

The Radio Hotel – Antenna Development Challenge

.....a Heads Up

by Rick Hiller – W5RH

The IARPA* in 2021 announced a challenge to the commercial and academic communities dealing with ESA's – Electrically Small Antennas. Just what is an ESA? It is an antenna that is typically .1, or less, of a wavelength long. The challenge is to present a designed ESA implementation that can be used from HF thru to SHF frequencies with 10 dB gain over current art. The IARPA has given a deadline of four years out, but in 3 steps: within 18 months show a meaningful design, 15 more months to demonstrate a prototype of 6dB gain and in the final 12 months demonstrate a 10dB gain product. [*Note: the original challenge can be found at <https://www.iarpa.gov/research-programs/equal-p>]*

So how do you give gain to a smaller than normal antenna, when it starts out behind the 8-ball in it's radiation field strength? For a start, you must think outside of the 80 year old antenna design tools box that is based on the LTI (Linear Time-Invariant) antenna system principles for a start. Hams are typically using LTI based antennas and are mainly interested in multi-banding, antenna gain, the radiation polarization and pattern (direction and angle of radiation), noise reduction, feed point/transmission line matching, physical size and degree of difficulty when deploying. If we wish to increase the gain of an LTI antenna system we can use parasitic elements, phasing of multiple elements and longer than ½ wl antennas. We can easily increase the radiation field strength by using more transmit power or by using a pre-amp on the receive side of things. Of course, both of these last listed solutions come with a slight caveat of increased \$'s and change out of the support equipment within the antenna system.

The small Mag Loop antennas, that quite a few hams use, are an example of an ESA. If you wish to read more in-depth about ESA's or the challenge, the below list of url's might just get you down that infamous rabbit hole. Speaking of rabbit holes; have a look at The Radio Hotel column "**AA0ST and Antennas 'Thru the Looking Glass'** <http://bvarc.org/newsletter/201704.pdf> " in the April 2017 BVARC Beacon. This is a related column concerning Chu's Limit and Non-foster elements, etc. If you research this a bit more, you will find that most of the principles defining ESA's were established in the mid-1900's and are still the limiting LTI antenna performance factors today. Hence the challenge from the IARPA.

From an antenna design interest standpoint, IARPA's challenge is going to be a very intense and enlightening exercise. The solution most probably will utilize non-LTI techniques and materials that we Hams have yet to discover. Although they do point out that there is a potential to fail, as this requirement is severely pushing the limits of current day physical capabilities. I, however, look forward to seeing what they can show us as they push forward to the edge of the antenna design envelope and beyond.

Enjoy the challenge. Enjoy your hobby. 73, Rick W5RH

Copy and paste these url's

Info on the challenge

<https://spectrum.ieee.org/electrically-small-antenna>

<https://www.iarpa.gov/newsroom/article/equal-p-not-all-antennas-are-created-equal>

<https://www.iarpa.gov/research-programs/equal-p>

Basics of an ESA

https://www.highfrequencyelectronics.com/Feb07/HFE0207_tutorial.pdf

Designing ESA's

<https://www.mwrf.com/technologies/components/article/21848593/meet-the-challenge-of-designing-electrically-small-antennas>

***IARPA – Intelligence Advanced Research Projects Activity**

*The purpose of **The Radio Hotel** is to give you a practical kick start into exploring the workings of antenna systems Google the buzz words and find out what they mean. Read up on antenna system theory to see how it all works together. You will be glad you did.*