such studies, the mirror image analysis becomes the only viable general alternative and does allow policy-makers to move forward with some confidence that the conclusions are not ill founded.

The GAO report quotes a Department of Energy study on the benefit of HPC systems to tier 3 countries' nuclear programs to refute the analysis of the 1995 Stanford study. However, the DOE study is consistent with the 1995 Stanford study.

Role of HPC applications in establishing control thresholds

The ultimate objective of HPC export control policy is to limit selected foreign organizations' ability to pursue certain applications of national security concern by restricting their access to the necessary computing hardware. However, a discussion of national security applications cannot be divorced from a discussion of the levels and types of computing power needed, and the controllability of that technology. This framework, developed in the 1995 Stanford study and elaborated in the 1998 study, posits and tests three basic premises:

1. There are problems of great national security importance that require HPC for their solution, and these problems cannot be solved, or can only be solved in severely degraded forms, without such computing assets.
2. There are countries of national security concern who have both the scientific and military wherewithal to pursue these or similar applications.
3. There are features of the necessary computers that permit effective forms of control.

The framework helps establish a range of threshold choices for which the basic premises hold, and at what levels, at any point in time. It can accommodate all data that is relevant to the discussion, e.g. technical details about computing systems, market data, computational requirements of national security applications, uses of HPC in foreign countries, and foreign HPC vendors.

> Much of the current public debate centers around applications that require relatively low levels of computing by today's standards, levels that can be obtained more easily and without much delay with each passing year by foreign entities of national security concern. The debate should focus on those applications in which HPC export controls can make a real difference.

Arguably, all three premises held during most of the Cold War. With changes in threats to U.S. national security interests and in HPC technologies, markets, and applications, the premises no longer hold at Cold War control thresholds. However, much of the current public debate centers around applications that require relatively low levels of computing by today's standards, levels which can be obtained more easily and without much delay with each passing year by foreign entities of national security concern. In particular, much of the debate that has raged around HPC export control policy has centered on the proliferation of nuclear, chemical, and biological weapons of mass destruction (WMD). While there is obviously good reason to be concerned about such applications, there continues to be a misperception that HPC is a major enabler of these threats. This yields an exaggerated view both of the importance of computing for WMD proliferation, and of our ability to deny widely available levels to undesirable end users. For example, the designs of the nuclear weapons in the current U.S. and Russian stockpiles are based on extensive nuclear test data. The designers used the test data in conjunction with computers no more powerful than a

single-processor Cray X-MP or Y-MP,[1] each of which has an Mtops rating less than today's Apple iMac consumer desktop machine. Among scientists at the Department of Energy and its weapons labs, there is widespread agreement that when test data are available, computing above this level is no longer on the critical path in designing nuclear weapons. When test data are not available to validate the applications, the use of even controllable HPC is of limited benefit.[2] In countering the proliferation of WMD, our energies should be focused on other, more effective measures than trying to control the export of readily available hardware platforms.

> Nuclear weapons in the current U.S. stockpile were designed with computers no more powerful than a single-processor Cray X-MP or Y-MP, each of which has composite theoretical performance (CTP) less than today's Apple iMac consumer desktop system.
>
> When test data are available, high levels of computing power by today's standards are not needed for nuclear weapons design. When test data are not available to validate applications, even a great deal of computing power is of limited benefit.

If not nuclear weapons design, what applications can serve to justify the policy? Although important and computationally demanding applications exist, it has been difficult to find constituencies willing to fight for them in the export control debate. We spent a great deal of effort during both the 1995 and 1998 studies to find HPC practitioners in the U.S. national security community who could provide a detailed assessment of the following question. With regard to their applications, *how would HPC export controls seriously handicap foreign organizations in pursuing the application, given technological progress in the areas of microprocessors, scalability and clustering?* The assessments had to go beyond descriptions of how computers are generally useful and describe what significant result can be achieved with, say, a 6,000 Mtops computer that cannot be achieved with a half-dozen easily clustered 1,500 Mtops systems. We were surprised at how difficult it was to find individuals within the Departments of Defense or Energy who believed in and were willing and able to argue in detail for a continuation of export controls at workstation or modest multiprocessor levels to protect applications within their spheres of activity.

One of the contributions of the Stanford studies, unacknowledged by the GAO report, was to bring into the discussion applications of national security importance that *can* serve to justify

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[1] While the national laboratories did use systems like an eight-processor Cray Y-MP/8 with CTP approaching 4,000 Mtops, individual weapons design codes ran on only one 500 Mtops processor at a time.

[2] DoE's Advanced Scientific Computing Initiative (ASCI) is applying computer simulation to the problems of stockpile management, not weapons design. A non-testing environment requires large-scale simulations that are necessary in the absence of new test data.

the policy. These applications, demanding levels or forms of computing power that can only be provided by systems that are controllable, fall into two broad categories: research and development (R&D) applications and operational applications. R&D examples include large-scale forces modeling, effects of weapons on structures, radar cross-section calculations, and shallow water submarine maneuvers. While many R&D activities can use less powerful systems running for longer periods of time to obtain a desired result, there is a substantial time advantage to using the more powerful systems. This time advantage contributes substantially to the technological lead the U.S. and its allies enjoy. Restricting the export of such high-end HPC systems can thus delay entities of national security concern in their pursuit of these same applications, enabling the U.S. to maintain its lead.

> There do exist applications of national security concern that require levels and forms of computing power that cannot be provided by readily available technologies. The 1996 export control revisions were strongly influenced by the requirements of such applications.

Unlike the situation with R&D examples, operational applications have time constraints that must be met. Important examples of operational applications are on-board signal processing and military-grade weather forecasting. Weather forecasters, for example, must have a result within a very strict time window, e.g. an hour for the computation of a single global forecast. The difference between a single 6,000 Mtops computer and a loosely coupled cluster of 1,500 Mtops computers is much greater for such applications than for any other research and development or operational application that we or anyone else has been able to identify. The 1996 policy was strongly influenced by the computational requirements of such applications.

LACK OF EMPIRICAL EVIDENCE OR ANALYSIS SUPPORTING ASSESSMENT OF CONTROLLABILITY

The second chief criticism by the GAO of the 1995 Stanford study is that "[T]he study lacked evidence or analysis to support its conclusion that HPCs were uncontrollable based on (1) world-wide availability and (2) insufficient resources to control them." [8]

The GAO report's conclusion is based on a very strict interpretation of "foreign availability" as defined by the Export Administration Act (EAA) of 1979, as amended.[3] The GAO report correctly noted that only about half a dozen companies outside the United States, located in Japan and Western Europe, compete with U.S. HPC vendors in general computer technology markets and that these non-U.S. vendors have almost no sales to tier 3 countries. The GAO report also correctly notes that tier 3 countries have limited ability to produce HPC systems that are comparable in quantity, quality, and power to those produced by major HPC-supplier

[3] The EAA describes foreign availability as goods or technology available without restriction to controlled destinations from sources outside the United States in sufficient quantities and comparable quality to those produced in the United States so as to render the controls ineffective in achieving their purposes.

countries. The 1995 Stanford study explicitly covered this point in some detail for Russia, China, and India.

The GAO ignored the point that technologies associated with HPC have changed dramatically since 1979. If a lack of foreign availability under the old EAA definition is sufficient to establish a technology's controllability, then it should be true that any technology available only from U.S. vendors (or their licensees) is controllable. Consider, however, microprocessors and the single-processor desktop and desk-side systems based on them. The international market for advanced general-purpose microprocessors is completely dominated by U.S. companies such as Intel, Cyrix, AMD, Compaq/DEC, IBM, Motorola, Hewlett-Packard, MIPS, Sun Microsystems, Texas Instruments and their foreign licensees (e.g. Samsung, NEC, Toshiba, Fujitsu). Hundreds of thousands of microprocessors with individual performance above 500 Mtops are manufactured each year, as are tens of millions of processors with performance between 300-500 Mtops. As one small example, in a six-week period from mid-August to the end of September 1998, Apple Computer sold 278,000 iMacs (233 MHz G3 processor, 524 Mtops) [9].

> Advanced microprocessors lack foreign availability, yet are completely uncontrollable. They prove that the 1970s concept of "foreign availability" is inadequate for determining controllability in the 1990s.

Throughout the tier 3 countries, there is a modest number, 200-300 at most, of organizations such as foreign military research and development installations that have the motivation, technical ability, and funding to use HPC technologies to the serious detriment of U.S. national security interests. Do opponents of the current export control regime believe that advanced microprocessors are controllable, and that control efforts by the U.S. government could prevent these few installations from obtaining small numbers of them? If so, such beliefs are exceedingly unrealistic. Do they intend to license all of the hundreds of thousands of machines using these microprocessors and track them throughout their useful life, and provide funding for this licensing and tracking effort? If not, they must agree that factors other than the 1979 definition of foreign availability must be taken into account to establish effective international controllability. These factors include the installed base, size, cost, age, distribution channels, and dependence on vendor support. An additional factor, scalability, is significant for reasons discussed below.

Foreign availability, when it exists, is certainly a strong form of worldwide availability. But as the discussion above indicates, it is not the only factor influencing controllability, and may not even be the dominant factor. We determined that the foreign availability of HPC technologies from countries such as Russia, China, and India was not an important factor outside their own countries, even if their likely exaggerated claims of computing capabilities were true. But even when indigenous HPC vendors may not be "competitive" on the world HPC market, they can be effective in helping a tier 3 or 4 country achieve competence in an area of national security concern to the United States. An example of this is the role of indigenous computing in the Indian nuclear program. Unlike the GAO, we also determined

that the actual nature of worldwide availability of HPC is much more strongly shaped by the qualities of HPC systems of U.S. origin and their markets.

> The controllability of HPC technologies today is more strongly determined by the quantities and qualities of systems of U.S. origin and their markets than by systems of foreign origin. Some U.S. HPC systems may be quite difficult to control even though no comparable foreign systems exist.

While it is clear that systems at 500 Mtops are uncontrollable, the question remains whether there are more powerful systems that are also uncontrollable? The values of the parameters affecting controllability can be, and were, empirically established. The size, cost, age and performance of systems are easily determined from vendor literature. We obtained data on the size of vendors' installed bases. While exact figures for units installed were not available, the data we obtained were sufficiently accurate to draw our conclusions. Some of this information was vendor proprietary and did not appear explicitly in the 1995 Stanford study; however, the data was a factor in the conclusions. The 1998 Stanford study, completed in May, updated, extended, and validated the work started in the 1995 study.

To get a sense of the controllability of more powerful systems, it is instructive to compare an important class of 1990s HPC systems with their 1980s counterpart: today's single-rack and desk-side multiprocessors with VAX minicomputers from Digital Equipment Corporation. Between the late 1970s and early 1990s, thousands of units of the VAX 11/780 and its successors were installed. VAXes were more controllable than the single-rack multiprocessors of 1995-96 and substantially more controllable than desk-side multiprocessors. They were physically larger and less scalable, were manufactured by a single U.S. company, used software unavailable from other vendors, had smaller foreign markets than today's systems, and were more difficult to install and maintain. The U. S. singled out VAXes for control at a time when COCOM offered a much stronger multilateral regime for controlling computing exports than exists today. Yet, Soviet and East German facilities with national security priority were able to get one or more VAXes and run them without too much difficulty. It is likely that hundreds were obtained illegally, a few well-publicized intercepts notwithstanding.[4] Even Syria, not a computing powerhouse by any measure, was able to acquire illegally and productively use VAX computers. By 1995-96, U.S. vendors had installed thousands of single-rack multiprocessors and tens of thousands of desk-side multiprocessors. The precise point at which technologies become "uncontrollable" is a subject for legitimate discussion. However, it is clear that controls trying to regulate the export of today's single-rack and desk-side multiprocessors would be less effective than

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[4] During the final years of the USSR and GDR, some of the authors of the 1995 Stanford study observed first-hand illegally acquired VAXes. The U.S. Government was unaware of and unable to track most of the illegal VAX acquisitions found. Efforts to control IBM 286 PC clones during the late 1980s were even less successful.

those in place during the heyday of the VAX. The nature of the technology makes the task more challenging and the international mechanisms are weaker.

> In spite of strict COCOM export controls, Soviet, East German, and even Syrian organizations illegally acquired and productively used VAX minicomputers during the 1980s and early 1990s. Today's single-rack and deskside multiprocessor HPC systems are less controllable than VAXes and more available to such organizations.

The GAO report was critical of the fact that the 1995 Stanford study

> suggested only vague thresholds for [the] six factors to determine "uncontrollability." For example, it noted that the threshold at which it becomes difficult to track numbers of units could vary from 200 to several thousand [10].

The criticism is ill-founded for two reasons. First, while extreme examples of "controllable" and "uncontrollable" technologies are easy to identify, many of the technologies at the center of the current dispute – e.g. multiprocessor workstations and servers – lie between the two extremes. Since controllability is partly a function of the amount of effort expended on control, it is more accurate to speak of such technologies as being "more controllable" and "less controllable" rather than "controllable" and "uncontrollable." Second, the GAO report fails to point out that our report tended to be conservative in its judgments. While views regarding the threshold at which it becomes difficult to track individual units did vary from 200 to several thousand, we chose to use the conservative end of this range. The 1995 Stanford study did not conclude that 200 machines were difficult to track. Instead, it argued that several thousands were. Furthermore, to ensure that the systems on which we based our conclusions did in fact have cumulative installed bases in the thousands or more, we did not consider them until they had been in production for two years. It is at this point (or sooner for desk-side and smaller systems) that systems become available in primary markets in volumes that are difficult to track, and begin to appear on the secondary markets. Secondary market channels are often outside the control of vendors and subsidiaries who are generally compliant with export regulations.[5] The GAO report claims that we "asserted that as U.S. HPCs were sold openly for two years, their export would become uncontrollable" [10]. The

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[5] A review of vendors of refurbished systems in early 1998 supported the prediction that by the end of 1997 or early 1998 systems with a full-configuration performance above 7000 Mtops would be available on the secondary markets. These systems included refurbished DEC AlphaServer 8400 5/300 (7,639 Mtops, introduced in 1995) and Sun Ultra Enterprise 4000/250, a high-end desk-side system (7,062 Mtops, introduced in early 1997). Vendors of refurbished systems will configure and test the system before shipping. However, they usually perform no on-site services, except on special request and at additional cost. In short, there are few efforts to control where the technology goes. Year-old desk-side systems are also widely available on the secondary market. For example, the AlphaServer 4100 5/466 (4,033 Mtops, introduced in early 1997) is available from brokers not only in the United States, but also in the Netherlands, Austria, and other countries.

implications are that we applied this statement to all HPC systems and claimed it as a sufficient factor. Both implications are incorrect. For example, Cray vector pipeline systems that are ten years old continue to be controllable because of their small installed base and extensive need for on-going vendor support. We applied the two-year lag only to those systems that had other features that made control difficult, e.g. the single-rack symmetrical multiprocessor (SMP) systems.

> As the 1995 Stanford study predicted, HPC systems scalable to over 7,000 Mtops became available in 1997 on refurbished equipment markets, outside the control of the original vendors.

What is the performance of these single-rack and desk-side systems? The answer is critical because it shapes the performance thresholds at which policy makers may draw viable control thresholds. In 1995, the performance of desk-side multiprocessor systems whose installed base was in the tens of thousands ranged up to approximately 1500 Mtops; by 1996 the performance was approximately 2500 Mtops. During these years, the performance of single-rack systems with installed bases in the thousands ranged up to just over 4000 Mtops in 1995 and nearly 5000 Mtops in 1996. To understand these figures, one must understand scalability, one of the most important developments in the design of HPC systems in the 1990s. The desk-side multiprocessors and single-rack servers were designed so that users could purchase a small configuration consisting of a few processors, and incrementally add CPUs, memory, and input/output capability as their computing needs increased. In most cases, adding boards is an operation that is not difficult and can be performed by competent users in the field. In 1996, were there tens of thousands of fully configured 2500 Mtops desk-side systems and thousands of 4500 Mtops single-rack servers sold? No. Most units were installed with a quarter or a half of the maximum permitted processors. Could an end-user acquire a modest performance configuration legally and then upgrade it to these performance levels by himself or with minimal assistance? Yes. The technology is designed to accommodate such upgrading. Were there large numbers of installations that could be upgraded to these levels? Yes. Do the small number of high priority, well-heeled, technically competent installations that are the main targets of HPC export controls have the capability to do these upgrades, or to get someone to do them? Very likely.

> By 1995/1996, tens of thousands of deskside systems that could be scaled to 2,000 Mtops by end users had been installed worldwide. At the same time, thousands of single-rack multiprocessors scalable by end users to between 4,000 and 5,000 Mtops had been shipped.
>
> By 1997/1998, deskside systems with comparably large markets had reached 4,000 Mtops; single-rack multiprocessors, over 7,000 Mtops.
>
> Such levels of computing could be obtained by the relatively small number of well-heeled, technically competent foreign organizations that are a threat to U.S. national security interests.

The goal of our analysis of HPC technologies and markets was to try to identify performance points at which the government might decide to impose controls. What we found was the following: By late 1995, there were tens of thousands of systems that were easily scalable to around 2,000 Mtops. At the same time, there were thousands of units that easily scaled to between 4,000 and 5,000 Mtops. Within the band from roughly 2,000 to 4,500 Mtops a control threshold would be unstable, in the following sense. The CTP metric is imprecise enough that platforms whose CTP ratings differ by 50% or more may yield comparable performance on a given application. Because of the density of vendor offerings in the 2,000 to 4,500 Mtops range, any threshold drawn within this band risks making some companies with products just below the threshold winners, and companies with products just above the threshold losers for no clearly justifiable national security reason. Moreover, for any possible threshold within this band a system below the threshold can easily be upgraded to a performance above the threshold.

In short, there were only two clear choices: below the 2,000 Mtops threshold, or above the 4,500 Mtops level. Applications of national security importance that fall in-between the two thresholds (discussed above) and the level of effort required to control systems below 2,000 Mtops were the basis for choosing between the two thresholds.

In 1995-1996, systems scalable to 2,000 Mtops cost from a few tens to a few hundred thousand dollars, a sum easily within the budgets of most of the 200 to 300 well-heeled tier 3 organizations of primary concern. COCOM failed to prevent such organizations from obtaining VAXes. Effectively enforcing a threshold below 2,000 Mtops in 1995-1996 would have required a multilateral control mechanism far more extensive and costly than COCOM. It is difficult to imagine this being possible given the budgetary constraints and the clear lack of international interest among the scores of countries that would have to participate.

> In 1995/1996, effective controls over systems below 2,000 Mtops would have required a multilateral control mechanism far more extensive and costly than COCOM.

We have briefly outlined the analysis underlying the conclusions of the 1995 Stanford Study. Data regarding the nature of the HPC technologies and markets was empirical. While the study did not try to assign dollar values to the cost of control at various thresholds, the comparison with the costs and challenges faced by COCOM in trying to control a smaller number of more controllable systems provides a strong point of reference. To say that the 1995 Stanford study lacked evidence or analysis to support its conclusions is incorrect.

Conclusion

In conclusion, the GAO report is ill-founded in its two major criticisms of the 1995 Stanford study: that it did not assess the capabilities of countries of concern to use HPCs for military and other national security applications, and that it lacked empirical evidence or analysis to support its conclusion that HPCs were uncontrollable. The GAO came to these conclusions

because of two fundamentally unrealistic presumptions. First, it in essence assumed that the 1979 definition of foreign availability is the only criterion that can capture the true availability of HPC technology throughout the world. Second, it applied an impossible criterion for assessing what countries of national security concern might do with HPC technologies. Given these two flaws, which disregard the reality of today's technologies, markets, and applications, the GAO study was preordained to imply that no significant relaxation of export controls should have been made.

> The GAO report was preordained to imply that no significant relaxation of export controls should have been made because it was based on fundamentally unrealistic presumptions that disregard the reality of today's HPC technologies, markets, and applications.

While the 1995 Stanford study may have had shortcomings due to the lack of availability of ideal intelligence information, they are not those highlighted by the GAO. In fact, the 1995 study laid the groundwork for several advances in handling HPC export controls. First, as a result of the study, there now exists a unifying framework reflecting the salient technical issues and viewpoints that can guide policy-makers toward selection of control thresholds.

Second, policy makers have committed to revisiting the policy regularly, a key recommendation of the 1995 study. Previously, revision came only at widely spaced, irregular intervals. Consequently, stakeholders were forced to speculate on trends far into the future and to take strident positions. The time between revisions is still too long, especially compared to the rate of technological advance. However, extreme positions are less likely when industry and regulatory stakeholders are confident that regular reviews will take place.

Third, while not proposed in the 1995 Stanford study, the tiered arrangement of countries allows allies of the United States, and other countries that pose no national security concern to the United States to have little to no regulation of their ability to acquire U.S. HPC hardware. This, combined with reports from HPC vendors to the Department of Commerce on sales of systems above 2,000 Mtops, has made it possible to objectively estimate the cost to U.S. industry of various proposed control thresholds. By far the largest foreign HPC markets are in countries of little threat to U.S. national security. In 1996 and 1997, the number of systems between 2,000 and 7,000 Mtops exported to Tier 1 countries was over 10 times the number exported to Tier 3 destinations. Above 7,000 Mtops, licensing restrictions limited the number of Tier 3 exports to just 0.5% of the number exported to Tier 1 countries. By permitting exports to Tier 1 countries to take place under general license, policy makers have done little to compromise U.S. national security interests, while preserving the competitiveness of U.S. computer companies in their most significant markets.

Taken together, these three developments have caused the level of agreement among the major stakeholders to expand considerably. This point was completely overlooked in the GAO report.

References

[1] U.S. General Accounting Office, *Export Controls: Information on the Decision to Revise High Performance Computer Controls*, Washington, DC, 1998 (GAO/NSIAD-98-196, Sept. 16, 1998).

[2] Goodman, S. E., P. Wolcott, and G. Burkhart, *Building on the Basics: An Examination of High-Performance Computing Export Control Policy in the 1990s*, Center for International Security and Arms Control, Stanford University, Stanford, CA, 1995.

[3] U.S. General Accounting Office, p. 7.

[4] Goodman, S. E., P. Wolcott, and G. Burkhart, p. 64.

[5] Goodman, S. E., P. Wolcott, and P. Homer, High-Performance Computing, National Security Applications, and Export Control Policy at the Close of the 20th Century, Stanford University, Stanford, CA, 1998.

[6] U.S. General Accounting Office, p. 8.

[7] Goodman, S. E., P. Wolcott, and G. Burkhart, pp. 42-43.

[8] U.S. General Accounting Office, p. 4.

[9] "Apple posts first profitable year since '95," Associated Press, Oct 14, 1998 <http://www.sjmercury.com/business/apple/docs/077873.htm.> (20 October, 1998).

[10] U.S. General Accounting Office, p. 6.

GAO COMMENTS ON THE RESPONSE OF THE DEPARTMENT OF DEFENSE TO GAO REPORT TITLED EXPORT CONTROLS: INFORMATION ON THE DECISION TO REVISE HIGH PERFORMANCE COMPUTER CONTROLS (GAO/NSIAD-98-196)

The Department of Defense (DOD) stated that the national security threat and proliferation impact of U.S. exports of High Performance Computers (HPCs) to countries of concern were taken into account during the interagency review of computer export controls. DOD said that in developing licensing policies for the four "tiers" of country destinations, the identification of actual security applications with the various levels of computing power required for them formed its analysis. This also helped DOD to determine the appropriate level of control and scope of safeguards required for these country destinations.

GAO COMMENT

Despite DOD's comment, GAO found that DOD did not conduct a country-by-country analysis of how countries of concern might use HPCs at any particular performance level for military or proliferation purposes. GAO requested documentation to show how such an analysis might have been conducted, but none was provided. The principal author of the 1995 Stanford Study of HPC controllability and officials in DOD's Defense Technology Security Administration (DTSA) and Defense Intelligence Agency (DIA) stated that they had not performed a threat assessment or analysis of other countries' use of HPCs for military and other national security purposes.

DTSA officials stated that they had reviewed DOD's own HPC applications, conducting a mirror-image analysis of how DOD uses HPCs above the 2,000 MTOPS level, but this review does not constitute an assessment of how countries of concern might use HPCs and what military advantages such countries could achieve. GAO asked the DTSA officials whether they or anyone in the executive branch had made a threat assessment or assessed the impact on national security of allowing more HPCs to go to particular countries of concern. DOD officials stated that such an analysis had not been performed. As GAO's report noted, the former Deputy Assistant Secretary of Defense for Counterproliferation Policy, who at the time was responsible in DOD for this matter, confirmed that such an analysis had not been performed.

DOD has since completed an analysis for the House National Security Committee of how countries of concern could use HPCs; however, this analysis was not completed until November 1998, nearly 3 years after the decision to relax HPC export controls was made. This classified DOD analysis discussed how countries of concern might use HPCs for military or proliferation purposes.

THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

DEC 8 1998

Honorable Carl Levin
Ranking Member
Subcommittee on International Security,
Proliferation and Federal Services
Committee on Governmental Affairs
United States Senate
Washington, D.C. 20510-6250

Dear Carl:

Thank you for your letter addressing GAO's report entitled "Export Controls: Information on the Decision to Revise High Performance Computer Controls" (GAO/NSIAD-98-196/OSD Case 1648).

Let me assure you that the national security threat and proliferation impact of U.S. exports of High Performance Computers (HPCs) to countries of concern were indeed taken into account during the 1995 interagency review of computer export controls. In developing licensing policies for the four "tiers" of country destinations, the identification of actual security applications with the various levels of computing power required for them formed our analysis. This helped us determine the appropriate level of control and scope of safeguards required for these country destinations. With respect to the foreign availability of HPCs, our interagency effort in 1995 found that computers below 7000 MTOPS for Tier III countries were becoming widely available. In addition, the study reviewed various technological advances in the computer industry. The GAO Report discusses "scalability," which refers to the capability to increase computer performance levels of a system by adding processing boards or by acquiring increasingly powerful microprocessors. The interagency effort determined that computers below the current Tier III threshold, as defined in 1995, are easily scalable, so that attempts to control them would be ineffective.

Regarding your additional points, DoD does believe that the current export controls for HPCs are adequately protective of our national security. DoD, in cooperation with other relevant agencies, performs periodic reviews of HPC export controls, during which security threat assessments have been and will continue to be a central focus.

Sincerely,

PREPARED STATEMENT OF MR. REINSCH

Mr. Chairman, thank you for the opportunity to testify before the Subcommittee on export policy for high performance computers. The debate over computer export policy has been marked by a good deal of smoke and heat, but perhaps not as much light as one could wish. I will try today to explain on the Administration's policy. Its fundamental premises are that like it or not, rapid technological progress has rendered control of high performance computers increasingly difficult, and that it is more important to our national security to have a healthy computer industry supplying state of the art products to our military and intelligence services than it is to attempt to control the uncontrollable and jeopardize our companies' futures in the process.

Four factors have shaped our thinking. The first is technological change. Improvements in microprocessor design have allowed high performance computers to become ever smaller, cheaper and faster. At the same time, improvements in microprocessors have made routine desk top computers capable of performing at were considered supercomputer levels a few years ago. The second factor is global diffusion. We must assess realistically our ability to control the distribution of computers when they are produced in the thousands or even tens of thousands and sold from a variety of sources around the world. Third is the growth of parallel processing , which greatly increases computer performance, and the concomitant ability of users to easily upgrade performance. Finally, there is our conclusion, based on research and the 1995 and 1998 studies, that computer power is a secondary consideration for many applications of national security concern. These factors—rapid technological change, limited controllability, scalability and limited national security application—have shaped our efforts to keep our policy in tune with today's technology and international security environment.

In doing so we have kept in mind the nature of the computer market, which is a vital element of U.S. economic strength. We are world leaders in the very competitive computer market with $2 billion a year in revenue, and this leadership helps us across the board in the information technology sector. The policy adopted by the United States in 1995 affected more than ten billion dollars in exports, which supported 140,000 jobs annually. If misapplied, export controls can profoundly damage this important sector, put these jobs at risk and seriously damage our national security by crippling our companies just as our national security establishment's reliance on them grows.

The competitive and increasingly global market has strong implications for export controls. Roughly half of the computers made in the United States are exported, and the sales fall in the ranges below:

- Computers capable of up to 400 MTOPS have been sold in the millions.
- Computers capable of 400 to 1,000 MTOPS have been sold in the tens of thousands.
- Thousands of computers capable of 1,000 to 5,000 MTOPS range have been sold.
- A few thousand computers capable of 5,000 to 10,000 MTOPS have been sold.
- Some hundreds of machines capable of more than 10,000 MTOPS have been sold.

Some of these computers can be reconfigured by their users to have much higher performance, and in the future, in response to market demands, more and more computers will be scalable. Our fundamental reality is that computers which are available in the thousands in markets around the world cannot be effectively controlled, even if they are built in the United States or based on U.S. technology. The 1995 study predicted many of these developments, and everything we have learned since then confirms them.

Let me turn now to the issue of technological change. Technological change means that computer performance is constantly improving, creating unavoidable pressure on export controls. In few other areas has the pace of technological change been so rapid and so dramatic as computers. Five years ago, the U.S. controlled as a supercomputer machines with a performance of 195 MTOPS. Today's average desktop PC is more powerful, and the software which can be run on it more sophisticated.

The engine of change is the microprocessor. Computer chips are produced in the millions in plants in the United States and overseas. You are all familiar with Moore's Law, which states that the performance of chips doubles every eighteen months. These performance increases are the result of both improved design and improved manufacturing techniques. As of August 1998, chips capable of roughly 500 MTOPS are being produced in the millions and chips capable of 1,800 MTOPS are being produced in the tens of thousands. Although the United States is the most advanced producer, plants around the world can make these chips. Within twelve

months, if industry projections are correct, we can expect to see chips capable of 2,000 MTOPS enter into mass production. When this occurs, we will see sales of 2,000 MTOPS computers numbered in the thousands, making the limitations on our ability to maintain effective controls even more obvious than they are now.

Other technological changes have made it easier to upgrade performance. These include the increased sophistication of software, the increased availability of interconnect technologies which offers substantial improvements in performance and which may allow numbers of low level workstations to be clustered together to give high performance. The spread of parallel processing, which allows many microprocessors to work simultaneously on the same problem, has also reduced the controllability of high performance computers.

Rapid advances in microprocessors, software, interconnects and parallel processing mean that the performance levels once associated with giant machines can now be obtained by smaller and relatively inexpensive computers. The implications of technological progress go beyond performance. High performance computers are smaller, cheaper, simpler to install and maintain and more reliable. These attributes are desirable in the marketplace, but they degrade our ability to control.

Another element of technological change could be called attainable performance or scalability. Manufacturers have sought to build platforms which can be easily upgraded through the addition of new boards. This allows users to buy computers at one performance threshold and then increase the performance later through upgrades. Some computers are designed to allow these upgrades to be performed without even turning off the machine and with system software that automatically adjusts to the higher performance levels. The result is that it is possible to buy a number of systems that perform well below 2,000 or even 1,000 MTOPS, and thus do not require a license for export, and then upgrade these machines to 5,000 or 6,000 MTOPS or more.

These technical developments pose real problems for controllability. Faster chips available in the millions; smaller, cheaper and more reliable computers with performance up to 7,000 MTOPS and computers which can be exported without a license and then upgraded to HPC performance, all have created serious limitations on our ability to control computer exports.

Foreign availability—the availability of high performance computers built by foreign manufacturers with foreign parts and technology—was a key determinant of our export policy during the Cold War. It now makes little sense and is of secondary importance in determining policy. We cannot realistically control the many thousands of U.S.-made computers sold freely in Europe, Asia and elsewhere. Many countries we sell to do not have re-export controls—in fact the *New York Times* recently quoted an official from a close European ally as saying that they advise their exporters to ignore U.S. re-export controls. We know there is a flourishing market in secondhand high performance computers overseas—some can be ordered directly over the Internet. As a result, even though the United States today dominates the market for high performance computers, there is a performance threshold below which we cannot realistically expect to maintain control of computers unless we restrict sales to even our closest allies.

That is why we have focussed on controllability—whether licensing can be effective in restricting access to high performance computers. *The studies in 1995 and this year suggest that HPCs are becoming less and less controllable because they are becoming smaller, cheaper, more powerful, and more reliable, requiring less vendor support.* The availability of fast, well-designed microprocessors has allowed manufacturers to build more and better computers. Machines capable of 4,000 to 5,000 MTOPS are small and easily transported. Computers well above 2,000 MTOPS are freely available on the global second hand market. We cannot realistically expect to keep the organizations responsible for weapons development in states of concern, organizations that are technically sophisticated, well funded and which enjoy strong government support, from clandestinely obtaining computers with a performance much below 10,000 MTOPS.

Computers are not a choke point for military production. High performance computers have attained a symbolic importance in our export control debates which their real utility may not warrant. The fundamental premise of critics of our policy is that high performance computers are essential for making advanced weaponry. This critique is wrong. The weapon systems found in the U.S. arsenal today—the tanks, airplanes, missiles and ships—were built with computers whose performance was below 1,000 MTOPS. These were the supercomputers of the 1980's, but today you can find more capable machines on many office desktops.

We have found that the amount of computing power needed to design and manufacture modern weapons, once you get over a few hundred MTOPS, is not significant. For example, the level of computational power used to develop all the bombs

in the current U.S. nuclear arsenal is less than that found today in many workstations. Other factors—skill in software design, access to sophisticated manufacturing techniques, experience in building weapons and good test data—are much more important than a high performance computer.

There are a number of applications—precise weather forecasting, computational fluid dynamics, and particle dynamics in particular—where high levels of computing power are significant, and our policy attempts to identify those and, where possible, protect them. This differs from those who have argued that high performance computers will give countries like China the ability to leap forward in military production. While HPCs no doubt provide some incremental benefit, as would a wide range of items, we do not believe they constitute a choke point in weapons development, and, as stated previously, even if they did, there are serious limitations on our ability to control them at all but the highest levels. There is no evidence that you need a high performance computer to make most modern weapons, including nuclear weapons, or that having access to high performance computers alone will give you improved military-industrial capabilities.

In fact, none of the nonproliferation regimes, the Missile Technology Control Regime, the Nuclear Suppliers Group, or the Australia Group consider computers important enough to control. The members of these regimes decided that computers are not essential for production of these weapons systems. The only regime which controls computers is the Wassenaar Arrangement, which inherited the old economic warfare controls aimed at the Soviet Union. These controls did not, in the end, work very well in preventing the Soviet bloc from getting its hands on widely available computers. They were helpful in keeping big machines that require extensive support out of enemy hands but failed to stop computers available in the thousands sold freely at relatively low prices around the globe without significant vendor support. We would do well to remember this lesson because what we are experiencing now is essentially an acceleration in the rate that ever-higher performing computers are becoming widely available. In other words, we can still control the high end, but whereas that used to be measured in hundreds of MTOPS; now it is measured in ten thousands.

The United States currently dominates the high performance computer market, in part because of the realistic computer export policy we adopted in 1995. Tighter controls would penalize U.S. firms for winning the high performance computer competition. Our firms' strength has driven most producers from all but the low end of the market and discouraged others from entering. Export controls, like any government intervention, can, however, reverse that situation. Controls at too low a level act as a subsidy for our foreign competitors, damage our national security, and cost the American economy exports and jobs.

Maintaining our status as world leader in information technology and computer manufacturing is critical to both our economic growth and our national security. Exports account for roughly half the revenues of U.S. computer companies. Ill-advised export controls would put this vital sector at risk and at the same time compromise our security by making it harder for the Pentagon to obtain the cutting edge technology it needs. Events since 1995 have confirmed we are on the right course, and I hope the Congress will support the administration as it moves into a new review of control parameters.

The Great Technology Giveaway?

Trading with Potential Foes

Michael Hirsh

For all its nuclear peril, the Cold War was in some ways a reassuring time. The enemy was clear, and so were America's choices, or at least it often seemed. So perhaps Congress can be forgiven for reverting to its Cold War reflexes when confronted with a sudden series of proliferation issues last spring. On May 11, India exploded several nuclear devices, becoming the first nation in three decades to declare itself a new member of the nuclear club. A few days later came the shocking allegation that two U.S. satellite companies, Loral Space & Communications and Hughes Electronics, had violated U.S. export restrictions by helping Beijing to improve its missile guidance systems—and, presumably, the aim of a handful of Chinese intercontinental ballistic missiles targeted at U.S. cities. Then on May 28, Pakistan set off its own nuclear tests, an event unconnected to the China controversy but one that seemed, nonetheless, to be insidiously linked. Pakistani Prime Minister Nawaz Sharif, after all, made a point of thanking the Chinese for their technical help on the bomb.

Suddenly, a world long decompressed from the Cold War seemed to be back on the brink. Only this time, Dr. Strangelove had a Chinese face. On May 20, the House voted overwhelmingly to ban the sale and launching of U.S. satellites in China. After the Pakistani tests, Congress also approved a $2.5 million investigation of all technology transfers to China. America's national security, declared some politicians, was being sacrificed at the altar of commerce. Both Republicans and Democrats accused the Clinton administration of carelessly liberalizing high-tech trade with China—encouraged, perhaps, by $1 million campaign donations from the likes of Loral chief Bernard L. Schwartz—and engaging Beijing with a stream of deals that were helping to transform what is still a large developing nation into a 21st century superpower.

That, anyhow, was the perception. Despite the amicable Clinton-Jiang summit in late June, it is a perception that has endured. But the truth is that such thinking is a dangerous anachronism. Demonizing China, a nation clearly in

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transition, may prove to be a self-fulfilling prophecy, unnecessarily fostering Cold War II. Even more important, Congress' reaction is a technological throwback; its worst mistake is not in misunderstanding China, but in failing to comprehend the transformation going on before its own eyes in the U.S. economy. The idea that national security and commercial interests trade off—that every time you sell a satellite overseas, you make a profit but lose a little bit of your military edge—harks back to a time when CIA bean counters worried over every uptick in Soviet technology, and when the U.S. defense industry was sequestered in top-secret grandeur, spending untold billions on weapons designed exclusively for the Pentagon, with older-generation models going to America's Cold War allies.

Today the situation could not be more different. Quietly, without most Americans noticing, a revolution has turned the U.S. defense industry upside down. Very little is custom-made for the Pentagon. So reduced is its procurement budget—at about $50 billion, it is now about one-third what it was at the start of the decade—that few defense contractors could survive without a heavy diet of commercial and overseas contracts. As a result, by necessity, the defense industry has grown civilianized. Now much of the best defense technology—like naval propulsion, electronics, and command-and-control telecommunications—is coming from the commercial sector. Dual use has become the rule and not the exception. Apart from a handful of quasi-monopolistic contractors like Lockheed Martin and Newport News Shipbuilding, "the industry is reconstituting itself into a commercially oriented business that also happens to have defense customers," said John R. Harbison, a long-time defense analyst for Booz, Allen & Hamilton, in an interview in June.

NOBODY BEATS THE WIZ

What that means is that, more than ever before, national security and commerce have become mutually reinforcing, not competing, interests. America's defense edge is part and parcel of its commercial prowess. And that prowess in turn depends on exports and a global leadership role for American business. Indeed, banning Loral, Hughes, and other satellite companies from competing for business in China would probably harm America's national security more than letting their prize technologies slip into Beijing's hands, which, in any case, almost never happens.

This growing reliance on commercial technology has been a long-term trend, one set in motion well before Bernie Schwartz ever met Bill Clinton. And it is probably irreversible, given how far ahead the commercial sector is already. "Once upon a time we had the resources in this department to lead the field," Paul G. Kaminski, the former Defense under secretary for acquisition and technology, told me in an interview shortly before he left office last year. "So if something interested us like the development of transistors or computers in missiles, we led the pack in developing it." Hence, for example, the Internet famously began as a highly classified data transmission network linking U.S. nuclear weapons labs. But three decades or so ago that balance began to change, and today it has become too expensive for the Defense Department to build new technology from scratch on "milspec," or military

specifications. "I think the amount spent on research in the Department of Defense was surpassed commercially in 1965," said Kaminski. "The disparity has grown ever more since," especially since the end of the Cold War. Kaminski told of sending a Defense Science Board task force to Bosnia to examine how the U.S. military was doing in supplying intelligence to forward-based troops. "They said, 'pretty badly,'" he recalled. "They said there were better modems in the corner store. So we put in place a fix, leasing a transponder on a commercial satellite. There was a 3,000-fold improvement. The only thing we needed was encryption."

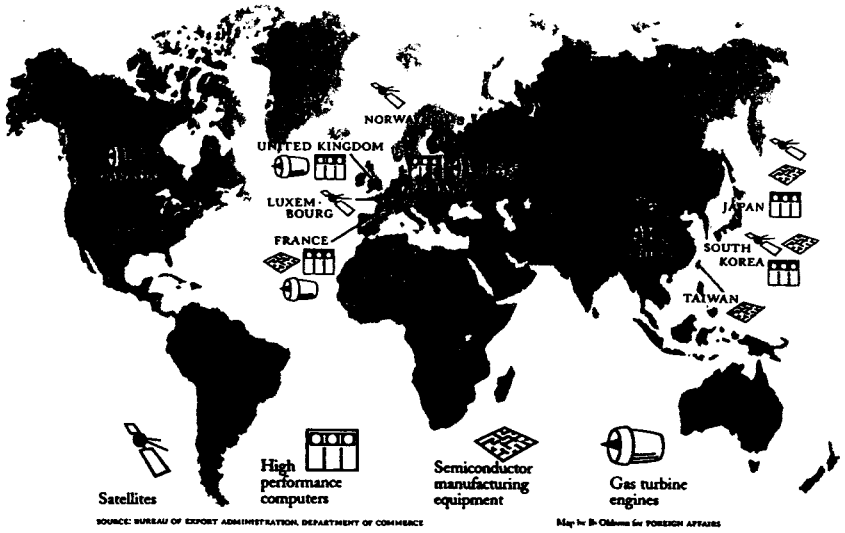
SATELLITES SCHMATELLITES

Satellites are a good example of how dramatically the Cold War order has been overturned. Once developed largely for spying and command and control, satellites have become the building blocks of an immense new commercial space industry. Last year was the first time that Vandenberg Air Force Base sent up more commercial than military payloads. "The U.S. military is now a minority user on its own ramps," Gil I. Klinger, the deputy under secretary of defense for space, told my colleague John Barry, *Newsweek's* defense correspondent, last spring. "Now we are chasing furiously behind the commercial users." In fact, several of the main U.S. defense satellite constellations are nearly obsolete, and intelligence sources say the Pentagon intends to go commercial to replace them.

No worry there, you might think: the United States is still far and away the world leader in this $27 billion commercial industry, which could grow to be worth as much as $170 billion by 2007. But others, like the Europeans, are close behind. And competition is intense. About 1,700 commercial satellite launches are projected for the next ten years, and there is a nearly three-year global backlog for launcher space. At present only four countries—the United States, Russia, France, and China—supply it. Launch schedules are crucial to competitiveness: when customers like CNN buy satellites or time on satellites from Loral or Hughes, they pay for it up front, and they do not get revenue until the satellite is aloft. So, to stay competitive, sellers like Loral need to minimize the time lag between purchase and launch. "If you cut our guys out of one of four satellite launchers in the world, it puts them at a significant competitive disadvantage," William A. Reinsch, under secretary of commerce for export administration, said in an interview in June. "Say the nearest launch window is in two years for U.S. satellites, and the Germans come in and say, 'Oh, by the way, we'll launch on China and they've got a window 9 months from now.' That's a 15-month revenue stream I can't get if I buy the American satellite."

Some critics point out that more countries are planning to offer launch services. But few experts dispute that a competitive rush is on and that the launch bottlenecks are staggering. Any loss of business for U.S. satellite companies may translate into a lost defense edge for the Pentagon down the line—especially since military and civilian satellite technology is so similar. The message is plain: to react to the putative threat from China by banning satellite sales to that country is to cut off Uncle Sam's nose to spite his face. There are side benefits to America's commercial dominance as well:

Top U.S. Export Markets for Some Dual Use Equipment



SOURCE: BUREAU OF EXPORT ADMINISTRATION, DEPARTMENT OF COMMERCE

U.S. intelligence, for instance, is helped far more if the Chinese military uses U.S. commercial satellites than it would be if China developed its own hard-wired, secure military alternative.

THE L.L. BEAN THREAT

The vibrancy of America's industrial base, of course, was also key to winning the Cold War. The Soviet Union was essentially bankrupted out of existence, not defeated on the battlefield. But the relationship between economics and national security was then an indirect one: a strong U.S. economy produced the taxes needed to supply the trillions of dollars plowed into defense. We all recall the hundreds of contractors who infamously slurped billions from the public trough, coughing back $2 billion stealth bombers and $600 hammers. Now that defense complex has been reduced to a handful of supersurvivors like Lockheed Martin, Boeing, and a few others that emerged from the flurry of mergers and acquisitions in the 1990s. This is one reason the United States is helping itself to a peace dividend that now includes a balanced budget. Indeed, if there is any issue Congress should be examining, it is whether defense consolidation has gone too far. In some platform sectors, like heavy tanks and nuclear carriers, only one monopoly supplier effectively remains where there were once two or more. That is why the Justice Department prevented the recent merger of giants Lockheed Martin and Northrop Grumman.

Another factor driving this revolution—and one that is also irreversible—is that more and more countries produce the same dual-use equipment. Take another controversial export case involving state-of-the-art machine tool equipment made by McDonnell Douglas, which was diverted to a Chinese military plant in 1995, possibly for cruise missile production. You would not know it from the hue and cry in Washington, but the Germans had sold the Chinese similar milling machines years before. A similar critique can be made of the recent controversy over an encrypted circuit board supposedly stolen by the Chinese after the 1996 crash of a rocket carrying a Loral satellite. In truth, that encryption is so old and widespread it is probably worthless. One industry survey last fall found that 653 encryption products were now available from 29 different nations. Norman R. Augustine, the recently retired head of Lockheed-Martin and a key force behind the industry's consolidation, says that much of the state-of-the-art technology that drives defense is "fungible. I think it's just not possible to keep it in the box anymore."

One problem for those who do want to keep it in a box is that the line dividing military technologies from civilian ones is constantly receding. One by one, commercial uses are being found for formerly military technologies—another peace dividend. Night vision goggles are important military equipment, covered as munitions by the State Department, but they are also available in the L.L. Bean catalog. Global positioning satellites, once intended for guiding ballistic missiles, today are within reach of every backpacker and car owner; around 250,000 GPS receivers are sold each month (although here the government, in a national emergency, could seize control of the network in a wink). Or consider chips hardened to withstand radiation. Once devised because the U.S. military wanted to protect its satellites from attack, today there is a civilian clamor for them. Fearing cyclical spikes in solar activity, companies hope to use them to preempt pager blackouts.

Just as important, warfare is getting increasingly high-tech and computerized, and it will only become more so as the 21st century brings electronic battlefields. Silicon Valley is crucial to the military-industrial complex of the future. Whereas the portion of the Defense Department's R&D procurement budget devoted to electronics was just one percent a couple of decades ago, now it is nearly half. Computer technology accounts for much of this increase. In 1995 the Clinton administration authorized an independent study, which was followed by an internal administration review, that concluded that the ability to design and make nuclear weapons—a key reason for export controls on computers—had long since flown the coop. At the same time, Defense Secretary William J. Perry came to realize that top-grade supercomputers were going to be necessary for 21st century warfare—determining everything from warhead design to weather patterns in the Adriatic Sea in the event of a NATO air strike. But "if you examine our high performance computer companies, of which there are now only seven, every single one of them gets more than 50 percent of its revenues from exports," says Reinsch. "Perry understood that if you rely on the Pentagon as your computer market you're going to go broke. The only way these guys are going to stay in business and make new-

generation products that the Pentagon can buy is if they're out in the marketplace leading the way in exports." Clinton, as a result, has constantly raised the export threshold for supercomputers, allowing more and more powerful machines to be sold abroad without a license.

THE LAST SUPPER

One of the great ironies of the satellite scandal is that the Pentagon has been portrayed by press reports as the agency most worried by the national security threat allegedly posed by Loral and Hughes. But it was former Pentagon chief Perry who was the brains behind putting defense technologies up for sale. It was Perry, then deputy defense secretary, who one night in 1993 gathered the biggest names in the arms industry and announced, at what became known as the Last Supper, that about half of them would soon disappear from the Pentagon's payroll, victims of post–Cold War budget cuts. Then, in June 1994, Perry issued a momentous memo making commercial rather than military specifications the norm for Pentagon purchases. That same year he oversaw the dissolution of Cocom, the Soviet-era Coordinating Committee for Multilateral Export Controls, and opened the way to the overseas sales of almost all computer and telecommunications equipment without export licenses. Such licenses once would have made these deals illegal without U.S. government approval. As a result, the number of licensing cases involving potentially dual-use technology abroad dropped from a high of 120,000 per year under the Reagan administration to fewer than 9,000 cases by 1996.

The Perry doctrine enraged the hardliners in the Defense Department's Defense Technology Security Administration, a Reagan-era body whose raison d'être is keeping wraps on dual-use goods—and which has been mainly responsible for press leaks on the satellite issue. But the policy met with a willing audience at the Commerce Department, which began trumpeting export promotion under Secretary Ron Brown. Hence the seeds of the current scandal were sown: U.S. exporters loved the policy and began pushing for ever more market openings. Under intense corporate lobbying—by such big political donors and high-tech China exporters as Hughes, AT&T, Loral, and United Technologies—more and more equipment was redefined as dual-use rather than munitions, which puts it under the perusal of the State Department, and moved to a fast-track approval process at Commerce.

Perry had simply decided that in the post–Cold War era it was all but impossible to halt the global flow of dual-use technologies, and that America had to go with the flow to keep its industries alive. True, many of these new exports dovetailed nicely with Beijing's high-tech wish list, but they also made eminent sense in the new commercialized environment. Indeed, there was not much choice. "I think the criterion [for export control] is whether or not we are sole possessors of the technology," Perry explained in an interview last year, before the current controversy erupted. "There was a consistent effort during the whole time I was in the government to reach agreement with Western countries on a unified approach to technology control . . . We did not have much success." At the same time export fever began to overtake the Europeans, who were anxious about their own ailing defense

industries. The government did manage to replace Cocom in 1996 with something called the Wassenaar arrangement, a less formal accord among Western countries for keeping a lid on military-related exports. But with the exception of a few targeted rogue nations such as Libya, it is proving to be mostly a paper tiger.

ONE STEP AHEAD

None of this means the West should just drop efforts at export control. Nor does it belie the potential seriousness of the allegation against Loral and Hughes. Both weapons sales and dual-use technologies that clearly contribute to missile, nuclear, or biochemical weapons production need to be assiduously monitored, even with all the headaches of doing so. And they are, at least under law: if it is true that these two satellite companies evaded the required State Department approval before passing on missile guidance information to China, that would be an indisputable violation of U.S. export controls. But it is important to remember that for now the allegation remains a singular one, hardly something that would justify banning all satellite exports to China. Contrary to reports, the Pentagon is sharply divided over whether national security was harmed at all.

The changing nature of technology and geopolitics also means that Washington must keep refining export controls. A General Accounting Office report on another dual-use controversy—involving the sale of AT&T switching equipment to a People's Liberation Army–affiliated company—criticized the Commerce Department on this score in November 1996. It pointed out that, under loosened Commerce rules, companies are pretty much on their own in determining who is a civilian versus a military end user in China, but it concluded that Commerce does not "offer any guidance on how" to do so. Before high-tech exports were liberalized, when companies were forced to apply for an export license, the GAO report noted, the Commerce Department would conduct its own review "using available government resources such as embassy personnel and intelligence reports." It noted that exporters "do not have such resources available to them when making a civil end-user determination." Commerce has responded, creating a blacklist with 28 suspect end users.

The larger point, however, is that America's export control policy can no longer be to close down its borders. In an era of open technology transfer, the centerpiece of any viable strategy must be to keep one's industries running faster than the next economy's. U.S. policy should be twofold: to promote U.S. commercial leadership in dual-use technologies, and to maintain tough but reasonable export monitoring that will slow—even if it does not stop—the acquisition of those technologies by potential enemies. America's national security will be assured as long as the Chinese (or, through them, the Iranians or Pakistanis) are always lagging a few product cycles behind. But that is about all that can be done. "There's going to be a lot more slippage and leakage," says former Assistant Defense Secretary Joseph S. Nye, Jr. "This technology is broadly shared, and the sense of threat [about China] isn't broadly shared."

Unfortunately, the Clinton administration has done a wretched job of articulating this new reality. It is another example of

how the president's essential centrism—and, perhaps, the taint of scandal—have prevented him from breaking new conceptual ground and seizing the mantle of real leadership. FDR described great presidents as "leaders of thought at times when certain ideas in the life of the nation had to be clarified." Clinton continues to justify his technology transfer policy by pointing out that he is only following what President Bush did, an irony much noted to his detriment, since Clinton notoriously attacked Bush's engagement policy, and by focusing on the negative—in other words, what the United States does not allow China to have. Or he makes the same droning point about China trade being crucial to U.S. jobs. What no one has explained is that trade—yes, trade with China—may well be crucial to U.S. national security. Maybe that is why the comprehension of this new paradigm is sinking in so slowly, especially on Capitol Hill.