

# Using a Dynamic Channel Emulator to Support Over the Air Testing by Student Design Teams

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Student design teams provide students with opportunities to participate in intramural competitions or major projects and gain practical experience with leading edge technologies. Many of these projects use wireless technology to connect student operators with remote devices such as solar-powered vehicles, electric vehicles, drones, rockets and satellites. Initially, many students pursue such wireless design efforts with a hobbyist's mindset and implement designs based on their best understanding of the problem followed by fixes once issues are observed in the field. In the case of rockets, such an approach is both time-consuming and expensive. In the case of satellites, only a very limited number of software changes are possible once the satellite launched. Accordingly, we are encouraging student design teams to adopt a test culture in which requirements are defined in advance and implementation-independent tests are devised before design begins. This permits a significant number of potential flaws to be identified before the system is fielded and allows students to more fully develop their design intuition. This is not a moot problem. Failure of the communication subsystem has been responsible for approximately 20% of small satellite mission failures over the period between 2000 and 2019. Insufficient system-level integration and testing has been cited as one reason why corrective actions weren't taken to prevent such failures before launch.

While many student designers use inline attenuators to simulate the worst-case path loss that their system will experience, this is insufficient in aerospace applications where Doppler shift, the rate of change of path loss due to vehicle trajectory, fading due to vehicle rotation, and even deficiencies in antenna performance can be significant. In response, we have developed a GTEM-based dynamic channel emulator that will permit designers of rocket and CubeSat payloads operating at frequencies up to 20 GHz to evaluate their vehicle's communications subsystem over multiple simulated flights or passes with the spacecraft in as close to flight condition as possible including fully deployed antennas. A block diagram is shown in Fig. 1. Such tests confirm that the communications subsystem will function correctly while experiencing: 1) path loss and Doppler shift, 2) random fading due to vehicle motion or rain fading, and 3) noise, interference, or scintillation that perfectly matches what would be experienced during actual flights or passes. Initial use of the facility by student design teams confirms that our dynamic channel emulator is an effective way to close the loop during the design process and enhance the student experience.

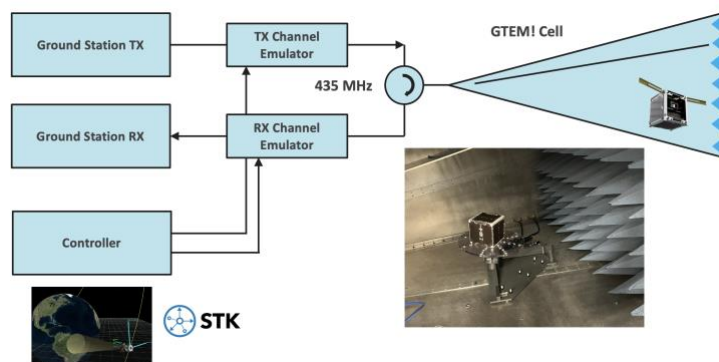


Fig. 1 – Dynamic Channel Emulator

