



2018 IEEE AP-S Student Design Contest: Radiolocation and Channel Sounding

Travel to the 2018 IEEE AP-S USNC-URSI and win up to US \$1,500!



Join the 9th IEEE Antennas and Propagation Society (AP-S) Antenna Design Contest! Design and build a radio system to sound a radio channel in real time localize the position of a hidden transmitter. The top 6 teams will receive up to US \$2,500 in travel funds to attend the IEEE Antennas and Propagation Symposium in Boston, Massachusetts, July 8-13, 2018 to demonstrate their working systems. From these 6 teams, 1st, 2nd and 3rd place winners will be announced at the 2018 IEEE AP-S Awards Presentation at the conference and will receive cash awards of US\$1,500, \$750 and \$250, respectively. Final reports will have the opportunity to be considered for publication in the IEEE AP Magazine. Important deadlines are **November 24, 2017** and **March 30, 2018**.

Goal: Design and build a radio system to sound a radio channel in real time and accurately determine the location of a hidden transmitter.

Specifications:

- The channel sounder must be portable. Excluding an external computer (if needed), the dimensions of the system must not exceed 1m x 1m x 0.1m.
- The system must be able to function on a battery.
- The system must sound the channel and localize the transmitter in real time.
- Teams will engage in a “fox hunt” at the Symposium to find the actual hidden transmitter using their system.
- The technical details of the transmitter will can be found in the appendix at the end of this document. Broadly, the transmitter will
 - Utilize a center frequency within the 5 GHz ISM band (5.725 – 5.875 GHz);
 - Transmit a modulated pseudo-noise (PN) sequence at a prescribed rate.
- Merit will be assigned to designs based on the following criteria, equally weighted:
 - Creativity and justification of the design;
 - Capabilities of the channel sounder to extract useful metrics about the channel, e.g. delay spread profile, transfer function, polarimetric information, angle-of-arrival information, etc.;
 - The ability of the team to find an actual hidden transmitter at the Symposium;
 - Quality of the experimental model and results.
- Existing licensed software at the university (e.g., electromagnetic simulation software) or free software may be used. Any other commercial software used for the project should be included in the budget. The total production cost for the entire system must be less than US\$1,500.

Eligibility:

The team should consist of 2 to 5 students, with at least 50% being undergraduate students. For a 5-year Bachelor-cum-Master degree program, students in years 1 to 3 are considered undergraduates. Each team should be advised

by a professional mentor who is a member of the IEEE AP-S, but the work needs to be done primarily by the students. No student or mentor should be involved in more than one team.

The Application and Review Process:

1. All applicants must submit a preliminary design by **November 24, 2017**. It must include:
 - a. A proposal limited to two pages and in 12-pt Times New Roman font that includes
 - i) A detailed description of the link scenario being considered by the design.
 - ii) A detailed description of the system to be built.
 - iii) A bill of materials (up to US \$1,500).
 - b. A letter from a professional mentor, such as a professor or engineer in industry indicating agreement to supervise the project (the students being mainly responsible for doing the work). The mentor must be an AP-S member (please provide IEEE membership number) and must verify that all team members are graduate or undergraduate students at a university, college, or technical school. The proposal and letter must be integrated into a single PDF file named TeamName.pdf.
2. The college of reviewers will assess each preliminary design based on likelihood of achieving the design goal and specifications, creativity, and quality of written materials. Six semi-finalist teams will be selected by **December 15, 2017** and will receive US\$1,500 each to build and test their designs.
3. Each of the six semi-finalist teams must submit their final design by **March 30, 2018** in the form of a video demonstration of the working system (≤ 5 minutes), and a final report (≤ 5 pages) in PDF format (≤ 5 MB file size). Submission instructions for the video demonstration will be provided later (some videos from previous contests are available on YouTube – search for “AP-S Student Design Contest”). The report should follow the two-column format of the IEEE Transactions on Antennas and Propagation and include:
 - i) A detailed description of the system’s design and channel sounding capabilities
 - ii) A list of parts and materials required, including where to obtain them and costs.
 - iii) Photos of the final system (including a scale to show how large it is).
 - iv) Measurements obtained using the system for the specified test scenarios.
 - v) Biographies (100 words or less each) and photos of all design team members.
4. Several Design Contest Judges will be appointed to assess each semi-finalist’s design based on achieved performance, creativity, completeness of the description, functionality of the system as determined by the video, and quality of written materials. Six finalist teams will be selected by April 28, 2018 to receive stipends of up to US\$2,500 per team to travel to and attend the IEEE AP-S Symposium. The stipend is intended to cover equipment shipping costs and all expenses for one team representative; however, it may be divided among multiple team members.
5. The finalists will be expected to demonstrate their working systems during the Symposium and attend the Awards Banquet. Two celebratory dinner tickets will be reimbursed per team, for one team member and the team mentor. Each team should bring all necessary equipment for the demonstration. The received power will be measured for the test scenarios using the same experimental setup. The Design Contest Judges will assess the final demonstrations and take into account the final reports to select the 1st, 2nd, and 3rd prize winners, who will receive certificates and cash prizes of US\$1,500, \$750 and \$250, respectively. The prize winners will be announced at the Awards Presentation.
6. After the Symposium, the finalists may revise their final reports for possible submission and publication in the IEEE AP Magazine under the Education Column (the reports will be reviewed and must meet Magazine standards). Team mentors may either be listed as a co-author or acknowledged in the paper.

How to Submit Materials:

Send all questions and materials to designcontest@ieeeaps.org with the subject line “2018 IEEE AP-S Design Contest.” **Messages without this subject line may not be received.** All submitted materials must be in PDF format according to the guidelines above.

Appendix: Transmitter Details

The transmitter characteristics are as follows. Transmitter characteristics will be finalized after selection of finalists.

- The transmitter's center frequency is within the 5 GHz ISM band (5.725 – 5.875 GHz). Receivers must be capable of tuning to any frequency within this band. The carrier frequency will nominally be 5.8 GHz.
- The carrier will be modulated using BPSK.
- The baseband transmitter signal will be a pseudo-noise (PN) sequence generated by a linear a 9th order feedback shift-register (PN9) at rate of 1 Mchips/s. Details of the PN9 sequency can be found here:

<http://rfmw.em.keysight.com/wireless/helpfiles/n7617b/Content/Main/PN%20sequence%20generation.htm>

- Raised cosine (root Nyquist) filtering with a rolloff factor of 0.5 will be applied to the baseband signal.
- The modulated signal will be amplified and applied to a single monopole antenna.
- The EIRP of the transmitter will not exceed ISM limitations in the 5 GHz ISM band (30 dBm transmit power, 36 dBm EIRP).