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ONE HUNDRED YEARS AGO, Heinrich Hertz's experiments, proving the validity of Maxwell's equations, opened up a new world, whose full dimensions have only in recent years been adequately appreciated. Your theme of *Microwaves Linking Nations* is most appropriate since through satellites using microwave frequencies the world is today interlinked as never before. The full impact of this global net is yet to be fully felt, but there is no doubt that it is and will be changing in a fundamental way the nature of the world in which we live.

When Hertz began his experimentation, twenty years had passed since the publication of Maxwell's equations, but few people understood them and many of these had expressed doubt as to their significance. It remained for Hertz, who combined the theoretical knowledge to understand Maxwell's equations with the experimenter's approach, to build equipment showing that the electrical waves were like light waves and could be reflected, refracted, and polarized.

Hertz apparently never attempted to build a radio communications system but his papers, unlike those of Maxwell, could be more readily understood and therefore resulted in stimulating others to do so.

One of those was Marconi. John Kraus, in a recent paper in the IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, tells the story as follows: "If William Proxmire had been around in Hertz's time, Hertz's apparatus might well have received a Golden Fleece Award as a complete waste of money and effort—a toy of absolutely no practical value." Yet from this simple beginning has come all of wireless, all of radio, all of TV, and all of space communications.

However, Hertz's equipment did remain a laboratory curiosity for nearly a decade until 20-year-old Guglielmo Marconi, on a summer vacation in the Alps, chanced upon a magazine that described Hertz's experiments. Young Guglielmo wondered if these Hertzian waves could be used to send messages. He became obsessed with the idea, cut short his vacation, and rushed home to test it. The rest is history.

While perusing your advance program, I noticed that I was listed as the "father of the U.S. satellite communications industry." While I must admit to having a fair amount to do with the upbringing of this communications satellite child—a remarkably rapidly growing child, but one with a host of growing pains and difficult and complex behavioral patterns—I must deny any paternity claims. I believe that the credit for the more pleasurable contribution of conception belongs to my old friend Arthur Clarke, whom we have just seen on video tape. But even he did not visualize that this child would grow to maturity so quickly. He originally believed that commercial exploitation of communications satellites in synchronous orbit was unlikely before the end of this century. The key reason for the difference between that vision and reality really lies in the fantastic developments in solid-state technology in the intervening years and the enormous impact that these had on the size, weight, and operating lifetime of critical communications system components. But Clarke remains one of the most optimistic spokesmen for the enormous potential in communications technology and the importance of it to the sound development of our shrinking globe.

"It's probably true," Clarke has observed, "that in communications technology anything that can be conceived, and that does not violate natural laws, can be realized in practice. We may not be able to do it right now, owing to ignorance or economics, but those barriers are liable to be breached with remarkable speed." He goes on to point out that "man is a communicating animal; he demands news, information, entertainment, almost as much as food."

The proliferation of communications in this century is testament to the truth of these words. We have an insatiable appetite for knowledge. We crave ever-larger amounts of information, packaged in usable form and delivered to us at ever-increasing speeds. Microwave technology continues to be a driving force in satisfying this urgent need to exchange information and act swiftly on what we've learned.

It is sobering to reflect that microwave communications is still a remarkably young technology. Only toward the middle of this century did it begin to receive widespread use. And it was able to reach its full potential only with the advent of satellites.

Before that time, our ability to send vast amounts of information over long distances stopped at the water's edge. Microwave towers stretched across the landscape at intervals of 30 miles or so, but their utility was confined to the land.

We required some means for enabling microwaves to bridge the oceans of the world. And we found it in the satellite—a space-age tower in the sky that brought microwave technology to the service of international communications.

No longer did the oceans limit the spread of this technology. The satellite overcame all geographical barriers and caused us to revise our notions of distance. We began to reach out to points across the globe as easily as we dialed our neighbors across the street. For the first time in man's history, distance became irrelevant to communication.

Initially, satellites shared the same frequencies with terrestrial microwave systems. In order to minimize interference and congestion, we had to locate our earth stations in relatively remote areas. But as satellites moved into the higher frequencies of 14/11 gigahertz, new possibilities opened up.

For the first time, we could situate earth stations in urban centers as well as in the countryside. Improvements in technology led to smaller, more portable, more flexible antennas. We were able to move earth stations nearer to the customer, even putting one right on his premises if he wanted. And our industry was able to offer new services and networking arrangements more specifically tailored to individual customer needs.

From antennas perched atop office buildings to teleport complexes providing the interface between domestic and international networks—from backyard dishes pulling down TV programs to ground antennas feeding signals into elaborate terrestrial networks—our industry took off on a second wave of activity.

What lies ahead? Despite the sage advice of Sam Goldwyn never to make forecasts, "especially about the future," certain trends do seem apparent. Within the next five to ten years, we are likely to see satellites begin to make use of the 20/30-gigahertz frequency ranges. This development will yield more satellite capacity and flexibility.

Also, I believe we are going to see full direct broadcasting come into the marketplace. Dishes as tiny as two to three feet in diameter will be installed at residences to receive programming beamed directly into the home. When this occurs, satellite technology will have passed yet another milestone. The technology will have evolved from 100-foot-diameter antennas located away from population centers to small, flat-disk antennas inobtrusively placed right at our homes.

Already, we take microwave developments and satellite technology largely for granted. And perhaps this is a sign of its remarkable success in infiltrating our lives and becoming a crucial part of our existence.

Alfred North Whitehead makes a telling point when he says: "It is a profoundly erroneous truism, repeated by all copy books and by eminent people when they make speeches, that we should cultivate the habit of thinking of what we are doing. The precise opposite is the case. Civilization advances by extending the number of important operations which we can perform without thinking about them."

Our technology has become so second-nature to us that we have to step back every once in a while to appreciate how far we have come in such a short time.

Early Bird, launched in 1965, could handle only 240 circuits. The next generation of INTELSAT satellites each will have capacity for 40000 circuits.

Early Bird weighed some 33 kilograms and transmitted 4 watts of power. The INTELSAT VI satellite will weigh 2300 kilograms and put out 460 watts.

Early Bird provided only point-to-point connections at 6/4 gigahertz. The INTELSAT VI will have several distinct beams providing a sixfold reuse of the 6/4-gigahertz frequencies and it will employ two additional beams at 14/11 gigahertz.

For the future, with on-board satellite switching and the ability to shift the concentration of power rapidly from beam to beam as demand dictates, we will move toward satellites of enormous capacity and unprecedented flexibility. These new satellites will be amazingly agile and more than capable of serving tomorrow's broad array of international communications needs.

Back in the 1830's, Samuel Morse was arguing before Congress for the construction of a telegraph system. And he pointed out that it would not be long before the nation saw that electrical wires could "diffuse, with the speed of thought, a knowledge of all that is occurring throughout the land, making, in fact, one neighborhood of the whole country." In this century, we find ourselves speaking in similar terms—only this time about the entire world.

We are on the verge of seeing the broad-band capabilities of satellites and fiber-optic cables enable all manner of information to speed among computers in homes, factories, and offices across the globe. The teaming of computers and communications will yield astounding transformations in the way we live and work.

A century ago, Hertz demonstrated that a flow of current in one electrical circuit could produce a corresponding flow in another circuit. He could have had but the faintest inkling of what would emerge from his finding that electrical waves propagate through space at the speed of light.

We likewise are in the dark about where microwaves ultimately may take us. The more we learn, the more we recognize how little we know. The more we progress in applying our knowledge, the more we sense that our journey has only begun.

Einstein was once pressed to identify the most important personal insight he had gained as a man of science working in the twentieth century. He replied, "One thing I have learned in a long life: that all our science, measured against reality, is primitive and childlike—and yet it is the most precious thing we have."

So far, we have witnessed only the beginning of what this technology can do. Surely, in the future, we will see microwaves linking nations in ways undreamt of today. Just try to imagine what those observing the bicentenary of microwaves will be celebrating. We merely stand at the threshold.

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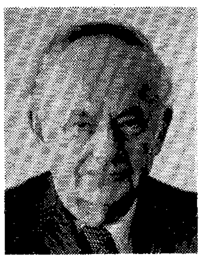

Dr. Charyk became President and a director shortly after the Corporation's incorporation in the District of Columbia on February 1, 1963. He was elected Chief Executive Officer on January 19, 1979, and, most recently, served as Chairman of the Board of Directors from May 1983 until his retirement, in October 1985. Before joining COMSAT, Dr. Charyk was with the United States Air Force as Chief Scientist and Assistant Secretary for Research and Development in 1959, and Under Secretary from January 1960 until February 1963. In 1955, he became Director of the Aerophysics and Chemistry Laboratory of Lockheed Aircraft Corporation. In 1956, he joined Aeronutronic Systems, Inc., a subsidiary of Ford Motor Company, as Director of the Missile Technology Laboratory and later became General Manager of the Space Technology Division. From 1943 to 1946, he was an engineer with the Jet Propulsion Laboratory at the California Institute of Technology, and was an instructor in aeronautics at the California Institute of Technology in 1945. From 1946 to 1955, he was a Professor of aeronautics at Princeton University, where he helped establish the Guggenheim Jet Propulsion Center.

Dr. Charyk was born in Canmore, Alberta, Canada, on September 9, 1920. He holds a B.Sc. degree in engineering physics from the University of Alberta, an M.S. in aeronautics, and a Ph.D. in aeronautics (magna cum laude) from the California Institute of Technology. He also holds an honorary LL.D. from the University of Alberta and an honorary Dr. Ing. from the University of Bologna.

Dr. Charyk is a Fellow of the American Institute of Aeronautics and Astronautics and a member of the National Academy of Engineering, the International Academy of Astronautics, the National Institute of Social Sciences, the National Space Club, and the Armed Forces Communications and Electronics Association. Dr. Charyk is also the recipient of numerous awards.