

April 1, 1958

Dear Doctor Eisenhower:

A recent development at the Applied Physics Laboratory seems to have such considerable possibilities as an instrument of international prestige that I am bringing it to your attention in a very early stage of its unfolding.

Briefly stated we have found that by observing the change in frequency of the radio waves transmitted by a satellite as it approaches and then recedes, it is possible to calculate very accurately the position of the observing station on the earth, if the orbit parameters of the satellite are known. The significance of this discovery lies in the relative simplicity of the equipment at the observing station and hence the adaptability of the method for accurate determination of position by ships, aircraft or land vehicles. While other methods of using satellites for navigation purposes have been proposed, it appears that the simplicity of our scheme is unique.

We have realized at once the military significance of this work and have discussed it with interested authorities in the Navy receiving considerable encouragement, and we propose to pursue the development vigorously under Navy auspices.

The development calls for the transport of stable oscillators on board satellites to control the frequency of the radio waves they send out, exact determination of the orbits of the satellite by methods now worked out and instrumented, and the development of simple stations for obtaining the signals, determining the doppler frequency changes accurately as a function of time and a special purpose computer for interpreting the results.

The chief outstanding research problem is a quantitative study of the propagation of the radio waves from the satellite to the earth.

Important as may be the military applications, the idea is too simple a one to hold secret for long and many people throughout the world are working in this field. However, its value to our Services does not depend on concealment of the idea from the enemy, but on the effective use we make of the technical developments it suggests. Realizing that any secret entailed in this development cannot be long kept from the rest of the world, we are of the opinion that the best thing for the country would be to capitalize on the possibilities of this development to enhance the prestige of the United States by using satellites to render their first important international service of great peacetime value to all people. By the development of a suitable series of satellites capable of transmitting stable radio frequencies for periods of several years, by publishing timely and precise information about their orbits, and by devising simple equipment for interpreting the doppler signals received, it should be possible to provide any ship, plane, vehicle, or person with a means of determining precisely where he is, at all times and in all weather.

This gives us the possibility of drawing from our first venture into space a dividend in which the whole world can share. The service provided would be similar to that now given by the exact time signals broadcast on a world wide basis by station WWV of the National Bureau of Standards.

You may be interested in the background of this work. Within a few hours of the announcement of the launching of Sputnik I, a few members of the Laboratory staff on their own time put together apparatus to listen to its radio signals and soon extended this work to determining the doppler effect on these signals as the satellite approached, passed by and receded. It was known that certain pieces of information about the nature of the satellite orbit could be obtained from such observations and, indeed, a number of groups in this country and in Great Britain made similar observations. The quality of the data seemed so good that certain members of the Laboratory devoted a great deal of effort to analyzing it and attempting to extract from it the maximum amount of information. In this effort, with the help of the Univac Computing machine, they were successful beyond their most sanguine hopes, finding from the observations of the doppler shift as a function of time in one pass of the satellite they were able to determine all eight parameters describing its orbit and the refraction of the radio signals. The parameters so obtained were in close agreement with the best observations published to date by U.S. and British workers. The success of this analysis suggested to some members of the Laboratory that the inverse problem, namely determining the position of the observing station from a knowledge of the doppler shift and the parameters of the satellite orbit, might be worth investigating. Up to date the results are so striking that their applications are being followed vigorously.

In the preliminary stages of any investigation of this sort there remains room for uncertainty about the final outcome, even though an atmosphere of optimism may prevail. We are trying to find means of reducing these uncertainties to the minimum but in the meantime are attempting to maintain the conservative attitude referred to popularly as "keeping our fingers crossed."

I shall keep you in touch with any major developments that may occur.

Yours sincerely,

R. E. Gibson

Doctor Milton S. Eisenhower
President
The Johns Hopkins University
Baltimore 18, Maryland