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LabVIEW based communication system for Ionosonde with Hexadecimal data

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Abstract: The Ionosphere of the earth is very important from the point of view of communication. Its characteristics can be studied using RADAR called as Ionosonde. The data collected by the Ionosonde must be transferred to a PC for analysis. This communication is done using TCP/IP protocol with hexadecimal data format. A LabVIEW program is used to communicate with the Ionosonde system.

Keywords: ASCII, Hexadecimal, Internet, Ionosonde, LabVIEW, TCP/IP.

I. Introduction to Ionosonde system

Ionosphere is a part of earth's atmosphere extending from about 50 km to 500 km above the earth's surface. This layer is capable of reflecting radio waves send towards it back to the earth. Hence this layer is very important from the point of view of wireless communication.

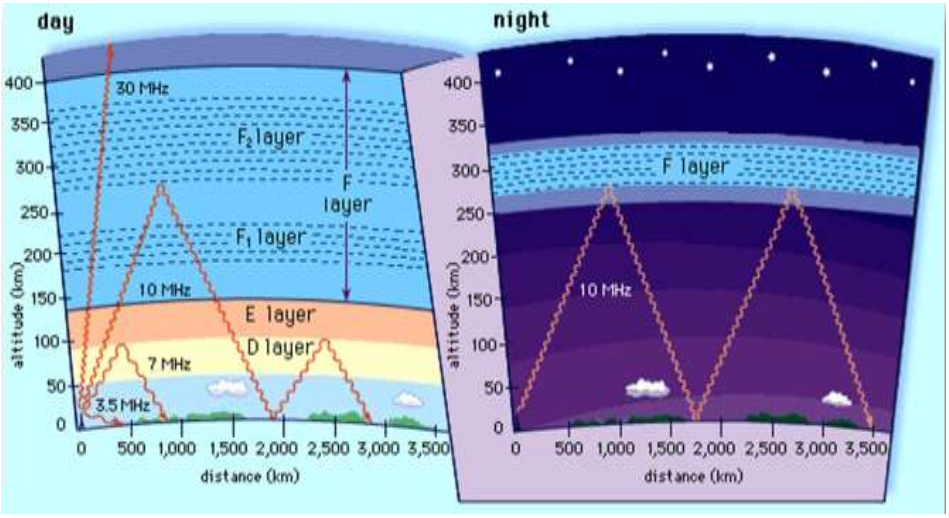

Figure 1: Ionosphere

The ionosphere comprises of different layers which are result of ionization and recombination process. These layers are having different composition and their height and existence depends on the time of the day and night.

Ionosonde is a RADAR used to study the Ionosphere. This system radiates pulsed electromagnetic radiation with carrier frequency in the range 1-20 MHz towards the sky. The received echo is subjected to the measurement of parameters like the amplitude, phase, Doppler frequency shift and polarization, as a function of the range. The parameters like critical frequency, virtual heights of ionospheric layers electron density profile are computed from these echoes. The other parameters like maximum usable frequency (MUF), skin distance etc can also be derived from the ionospheric observations in near real time.

A DSP hardware system is developed for processing Ionosonde Radar Signals in real time. This system is having 4 signal processing boards and one mother board.

The Motherboard generates the required transmit code signals with the help of DDS. These signals are fed to antenna to transmit into the space. The transmitted signals are reflected back from the ionosphere. An external signal conditioning sub-system (HF receiver) will receive these signals and amplify / band pass filter adaptively using suitable timing signals generated by the motherboard.

Over all, the DSP hardware system is capable of receiving 8 analog inputs as 4 pairs of received echo signals in two polarizations each. The echo signals are received by the receiving antennae and these received signals are fed to the inputs of signal processing boards, where, these signals are digitized and digitally down converted (HF to base band). In-phase and Quadrature-phase signals are derived by using the digital down converter. This down converted data is sent to PC via mother board. Mother board transfers the down converted data to PC via Ethernet interface. The communication between the motherboard and computer uses hexadecimal data.

II. Hexadecimal and ASCII format communication

Hexadecimal data is almost universally used in computing. It is a positional numeral system which has base 16. It uses symbols 0 to 9 and A to F. Each hexadecimal digit represents 4 bits. Its primary use is a human friendly representation of binary coded values in computing.
First advantage of hexadecimal data format is that it can be used to write down very large integers in compact form. As the value of the number increases, the difference between lengths of hexadecimal representation and its decimal form becomes more pronounced. The most significant advantage is that the hex values are closely related to binary values.

Hexadecimal format communication is required when data is required to be sent to microprocessors of controllers for direct processing. If the data is intended to be displayed, then hexadecimal numbers tend to produce non-readable characters on the display. In that case, ASCII format is preferable.

ASCII is a character encoding scheme based on the English alphabet [1]. Hence it can represent the different characters properly for purposes such as displaying on a screen. It is used to represent text in computers and other devices that use text. Most modern character encoding schemes are based on ASCII.

III. TCP/IP communication in LabVIEW

LabVIEW contains a set of functions related to TCP/IP for setting up internet communication [2]. The architecture used in LabVIEW for internet communication is the Client-Server architecture. One terminal will act as the server terminal. This terminal generally provides data to the clients. Hence the server manages the centralized database. The clients can access the database through the server only. The server can also read data from the clients for storage in the database.

The client is a computer or a device which relies on the server for its data requirements. The client connects to the server via a network.
The communication is always initiated by the client. The server responds to the incoming requests. The link is then set up between the client and the server. The data is then transferred between the two. [3]

The default format used by LabVIEW for TCP/IP communication is ASCII. Hence if we directly write some data using the TCP Write function, then the data is transmitted in ASCII Format.

IV. Hexadecimal format communication

For hexadecimal format communication, we are having the data to be transmitted already in hexadecimal format. But for transmission over internet, it must be in string form. So some conversion is needed.
First the data must be converted into an array form. In this array, each element contains a byte of data in hexadecimal format. This data can then be converted to string format. This is done using the "Byte to string converter" function. This data can now be transmitted over TCP/IP. If the hexadecimal data is being read from a file stored on the computer, then it can be read using the Read spreadsheet function or Read text file function, as per the requirement. The data is then stored into an array and further processed as indicated above. The block diagrams for client and server using hexadecimal data format are shown in this paper. The Server uses the TCP Listen function and keeps waiting for an incoming request from a client. The client can then communicate with the server using the TCP Open connection function. The Server's IP address must be given to the client. Also the server and client must communicate on the same port [5].

The following figure shows the block diagram of a Client which is sending hexadecimal data over TCP network.

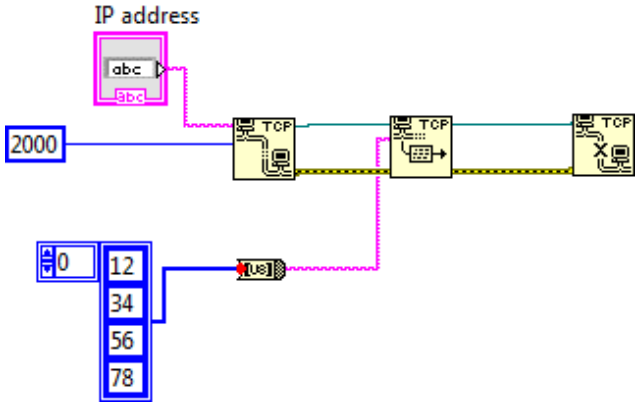

Figure 2: Client Block diagram for hex communication

Similarly data is received over TCP/IP using the TCP read function. This data is again received in string format. Hence it must be converted. This is done using the "String to Byte converter" function.

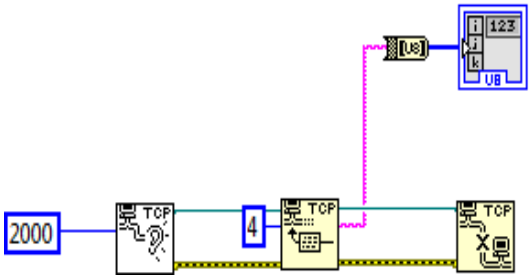

Figure 3: Server Block Diagram for hex communication

This is the block diagram of a server which receives the hexadecimal data from the client over internet.

Conclusion

Ionospheric radio link is an important method of wireless communication. The parameters needed to setup this radio link, such as the frequency of the carrier, the transmitted power, the type of modulation, the angle of radiation, etc. can be decided only after knowing the profile of ionization in the earth's atmosphere, or at least some parameters related to the Ionosphere. An ionosonde is used for finding the optimum operation frequencies for broadcasts or two-way communications in the high frequency range.

Hexadecimal communication is used when the data is to be sent to a processor for direct processing, whereas ASCII is preferred in cases where the data is to be displayed rather than processed. The hexadecimal communication requires an additional step of conversion, but time is made up in the actual transmission

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