A REVOLUTIONARY ANTENNA CONCEPT

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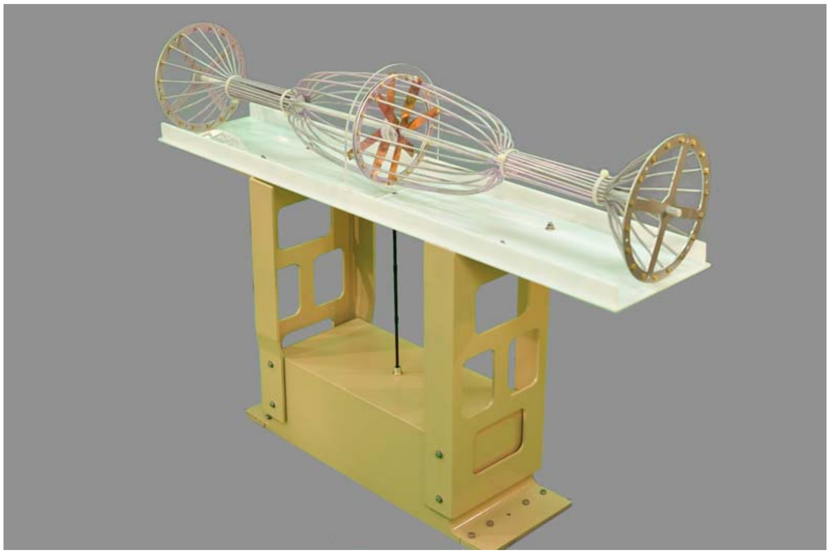
INTRODUCTION: Before satellites allowed long range communications, HF radio was the only solution. Now there are a finite number of satellites, thus there is a limit to the number of users. For example in the military, unless you have a high priority, you are out of luck. So, you are now dependent on HF radio – we have gone full circle.

The antenna concept described in this article overcomes the deficiencies of conventional antennas including their very large size, which places a severe limit to mobility. The new patented[3] HF antenna for NVIS communications is shown without the protective cover which is only 4 feet in length. An automatic antenna tuner is housed in the base of the mount.

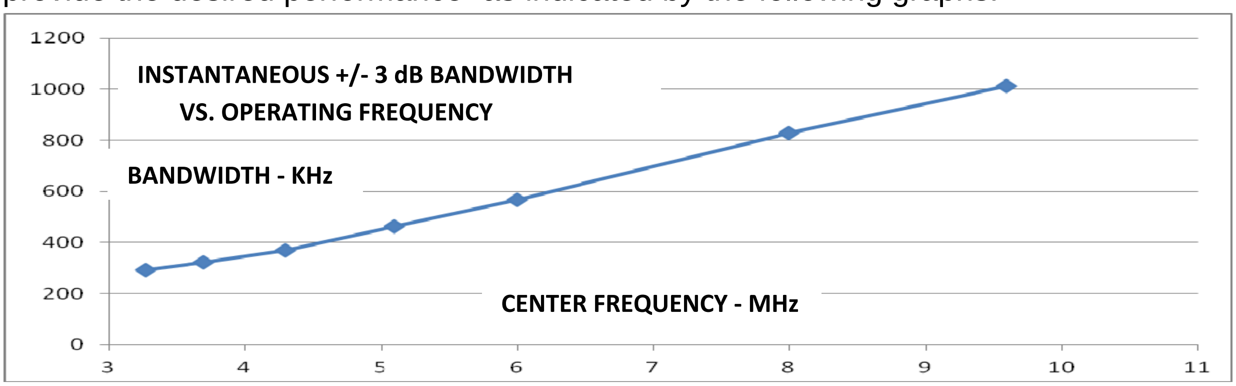


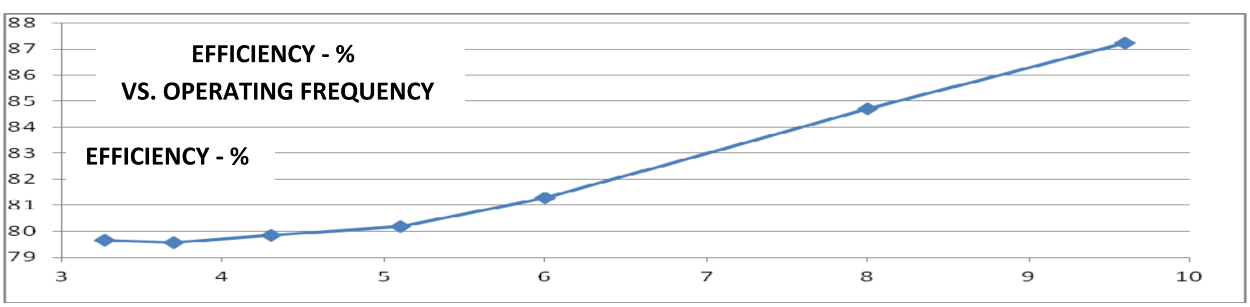
TYPICAL APPLICATION: There are numerous military and commercial applications for such an antenna; however, after the 9/11 attack and the resulting establishment of the Department of Homeland Security, it became apparent that large segments of the Nation's communication system could result in a massive shut down. In view of this, Congress and the Administration recognized that a successful response to a future major incident, either a terrorist attack or in case of a Katrina type natural disaster, would require interoperability between the Nations public safety, public health and emergency management entities at all levels both public and private. The Department of Homeland Security (DHS) developed the National Emergency Communications Plan (NECP). This plan was tasked with providing the ability for federal, state, and local government agencies to continue to communicate in the event of disasters.

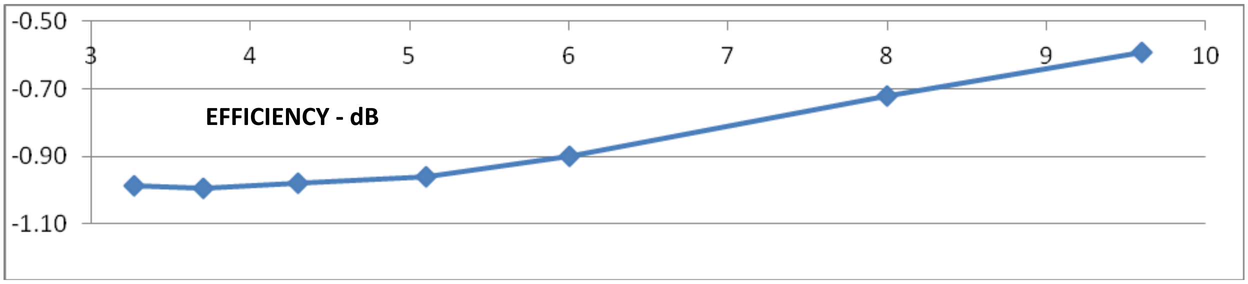
The National Communications System (NCS) agency through the Shared Resources (SHARES) High Frequency Radio Program played heavily in to this movement by promoting interoperability between High Frequency (HF) radio systems used by the Federal Departments and agencies. The SHARES HF Radio Program provides a backup communications capability through an established HF radio communication infrastructure of existing federally controlled HF radio stations. These stations with their elegant fixed dipole, and other antenna arrays do not lend themselves to a movement down the infrastructure chain, into applications such as local hospital, public service, and even Federal regional office complexes in towns, cities, or mobile applications where the large dipole antenna is simply not practical; thus, ushering in the need for a small compact HF antenna with performance numbers comparable to the standard dipole, but with 24KHz/48KHz bandwidth capacity that accommodates in excess of 120,000 bps data rates… previously unheard of within the HF band.

NEED FOR A NEW DESIGN: The antennas in current use are known as Hertz antennas developed in the late 1880's. Typically they are ½ wavelength long and, for optimum performance, are mounted ¼ wavelength above ground. At 4 MHz, for example, the antenna is 120 feet long and 60 feet high. It is mounted horizontally to allow the radiated signal to propagate at high angles. The signal bounces off the ionosphere and down to the receiver at a far distance, typically out to about 600 miles during the day, much further at night. In use, the ionosphere continually changes thus creating the need for an antenna that can be readily shifted to any frequency over the range of about 3.5 to 8 MHz. For much greater distances vertical antennas are used for low angle propagation in the 8 to 30 MHz range.

ENTER THE EH ANTENNA: There has always been a need for a small high efficiency antenna with broad instantaneous bandwidth. That was an oxymoron until the EH Antenna came on the scene. For the 3.5 to 8 MHz range an antenna that is only 4 feet in length and mounted 2 feet above the ground (or roof of a building or vehicle) can provide the desired performance as indicated by the following graphs:

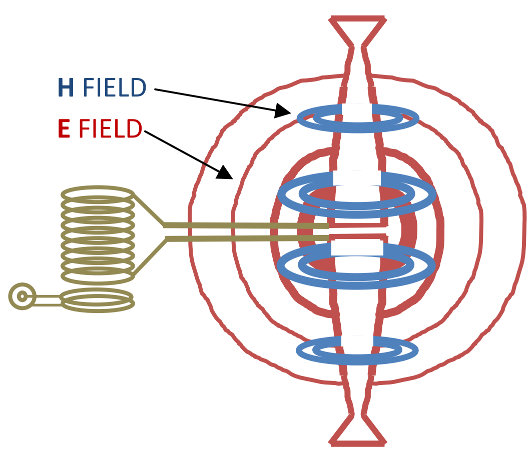






TECHNICAL CONSIDERATIONS: To gain a total understanding of the significance of the new antenna concept we need to review the history of antennas. In the beginning there was the Hertz antenna, basically a length of wire that allowed radiation. The working Hertz antenna is typically a resonant antenna including the common horizontal wire dipole. When RF voltage (a sine wave) is applied, current flows on the wire. That current causes the development of a magnetic field surrounding the wire. A changing magnetic field creates an electric field. Radiation occurs when the electric (**E**) and magnetic (**H**) fields are combined. Unfortunately, since one field creates the other, they are 90 degrees displaced in time. Because the fields propagate at different rates, they do not combine until the "far field" distance from the antenna. Therefore the fields have a very large volume when they combine. The fields interact with ground and other items where absorption reduces the efficiency of the antenna. In addition, these fields cause interference to electronic equipment.

With that background of the "conventional antenna", we now consider the **EH** antenna concept. Envision a dipole with very short but large diameter elements. This arrangement has relatively high capacity between the elements. A parallel tuning coil allows resonance at the desired operating frequency and provides a source of high voltage between the cylinders. With reference to the figure below note that when a voltage is applied to the cylinders a large electric field is developed that surrounds the cylinders but is more concentrated between the two cylinders. The difference in voltage potential between the top and bottom of each cylinder causes current to flow on the cylinder, which creates an **H** field. As an indication of the timing between the **E** and **H** fields note that the current flow only occurs while the voltage is present. Also note that the **E** and **H** fields are physically orthogonal to each other. Now the Poynting theorem is satisfied and the two fields are efficiently integrated to produce radiation at the antenna. In effect, the far field has been moved to the antenna.



- The net result of this simple configuration is as follows:
    - The EH Antenna[3] is very small and may have a total length of less than 1% of a wavelength. Typically the length is

nominally 3% of a wavelength but may be more if greater bandwidth is desired.

- The EH Antenna physical shape[4] determines the gain relative to conventional wire antennas.
- The EH Antenna may be tuned over a very wide frequency range with relatively constant radiation resistance so long as the antenna is small compared to a wavelength.
- The EH Antenna has very broad instantaneous bandwidth due to large capacity and high radiation resistance which is a result of efficiently integrating the **E** and **H** fields.
- The EH Antenna has high efficiency due to low loss (in the tuning coil) and high radiation resistance.
- The EH Antenna has low radiation resistance at all frequencies other than at resonance, therefore has low harmonic radiation.
- The EH Antenna is compatible with other electronic equipment because the **E** and **H** fields are contained within the sphere of the antenna, unlike the very large fields created by the Hertz antenna that cause Electromagnetic Interference (EMI).
- The EH Antenna has the same capture area as a full size antenna in spite of its size. It is not sensitive to independent **E** or **H** fields; therefore it is a very low-noise receiving antenna in the presence of manmade noise. These two factors result in an exceptional receiving antenna.
- When mounted as a vertical antenna it is a miniature dipole and therefore does not need radials, just a lightning ground. When mounted at a height of 1/8 wavelength the ground wave radiation equals that of a conventional ¼ wavelength antenna with buried radials.
- At VHF frequencies the EH Antenna used on hand held radios has gain and elliptical polarization (almost circular), thus allowing excellent communications whereas conventional vertical antennas would suffer from multiple reflections especially in large city areas.
- All communicators including AM Broadcast and all frequencies in the HF and VHF spectrum can now realize their dream antenna.

This article is the first public presentation of the EH Antenna that is now in production. This article does not contain references because of it being new technology. Additional details may be obtained at bmcarthur@alphacognetics.com. Please visit us at booth 772 at IWCE 2013 to see this remarkable antenna system and others for different frequency ranges.

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[2]-Barrie McArthur-72 (BSEE) Mississippi State University came up through the communication ranks at Collins Radio (now Rockwell Collins), Diversified Technology, Inc, Omega-Tec LLC, and is now President/CEO of Alpha Cognetics LLC.

[3] EH Antenna - Patent US6,486,846

[4] Paul Birke – Retired Engineer Westinghouse Canada and specialist in Field Theory. He influenced the shape of the antenna to optimize performance. nonlinear@rogers.com

Special Note: Hart and Birke are co-authors of a new text book that will present the theory of the EH Antenna. This is pertinent since this is the first change in antenna concept since 1880. That book is nearing completion and will be released in 2013.