Efforts to deliver the first drone-based, mobile quantum network

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From left: FAU graduate student Anthony Davis; Warner A. Miller, Ph.D.; and collaborator Pedram Nimreezi, stand behind the large drone, which includes a network of a ground station, lasers and fiber optics. Photo by Alex Dolce. Credit: Florida Atlantic University

Hacked bank and Twitter accounts, malicious power outages and

attempts to tamper with medical records threaten the security of the nation's health, money, energy, society and infrastructure. Harnessing the laws of nature—namely quantum physics—a cutting-edge teleportation technology is taking cybersecurity to new, "unhackable" heights using miniscule particles of light, or "beams."

Florida Atlantic University's Warner A. Miller, Ph.D., in concert with Qubitekk and L3Harris , is leading the United States' efforts to deliver the first drone-based, mobile quantum network to seamlessly maneuver around buildings, inclement weather and terrain and quickly adapt to changing environments such as warfare.

Together with Qubitekk, an award-winning leader in manufacturing entangled photon sources and other hardware for networking quantum processors and sensors, FAU has been entrusted by the U.S. Office of the Secretary of Defense to develop the project.

The network includes a ground station, drones, lasers and fiber optics to share quantum-secured information. Today's telecommunication networks use fiber optics, connected by laser beams from the ground and between planes and satellites—called fiber and free space optical networks. Drones are used to save lives, secure infrastructure, help the environment and thwart hostile military advances such as the war between Russia and Ukraine.

"The combination of quantum communication and unmanned aerial systems or UAS in this project represents an important advance in the Air Force's efforts to create fieldable quantum systems for the warfighter," said A. Matthew Smith, Ph.D., a senior research physicist at the Air Force Research Laboratory (AFRL) Information Directorate. "Additionally, the potential of secure communication from a portable quantum communication UAS in contested environments represents important future capabilities for the Air Force."

Miller is a professor of physics in FAU's Charles E. Schmidt College of Science and a retired lieutenant colonel, U.S. Air Force, who served honorably for 28 years and received a Meritorious Service Medal with Oak Leaf Cluster. He played a critical role in recently obtaining a $1.5 million Phase II Small Business Technology Transfer (STTR) federal grant awarded to Qubitekk. Miller also is collaborating with L3Harris, an agile global aerospace and defense technology innovator that has been involved in the project since 2019.

The team is collaborating with the U.S. Air Force to combine expertise from academia, including the University of Illinois Urbana-Champaign, government and industry with the future potential to scale up the project for larger applications with larger aerial platforms, as well as other ground and maritime platforms.

"The contract award represents a new stage in the development of two technologies. For quantum, it's a major step toward creating hack-proof quantum communication networks that will eventually span the globe, including in space. For drones and UAVs, it's another milestone in their evolution as the workhorses of the Air Force for a wide range of missions and capabilities," said Arthur Herman, Ph.D., senior fellow and director of the Quantum Alliance Initiative at Hudson Institute and one of the nation's foremost quantum experts in defense, energy and technology issues.

Quantum distribution provides a secure communication method for exchanging information between shared parties in a way that guarantees security. This phenomenon involves a pair of particles of light or photons that are generated in such a way that the individual quantum states of each are indefinite but correlated such that the act of measuring one instantaneously determines the result of measuring the other, even when they are at a great distance from one another. This phenomenon was referred to by Albert Einstein as "Spooky Action at a Distance."

Einstein noted that quantum mechanics should allow two objects to affect each other's behavior instantly across vast distances as if the two are connected by a mysterious communication channel.

FAU's contribution to the project and its student involvement in the technology is analogous to threading the eye of a fine needle using fiberoptics and co-propagating wavelengths that includes a near-infrared or invisible beam at the single-photon level. The entangled single-photon sources are produced by focusing a laser on special non-linear crystals and then processing the resulting "down-conversion" beam of photons. The optical alignment system uses mirrors that tilt to steer the photons directly where they need to go. The single photons travel one-by-one from the source drone to another to communicate securely.

"In war, for example, these drones would provide one-time crypto-keys to exchange critical information, which spies and enemies would not be able to intercept," said Miller. "Quantum protects our information using the laws of nature and not just by a clever manmade code. One of our collaborators aptly stated, 'whoever wins the quantum race will win the war.'"

Eventually, Miller plans to incorporate quantum memory in the drones so that they can conduct error correction, relay and store information.

"We are just scratching the surface of something that is going to amplify into a lot of different applications," said Miller. "This technology is not only going to be on drones or robots. Eventually, we will have this secure communication technology on buildings and satellites that will open up a free space optical link between them. The only limit is your imagination."

Provided by Florida Atlantic University