

# THE IONCAP PROGRAM ENHANCEMENT

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**ABSTRACT** The Ionospheric Communications Analysis and Prediction Program, known as IONCAP, is the most widely used HF transmission prediction program for US Military and other applications. From software applications viewpoint, however, the program is clumsy, slow and complicated as it allows only those users of having sufficient background in ionospheric physics and experience in computer data entry to operate the software.

The paper addresses a new version of IONCAP that first removes those obvious user-unfriendly shortcomings and next provides further advantage of enhancing the IONCAP program capability to the extent that a layperson can use it for various modern HF applications.

The fundamental tool applied is the Microsoft-based WINDOWS technology. To illustrate the ease of the operation of our enhanced program, we intend to provide a real system at the MILCOM meeting for on-site demonstration.

## I. INTRODUCTION

The Ionospheric Communications Analysis and Prediction Program, known as IONCAP, is the

most widely used HF transmission prediction program in the world. The program provides a parabolic modeling of the ionospheric electron density distribution by two parabolic layers, i.e., the E and F2 layers, with the height of maximum ionization, layer thickness, electron number densities, etc., derived from a stored database. It predicts the maximum frequency returned from the ionosphere, which establishes the upper limit of useful HF frequency range. Various possible modes of propagation via the ionosphere for a specified path are established. Finally, the program performs circuit calculation for deriving practical transmission parameters for either communications applications or other applications, such as broadcasting, the over-the-horizon radar transmission, etc. The program is recognized as a powerful program that estimates the strongest possible skywave signal, that when used in conjunction with an expected radio noise environment, yields the likelihood of a circuit operating satisfactorily over a required threshold. The likelihood may then be used as a criterion to select optimum frequencies, proper antennas, transmitting power, optimum time of operation, signal coverage, etc., for various applications.

For those who actually use the IONCAP program, it is known that the program is not

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generally user friendly. The program is compiled in a conventional manner in the relic of 70's with the input data entry, operational commands, applicational mode selection, and output presentations all being extensive tables or listings of numbers that need to be either "keyed in" or "read-out". The program can only be understood by users that have sufficient background in ionospheric physics and adequate experience in computer operations.

The enhancement work, as described in this paper, is to upgrade the operation of the IONCAP program for user-friendliness and as such, actually increase the capability of the program that will permit rapid (even realtime) and flexible use of the program for modern HF applications.

## II. SOFTWARE REPACKAGING

The essence of the effort is to reorient and repackage the IONCAP program. We use a powerful graphic tool, i.e., the Microsoft WINDOWS to achieve our objective. The work involves considerable amount of de-rigidize the program for layperson. The emphases are on input and output procedures in which we establish the mouse motion as the sole people-machine interaction medium. Tables and listing are no longer primarily output as the output presentation are largely graphics.

As to the capability enhancement, we completely do away with the original mode of operation that specifies the one-set-of-input before operation and creates one-set-of-output after operation. Rather, we reconfigure the IONCAP program as a real-time interactive program in the sense that vivid instantaneous motion of output curves on screen while the user changes its input parameters. To some extent, the program now behaves like a video game. More to it, the enhanced IONCAP program can now be used as an instantaneous design tool for all sorts of modern HF applications, such as the narrow-band or wideband mobile High Frequency communications network applications.

## III. BLACKBOXING THE IONOSPHERE

For actual communications users, details of ionosphere and wave propagation are not of interest. Their primary interest is on how to perform the system trade-off's. Unfortunately, the conventional IONCAP requires users to be reasonably knowledgeable about the ionosphere before they can manipulate the program. In our repackaging effort, we black-boxed the ionosphere such that users will not be forced to deal with the propagation physics.

We modularize the IONCAP program into sufficient details so that any improvement of the program for system applications is incorporated in a localized module that does not perturb other parts of the program. If the ionospheric physicists improve the propagation algorithm of IONCAP, from time to time, we can upgrade the algorithm accordingly without affecting the system applicational part of the software.

## IV. CONCLUSION

The essence of our effort is to reorient and repackage the IONCAP program. The reorientation is to allow typical system engineers and telecommunications decision makers, who do not necessarily have sufficient knowledge of the ionosphere and who are not accustomed to punch cards and keyboards, the convenient use of the program for their disciplinary applications. The repackaging enhances the IONCAP to provide output, and the evolution of the output, in graphic forms on a real time basis while the user continuous varies the input by mouse. This is particularly important for system trade-off exercises. We have enhanced IONCAP program to be manipulable like a video game program. The entire program is to be functional on an IBM PC computer for wide public circulation.

To illustrate our enhanced IONCAP program, we intend to provide an IBM-PC system for demonstration at the meeting.

Finally, we like to say a few words about future applications. The wave propagation in the ionosphere is a phenomenon; the phenomenon manifests itself differently for different types of systems of concern. For instance, fading level is a concern to a low-margin communications system in determining the link availability; excess time delay is a concern to a navigation system in determining the range and location; depolarization is a concern to a remote-sensing system which uses dual polarization returns to identify the target; non-stationary property is a concern to a tracking/surveillance system which has a requirement of setting proper dwell time when sweeping through the space; and common volume scattering is a concern to a jamming/anti-jamming system which has to be able to control the level of wanted to unwanted interference. For broader applications, the current IONCAP program has therefore to be further improved to produce different sets of output parameters that are appropriate for different system application.

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