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A Regulatory Play-By-Play Of The Super Bowl Drone Show

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It's time to answer the most important question on everyone's mind after Super Bowl LI: what type of regulatory approvals and deviations were required to enable Intel's massive display of 300 choreographed unmanned aircraft systems (UAS) that kicked off Lady Gaga's Super Bowl halftime show?

The halftime show began with Gaga singing a mashup of "God Bless America" and "This Land Is Your Land" while standing on the open roof of Houston's NRG Stadium. The camera panned out to reveal a sky of 300 UAS shimmering like stars behind the headliner.

Still swirling around the sky, the white lights of the UAS faded to red and blue. The aircraft then shifted to form the image of an American flag to accompany the patriotic number.

After concluding with a line from the Pledge of Allegiance, Lady Gaga appeared to jump into the stadium, and the sky faded to black. At the end of the performance, the drones returned to form the logos for Pepsi (the sponsor of the halftime show) and Intel.

This is not Intel's first UAS light show, nor its first performance in the U.S. The company debuted its "Drone 100" — a lightshow of 100 simultaneously operating UAS — in 2015 in Germany. In October 2016, Intel put on a 500-UAS display, also in Germany. And this past November, Intel's "Shooting Star" UAS debuted in the U.S. with a 300-UAS holiday-themed show at Florida's Walt Disney World Resort.

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While the impressive display of choreographed drones may look effortless, Intel's halftime show was the result not only of significant technological coordination and planning, but also considerable regulatory hoop-jumping.

Although the Federal Aviation Administration (FAA) has taken important steps toward facilitating the integration of commercial UAS operations into the National Airspace System by adopting its Part 107 regulations, these regulations by themselves would not allow a spectacle like the one Intel and Lady Gaga put together.

Part 107 imposes restrictions on altitude, nighttime operations, operations in certain airspace, operations over people, compliance with flight restrictions and simultaneous operation of multiple UAS, any one of which would have been enough to keep the halftime show grounded.

Intel avoided a number of the most significant regulatory hurdles by employing a little bit of movie magic. Fans sitting at home may have assumed that the UAS were dancing live above the thousands of fans watching the Super Bowl, but in fact this part of the performance was pre-taped.

While every part of Lady Gaga's performance that took place inside the stadium was live, her patriotic introduction was filmed several days in advance. This enabled Intel to avoid two major restrictions:

- The Super Bowl temporary flight restriction (TFR). Every year, the FAA imposes a TFR to prohibit certain aircraft operations within a wide radius of the Super Bowl. This year was no exception, and, in light of the massive proliferation of UAS use by commercial operators and hobbyists alike, the FAA even made clear that Houston would be a "No Drone Zone" for the Super Bowl.
- Prohibition on flights over people. The Part 107 rules prohibit operations over people other than those involved in flying the UAS. By filming in advance, Intel could better ensure that the UAS operations adjacent to the NRG stadium, a venue that seats more than 72,000, would not be conducted over any people. Although Intel has confirmed that Lady Gaga was in fact on the roof of the stadium when the UAS were filmed, the FAA has explained that the rules prohibit only those operations that are "directly over any part of a person." Thus, the UAS operating in the airspace behind Gaga would not violate the flight over persons rule, although Intel was required by other Part 107 rules to ensure, taking into account the course, speed, and trajectory of the UAS, that the operations were sufficiently far enough away from Gaga so as not to endanger her life or impose an undue hazard to her in the event of loss of control.

Intel dealt with the remainder of the regulatory restrictions by obtaining waivers from the FAA. The Part 107 rules permit the FAA administrator to waive several of the Part 107 operating requirements "if the Administrator finds that a proposed small UAS operation can safely be conducted under the terms of that certificate of waiver." Intel's halftime show required waivers of the following:

- Prohibition on Nighttime Operation. The rules prohibit nighttime UAS operations, and it was well after dark when Lady Gaga took to the roof of the stadium. Intel received a waiver of this rule in September

2016. Intel's certificate of waiver requires, among other things, that the UAS be lighted to allow the pilot to retain visual line of sight (VLOS) — a condition that obviously posed no concern when Intel's Shooting Stars were illuminating the sky, although it is less clear how Intel maintained VLOS when the drones appeared to go completely dark during the performance.

- Prohibition on Simultaneous Operation of Multiple UAS. Pilots operating under Part 107 may operate only one UAS at a time. Intel's September 2016 waiver permits operations of multiple UAS so long as the pilot meets certain conditions, including activating a "cylindrical two-layer geo-fence system" and associated flight control system that provides visual alerts if any of the UAS come into contact with the geo-fence boundaries. The waiver also imposes a .75-pound weight limit on the UAS that may be operated simultaneously. According to Intel, the Shooting Stars weigh only 280 grams, or .61 pounds.
- Altitude Restrictions. The Part 107 rules limit operations to 400 feet above ground level. Intel reports that it obtained a waiver to fly up to 700 feet for the performance. Although the FAA makes granted Part 107 waivers available on its website, Intel's altitude waiver is not yet available.
- Airspace Restrictions. Operators must obtain prior authorization from Air Traffic Control to operate in Class B, Class C, or Class D, and certain parts of Class E airspace. The FAA has established an online process mirroring its waiver process for requesting to operate in restricted airspace. Intel has stated that its 700-foot waiver also permits operations in Class B airspace to enable the Super Bowl performance.

Ultimately, the regulatory hurdles to orchestrating 300 drones to fly above a Super Bowl halftime show did not prove particularly challenging, but required sacrificing the component that would have brought a major "wow" factor — live performance.

Representatives from Intel have suggested that concerns about weather, and not regulatory restrictions, were the primary impetus for pre-filming the event, although it is unclear whether the FAA would have waived its flights-over-people restriction (to the extent such a waiver was required) or allowed Intel to circumvent a TFR to conduct its performance.

In the meantime, Intel's efforts will help de-mystify UAS technology, and demonstrate the benefits that UAS integration can provide. After all, it is hard to imagine that the UAS were more dangerous than a live fireworks display.