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Welcome

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Thank you very much, Minister Buhlmann for inviting me to this important forum. Information and communication technology are having a profound effect on the way of life of people in many different cultures throughout the world. No other technology in the past has spread so rapidly and with such transforming effect on society. Conferences such as this one play a valuable role in helping government planners, business leaders, and consumers to keep in touch with the advancing front of progress, and to digest the fascinating and rapidly shifting details of the still-dawning age of information.

The industrial revolution in its several phases depended upon new forms of energy, and new mechanical devices to use energy efficiently. First steam and coal, and later oil, replaced the traditional sources of animal, wind, and water power. This made new modes of transportation possible, and new ways of manufacturing. New population centers formed, and agriculture began for the first time to give way to other forms of livelihood. That first industrial revolution launched a period of globalization in the 19th century in which world trade grew rapidly in importance, and took many ancient cultures by surprise.

Then electricity appeared, with its multiple applications for motive power, illumination, and electrical communication, all of which were exploited early in the 20th century. The technology of powered flight reduced still further the barriers of time and space that separated nations. New discoveries in the science of matter brought synthetic goods, and color to our products, and medicines, and new materials for manufactured items.

None of these innovations, profound as they were, advanced as quickly, nor reached as deeply into the way we conduct our lives and our diverse businesses, as the technology of information in the late 20th and early 21st centuries.

We speak of two branches of this new technology, devoted respectively to the *processing* of information, and to its *transmission* from place to place. But there is a third branch, no less important, which is the means of *acquiring* information through sensors, detectors, or imaging. A fourth related branch includes the *actuators* that influence the environment in response to processed information. I describe these as the technology of *instrumentation*. The cycle of sensing, processing and transmitting information, and performing a function, follows the natural cycle of all work processes, and indeed the functional cycle of life itself.

Together these advances in instrumentation and information technology are giving us unprecedented control of matter at the atomic scale. They have opened new horizons not only in how we conduct our work, but in our very idea of what work is. The concept of work itself is changing, and with it the categories that economists use to describe and classify work products and services.

The transforming impact of computing and communication had been anticipated by visionaries and science fiction writers. Already more than 30 years ago, social forecasters had predicted effects of rapid communication and shared computing resources on the processes of work and education. They failed to anticipate the Internet phenomenon, and the World Wide Web, and cellular telephones. But they did predict changes in the way we teach and learn, and they envisioned dramatic workplace changes, particularly the decentralization of information-intensive activities. While enormous changes have taken place, however, they have not yet been as pervasive nor quite as dramatic as expected. One reason for the early over-optimism was a lack of appreciation for just how much bandwidth is required to replace the need for human presence. Another was the failure to anticipate the importance of microscale information, which leads to massive data bases, such as those required for medical images. Yet another underestimate was the importance of high bandwidth user feedback.

As this key role of bandwidth was recognized, it led to huge investments in telecommunications infrastructure during the past decade. The complexity of markets driving the need for this infrastructure were not, it now appears, sufficiently well understood, with the result that different parts of the whole chain of communication technologies developed at different rates. This has inhibited the implementation of key applications that are needed to drive the remaining infrastructure development to its completion. Different countries appear to have substantially different patterns of usage for computing and telecommunications applications, which further complicates infrastructure development. In the United States, the so-called "last mile" connection, linking high bandwidth backbones to the homes and business places of individual users, is being established more slowly than anticipated, but the connections are nevertheless steadily expanding. Public awareness is increasing in the U.S. of very attractive high bandwidth applications for education, medicine, and entertainment, and this is likely to accelerate through the decade.

Looking back on early visions of how society would change in the new information age, none of them today seem wildly unrealistic. It is not so much a question of "if", as a question of "when". Within a few years – you will have to decide how many years – I am confident that the network of high bandwidth connections will sustain a viable market for a new generation of high demand applications. Meanwhile, the pace of technology improvements, captured miraculously by Moore's Law, continues unabated. Information technology continues to drive applications in the rapidly unfolding and converging fields of biotechnology and nanotechnology, in which governments world-wide are investing heavily to achieve competitive advantages in commercial applications.

In the United States all these converging fields are receiving high priority for federal research funding. The National Networking and Information Technology Research and Development Program, known as NITRD, is a key component of President Bush's Tehcnology agenda. In his Fiscal Year 2004 Budget Proposal to Congress, the President has asked for $2.1 billion for this program. Funding is distributed among a dozen federal agencies, with six focus areas ranging from High End Computing to Social, Economic, and Workforce implications of information technology. This funding is complemented by a rapidly growing nanotechnology initiative, and a more mature initiative in biotechnology applied to medicine. Other nations have launched similar initiatives, contributing to a strong global flavor for the entire enterprise.

The global aspect of information technology development needs greater attention from policy and planning offices of all governments. Information technology companies are almost inherently multi-national. Among U.S. companies establishing new facilities in other countries, General Electric opened a $40 million R&D facility in India in 2000; Cisco Systems plans to invest $200 million there over the next three years, and already employs 700 at its Global Development Center in Bangalore. Sun Microsystems opened a similar facility in Bangalore in 1999 which employs more than 300. Microsoft, Oracle, EDS, and others have similar extra-national centers. China is also a popular choice for foreign-based R&D operations with HP, IBM, and Microsoft, among others, establishing centers there. Germany and the Phillipines are the next most-popular locations for IT outsourcing after India and China.

This astonishing growth in world-wide operations is affecting the international high technology workforce, changing patterns of education and research activity. It is also bringing pressure to bear on concepts of intellectual property rights, tax policy, and radiofrequency bandwidth regulation. International cooperation on these issues is essential to avoid artificial bottlenecks that will inhibit developments that will bring value to every nation.

International cooperation has a long history in the most basic areas of research, and I expect this to continue. Research teams everywhere are strongly international as well as interdisciplinary. Despite current backlogs of student visas in the United States, the U.S. research enterprise continues to employ large numbers of foreign students and scientists in universities and national laboratories. We value these contributions by foreign scientists, and are working to revise post-9/11 visa approval processes to ease the backlogs.

Most of the U.S. Government investment in IT research is going to universities, principally through the National Science Foundation. But our national laboratories are also playing a major role. This is particularly true in the high-end computing area where powerful computing is required for simulations of complex, highly interconnected systems such as global climate modeling, combustion, and turbulent systems. The national laboratories are also strengthening their materials characterization and preparation capabilities through a set of five nanotechnology centers co-located with x-ray synchrotron or neutron sources which are used for atomic scale materials studies.

Industrial laboratories also continue to play an important role in IT innovations, wherever they may be located. The U.S. Government is prepared to accept a complementary role in supporting long lead-time basic research, and expects the industry to pursue short lead-time lower risk research opportunities. It is understood that historical research strengths are difficult to maintain in industrial IT and telecommunications laboratories in the current era of de-regulation of these industries. Nevertheless, the traditionally strong laboratories of IBM, Lucent, and others continue to do excellent and important work.

Bell Labs, for example, which boasts a long list of inventions related to information technology, including the transistor, charged coupled devices, and cellular telephones, recently reported to my office that it had been granted its 30,000th U.S. patent. I know that Lucent Technologies chairman Patricia Russo will have more to say about this at the ITC forum tomorrow.

The transformation of societies around the globe by information technology is just beginning. Moore's Law still has many doubling periods to go before physical limitations end its run, potentially after as many as 35 doublings since Moore stated his law in 1965. The scale of the CeBIT conference alone tells us that large economic forces are at work in the fields represented here.

I am optimistic about this information revolution, but the current situation is fluid and will remain so for many years. What I know for sure is that governments will be challenged to respond with new laws and new accommodations to a movement that touches nearly every human activity. Only continual effort to reach across political and cultural boundaries will make it possible to exploit the new opportunities to all people. The CeBIT conferences, now extending around the globe, will certainly assist this effort, and I congratulate the organizers on their success.

Thank you.