Keynote Address

Supercomputer Leadership: A U.S. Priority

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When one reflects on the use of computers in this country, it is a natural pairing of Los Alamos and the National Security Agency. Although NSA's part has often been shrouded in secrecy in the past, the fact that the first Cray came here and that the second went to NSA is only one of the many symbols of the fact that both have pressed research in mathematics out ahead of the rest of the country. And it's been particularly fun for me over the last few hours to see a lot of admired colleagues from NSA in the audience. Hopefully, they're not identified just as Department of Defense attendees. But that's an old in-house joke.

Earlier, I had intended to speak at some length about the Microelectronic and Computer Technology Corporation (MCC). You've read a lot about it in the press, and perhaps we'll have a little time for questions to talk about it before it's time for you to move on to the important agenda you have ahead of you.

Some time ago I appeared on a television program in which a new book was being promoted. The book put forth the view that supercomputers offer great dangers to this society. I eventually became sufficiently frustrated during the discussion to liken the situation to children so afraid of the dark that they were afraid to ever go out and look and see the stars that were there. I think those who go about this critical challenge of defining the next generation of supercomputers are going to be challenged constantly. Why does this country need to proceed, to stay at the leading edge of technology in so many areas, but particularly in the area of computing? I hope to at least arm you with some arguments. You may discard them. You're also free to use them if they are of any benefit at all.

What are the challenges and opportunities that will face us in this world in the 1990s? The challenge primarily is going to take two major forms: military and economic. And we're going to have to learn to

balance both of those and to do it effectively if we're going to take advantage of the opportunities that the rest of this century offers.

Let me begin with the military side. We will primarily concentrate in the years ahead, as we have in the past decade, on the Soviet Union. But we're going to be worrying about instability in the Third World, political/military clashes, Arab/Israeli unsettled issues, and about Libya and North Korea. Mostly, we will focus on the evolving Soviet challenge—many components of it; on the strategic side, steady, sustained improvement in their strategic offensive forces. They are going a little slower at deploying new improvements right now than they have previously, and they may be deliberately holding back to see where there are some additional arms control opportunities. It may also be that they have technical difficulties that have encouraged them to hold back a little in the normal cycle we've seen of rolling out the next generation of strategic weapons systems. It is clear that there is an aggressive research and development program in defensive weapons systems, and there are areas where we've not proceeded in our own effort with sufficient detail to be very comfortable that we can make confident judgments about what progress they may or may not achieve in that area. But I would have to tell this group that I'm much more concerned, looking out over the next 15 years, about the evolving mobility of Soviet conventional forces than I am about changes in the strategic ones, because I believe that for any Soviet leadership, use of nuclear weapons is still going to be an act of desperation, not an early policy decision.

We have watched, over the past 18 years, following the ouster of Khrushchev, an increase in investment to solidify support by a new Politburo, an annual steady investment in Soviet defense capabilities, left largely to the Defense Ministry to allocate. And we have steadily watched not a growth in numbers—in fact, even perhaps a slight reduction in numbers—but an incredible change in the capability of conventional forces to be deployed, to go to fight, and to stay for far longer periods of time. The changes have occurred in air, land, and sea forces, and there are some advantages—not many—but there are some that accrue to their system of government, where a Merchant Marine is entirely owned by the government and can be marshalled to support those military efforts very quickly indeed.

But it is the evolving attitude about the use of force away from their periphery that concerns me at least as much as the changing capabilities. Nineteen seventy-five was a watershed year with the decision that November to move 15 000 Cuban troops and massive quantities of Soviet arms, by air and by sea, halfway around the globe to Angola in a 2-

week time frame. I won't dwell on how we tried to deal with the matter. We don't seem to be very good at learning our own lessons of history. Two years later, they proceeded with another effort in Ethiopia, and others have followed—Yemen, Kampuchea, Laos, and then their own use of force in Afghanistan. But when one stands back, while 1975 was a watershed about being willing to use force a very long distance away, the current old Bolsheviks have been very cautious about using that evolving power where there was a prospect for direct conflict with the U.S. and its allies.

What about the 1990s, when there will be almost a total change of the senior leadership for reasons of age and health? We may be fortunate. Because they've grown up in the Khrushchev-inspired era of the Communist Party being the world's largest bureaucracy and enjoy their privileged positions, having risen to dominance in the Politburo, largely through service in heavy machine industries and other areas that have benefited from this heavy investment in the defense structure in their own climbs to position of power, and therefore, they will be cautious about risking a privileged position. But there is at least as much danger that they will be more arrogant without the memory that the current old Bolsheviks have of Germans on the banks of the Volga, and therefore, will be far more willing to use military force when they see opportunity. What will drive that interest? Their inability to compete economically. The economy continues to be just this side of a total disaster. But it has nonetheless steadily produced very slight improvements in the consumer side year after year for 20 years throughout a sustained major military buildup. The principal problems—corruption and central planning—may now be under attack. I do not see a possibility of a turnaround on the economic side that would let them be a part of the great economic competition during the rest of the century. But I believe it is likely to be sufficiently successful that they can sustain their level of investment in their defense establishment without interruption. That means they will look to the outside world in their feeling of inferiority about great power status. But because of their inability to take part in, participate in, enjoy, and compete economically, they will look for opportunities for use of their burgeoning military power.

What is that economic challenge going to look like that they will be watching? It's going to be marked by very intense competition—for markets, for raw materials, for natural resources. Most of that competition for markets is going to take place West to West, inside the countries, within the economies of the U.S. and its principal military allies, with all the strains on alliances that that has to offer. But a lot of the competition

will gradually evolve, particularly into the 1990s, for markets and for raw materials and natural resources out in the Third World. If that Third World were stable, then one could look at the economic competition as something relatively easy to manage. But I'm afraid we're going to see the trend of continued instability. Only in Asia with the Association of Southeast Asian Nations and South Korea and Taiwan has there been sufficient political stability and economic growth to offer a reasonable prospect of continued stability. In fact, we may find there the new element in the economic competition that we'll find in the rest of this century.

For much of the rest of the Third World, we're going to have to contemplate how we can encourage political stability at the same time that we help bring them into a potentially great economic boom. Balancing and managing these economic opportunities to keep the alliances coherent, while limiting opportunity and temptation for the Soviets to use their mobile military power, is going to be the principal challenge with which we will have to deal. But it isn't just a world of challenge. It is a world of great opportunity, if we only look for it and take advantage of it.

The prospect of encouraging world stability, I think, is reasonably there if we lead and help share economic prosperity. To do that, to be able to bring about some balance about how we approach military challenge and a clear, sharp, long-term focus for the economic policies that will keep an alliance coherent, the number one requirement is a consensus on national security policy in this country. And a broad understanding that national security policy involves diplomacy, foreign aid, arms control, the structure of force levels of our defense forces and their deployment, and international trade will be needed. We must address all of those coherently in long-range planning if we are, in fact, to be in a position to take advantage of economic opportunities.

What's going to lead that economic boom? I believe the real leadership for it will come from the information-handling industry, which in 1981, worldwide, had revenues of about \$325 billion, with 5 million jobs; in the U.S. alone, some \$136 billion in revenues and 2 million jobs. We're not going to replace the basic industries. They're going to remain very critical. But we can help lead the way they're automated and become more productive and focus on retraining people who must operate the modernized facilities. But if we really seize the opportunity in the information-handling industry, we have a potential for providing excellent jobs for those entering the work force in these next 15 years, if we have prepared them along the way to be able to take positions in an adult

world. If one looks at the current growth in the information-handling industry, growing at 15% a year with just a reasonable effort to keep it rolling, that's a worldwide trillion-dollar annual revenue in the early 1990s—easily 15 million jobs. Half of that clearly should be in this country, if we invest now in the research and development, in the infrastructure that will sustain it, and prepare to manufacture high-quality products and market them in a way that insures that we compete as we have demonstrated we can at times in the past.

We are not well prepared to fully seize the opportunities that are here. In many cases, being prepared takes long-term planning. And we make short-term decisions. In 1963, cost effectiveness was the great catchword in looking at the national security budget; looking for ways to reduce investment, and by 1964, to pay for the commitment in Viet Nam. We decided it wasn't cost effective for the Department of Defense to make unconstrained grants for graduate education unless it was directly related to supporting design of a weapons system. If you stand back and examine the great economic boom of the 1940s and 1950s, you will find that the GI bill and unconstrained grants for graduate studies that came from organizations like the Office of Naval Research fueled much of the education. But to be cost effective, we dried up a lot of that in the mid-1960s. And it was at a point in time when the National Aeronautics and Space Administration's investment was beginning to decrease. Industry did not pick it up. No one else picked it up. And beginning in 1968, you can chart the drop in graduate students in the U.S. in sciences and math. The size of our educational institutions didn't really drop because foreign students came to take advantage of the opportunity. And we have, probably usefully over the long term for these Western economies, educated a great many of the bright graduate students who are now fueling the competitiveness of our allies. One of the early challenges that we have as a country is to again spur substantially greater investment in the graduate schools in science and mathematics, recognizing that a great deal of that has been done by the Defense Advanced Research Projects Agency over the last decade. Even quietly, the Office of Naval Research and its counterparts have still found some ways to play, but not nearly to the degree that the country can both absorb and very usefully benefit from. And as we look at where we find qualified graduate students, we must begin with the basic education systems across the country, insuring that we are producing students going into schools who have the fundamental background to permit them to take advantage of the educational opportunities they will have.

Simply because we have not invested in that graduate level education to the degree we should have for the last 25 years, we have to find new approaches, and that is why, following the model of the Electric Power Research Institute of some years ago and the Semiconductor Research Cooperative, we are evolving the MCC, where we pool talent from competing companies, accepting the wisdom of that part of the Japanese model and evolving it to our own intense free enterprise system, but recognizing we simply cannot afford, if we're going to meet the challenges, and certainly not if we're going to seize the opportunities, to continue to have a great many people recreate the same basic technologies across a large number of companies.

What are the U.S. needs? What do we need to do to try to seize the opportunities and to meet the challenges? Well, it won't surprise you that for the near term, finding again a consensus on national security policy is the first requirement. It isn't going to be easy to do, and I'll offer a tough suggestion for our Congressional leadership along the way. We have to draw the Congress and Executive together in the process and force long-range planning. As long as we're addressing problems on a year-to-year basis, we will never move on any kind of broad scale to address problems in a long-range way. Shifting to 3-year authorizations will be very painful, but I know of no other early way to produce a long-term focus on problems rather than an annual short-term look.

We need some modifications in the antitrust laws of this country to recognize that we are not dealing with the 1890s to 1910 and rapacious industrialists plundering U.S. society. But there is some genius in the antitrust laws that we want to sustain. Competition at the market place works in Japan, just as it works here. And so when we turn to modifications, we don't want to deal with everybody who's got a problem (often through their own mismanagement), but to make those changes that signal to industry that we want them to pool scarce resources for research; we want them to invest in long-range research, and we are prepared to give them tax credits or other write-offs to encourage the investment they ought to be making. The system of focus on quarterly profits, in fact, does not stimulate such investment. The antitrust laws should encourage the broadest sharing of research and not try to postulate what products might come out 6 to 10 years from now against what projected market share. Rather, the focus should be on how fast we can insure that the technology that's developed is placed in the hands of other U.S. corporations, particularly small companies, to insure competition at the market place.

Government must define its needs. What we don't need is another plan on how to invest in technology without any clear sense of how government will use it. We need now for the federal government to define what they see as the government needs in supercomputing, in other uses of information handling, and in telecommunications to finally provide us with something that would approach the quality of communications the government needs and clearly could afford if it had the right priority. That's going to have to be done across the government. The needs of the intelligence community are to deal with Soviet mobility, not just with Soviet forces on the Eurasian land mass. The key priorities for making political decisions are (1) being able to sort through incredible volumes of information and at the earliest point recognize preparation for movement of substantial forces outside Soviet borders and (2) the ability to follow burgeoning instability in Third World countries themselves. As one thinks about defensive systems, a critical problem is how to sort through, at a very early stage, incredible volumes of information to be able, within matters of seconds, to track individual elements of millions of moving events.

The next point is a harder one in the near term; that's investment in education. I'm not persuaded that substantial federal investment is the answer, though clearly some encouragement is necessary. Where does it need to come? It needs to come in the areas that you define as government needs, where it is unlikely that the commercial sector will see a market to pick up. And the same is true for your supercomputer needs: in defining now what your own needs are, in recognizing those areas where there will be a market and letting them be driven by the commercial market place, but letting the government invest in areas where the needs are likely to be predominantly those of the government.

There are also opportunities that we've not really begun to address in retraining the work force. We do know from our experience in the military that you can take an individual who is barely literate and, with computer-aided education, train him to become a first-class engine mechanic. The National Automobile Dealers' Association has spent a great deal of time putting together standards for adequate repair of automobiles, but there has been no great rush to retrain people with basic mechanical skills to do that. Wouldn't it be nice to be able to get your automobile repaired well and quickly?

For the long term, we have to push the frontiers of research and development. Computers are going to be at the leading edge. I hope that this week you'll define what the broad elements of that program ought to

look like. Many of you already know what MCC has set out to do, but that's only part of the competition. I think it's a very important part. To identify the talent and get the talent applied to the problems, both by the competing companies for MCC and among the universities, and insure that we recognize that, if we are really going to seize the opportunities of the 1990s, we are going to have to make some priorities, and those priorities are going to have to be increased investment at the university level in engineering and computer science departments. And we're going to have to beef up our long-term approach to education.

The key to success is the collaboration of government, academia, and the private sector. When we've had this collaboration in this country, it's normally been stimulated by fear of or the reality of military threats from the outside. We need to encourage that collaboration now for our long-term economic well being if we are to avoid repetition of the lessons of the past. When we shied away from collaboration for fear that we might damage academic freedom or that we would somehow suppress competitiveness at the market place, the alternative seemed to be trade barriers, which ultimately leads to breaking up of alliances. The 1990s can be an extraordinarily exciting time for all of us. But the challenges are there, and if we don't manage them and manage them effectively, then we are likely to find ourselves in the 1990s at a time of some very intense military confrontation. And on that cheerless note, let me send you off to the exciting events you have ahead of you.