ORNL/TM-2023/2858
CRADA/ NFE-20-08292

CRADA Final Report: CRADA Number NFE-20-08292 with Quantum Lock Technologies LLC

Erica Grant

Date January 23, 2023

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

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1. Abstract

At Quantum Lock Technologies, our mission is to use future-proof hardware and software to bridge the gap between physical access control and cyber security. Physical security includes access to doors, lockboxes/containers, and machinery/robots. Connecting physical access control to the cloud allows for remote detection, fast ledger updates, and mobile or remote access. However, this also opens physical security up to the world of cyber-attacks. At Quantum Lock, we use quantum random number generation to generate completely random and unpredictable digital keys to be used by connected equipment in a facility. This quantum technology is then paired with end-to-end encryption and a one-time-key communication protocol to ensure the highest level of security. Through the Innovation Crossroads program at Oak Ridge National Laboratory, we have developed benchtop prototypes of our technology, connected with utility boards as our first target customers, and prepared for our first pilot with customers (target end of summer 2022). Below is a photograph of myself at till energy substation where we plan to eventually apply our technology (see Figure 1).

Figure 1: Photograph of Participant at partner substation

2. Statement of Objectives

Objective 1: Hardware and software testing

Description
The first technical milestone will be to rigorously test the software for any cybersecurity weaknesses. Most recently, we have built out the necessary software for the Quantum Lock communication protocols and will be ready to start this phase of the project right away with the help of the cybersecurity institute with Dr. Peter Fuhr as the PI. While completing this milestone, we will begin understanding the market and technical needs of manufacturing facilities.

Task 1 Summary:

Task 1.1 – Understanding of advanced manufacturing facilities and equipment
Task 1.2 – Test hardware and software for cybersecurity robustness
Task 1.3 – Modify software to address any outcomes if the cybersecurity testing

Objective 2: Integration and Demonstration

Description
The second technical milestone will be to integrate Quantum Lock technology with access control systems and manufacturing equipment as a proof-of-concept and to test the limits of the prototypes for any cybersecurity, physical, power, or communication weaknesses. After the completion of this phase of the project, we will be able to launch a pilot to prove out the technology in a manufacturing facility or access control system.

Task 2 Summary:

Task 2.1 – Design integration of Quantum Lock with manufacturing equipment and access control systems
Task 2.2 – Test integration of Quantum Lock with manufacturing equipment and access control systems
Task 2.3 – Use results from tests to launch a pilot study with a manufacturing facility or access control system

3. Benefits to the Funding DOE Office's Mission

At Quantum Lock, we are building technology to help protect and enhance security for energy utilities and government facilities. In the pipeline, we also have plans to enhance security for the equipment at manufacturing facilities, which will enable them to be more automated and energy efficient.

This project developed enhanced security and detection for digitally-connected facilities and equipment by utilizing completely random and untraceable keys generated with a quantum random number generator (QRNG). In particular, this technology shows great promise in security for energy efficient manufacturing and access control systems. The project outcomes include a better understanding of advanced manufacturing security needs and a proof of concept hardware-

software solution that has been rigorously tested in cybersecurity and implemented on access control systems and advanced manufacturing equipment. Approximately 50% of advanced manufacturing facilities are hacked into every year. If successful, this project could be a solution to protect the proprietary information shared within an advanced manufacturing facility and other access control applications.

4. Technical Discussion of Work Performed by All Parties

The research tasks carried out under the CRADA at ORNL cybersecurity group include the security testing of the hardware, firmware, software, and cloud network. We also implemented this technology in an access control system and manufacturing equipment to test the technology for any bugs, security flaws, or system failures (see Figure 2). The research tasks carried out under the CRADA at ORNL Manufacturing Demonstration Facility (MDF) include studying the security needs of the manufacturing market, understanding the manufacturing facilities and equipment to integrate Quantum Lock technology, and testing the integration of Quantum Lock technology with manufacturing equipment.

Figure 2: View of the doors of the access control system at ORNL

Our product development goal through Innovation Crossroads was to develop working benchtop prototypes and iterate on those prototypes to develop a minimum viable product that we can use to pilot with our first customer. We have come close to achieving this goal. We currently have a

working benchtop prototype. Throughout the program we worked with Ovyl, an engineering firm out of Nashville, TN. They worked closely with us to get designs ready for our pilot and are on track for piloting at the end of the summer. Below is a picture of our hardware components (see Figure 3).

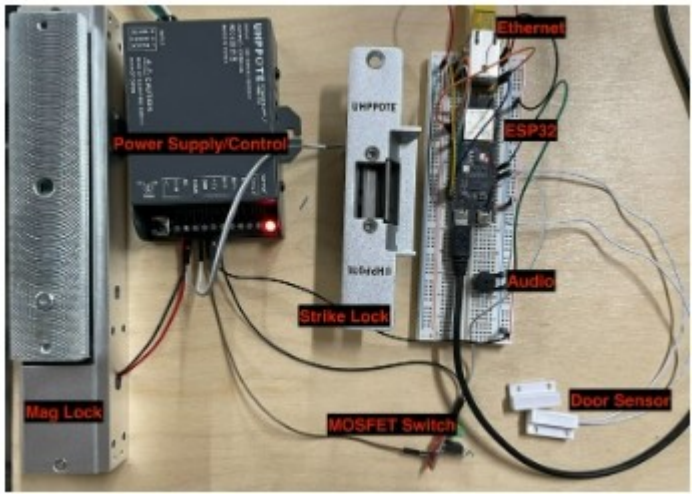

Figure 3: Hardware components of prototype system

Our product is a hardware-software solution. We are not in the business of selling mechanical locks. Instead, we have developed a versatile hardware lock module, a quantum hub that sits onsite and controls the system, and software that facilitates the encryption, communication protocols, cloud network, and ledger system.

In summary, this project achieved the following:

- Studied the security needs of the advanced manufacturing market both for access control of facility entrances, equipment, and any cloud networks.
- Studied the integration of Quantum Lock technology in advanced manufacturing facilities and equipment to address the needs of advanced manufacturing.
- Used cybersecurity protocols to test hardware and software for security robustness.
- Integrated Quantum Lock technology with a demo access control system at ORNL to further test the system for any bugs.
- Integrated Quantum Lock technology with demo manufacturing equipment at ORNL's manufacturing demonstration facility (MDF).

5. Subject Inventions (As defined in the CRADA)

None

6. Commercialization Possibilities

There are many opportunities for exit through partnerships with lock manufacturers and security organizations like Assa Abloy, Stanley Ventures, and Dorma Kaba. I have had interest from these organizations, but they would like to see traction in the market before moving forward with any formal partnership. This program enabled Quantum Lock to raise our first round of capital. We just wrapped up our· first seed round of $600k with investors. I am now fully supported by Quantum Lock as a full-time employee.

7. Plans for Future Collaboration

We plan to launch two pilots in April 2022 with Electric Power Board (EPB) of Chattanooga and Oak Ridge National Laboratory (ORNL). We then plan to expand in utility space through EPB and Tennessee Valley Authority (TVA) as well as ORNL and other DOE national Laboratories. We are hoping to expand access control in a wide variety of facilities including hospitals, enterprise and office buildings, data centers, etc. We also have plans to expand to retrofit smart locks in facilities like hotels, office spaces, and apartment buildings. Our other patent is for securing equipment, and we plan to expand to manufacturing facilities, research centers, etc. in the next 5 years.

8. Conclusion

Through Innovation Crossroads, I was able to make many professional achievements. Firstly, I was able to lead and manage a team of engineers at ORNL and Ovyl to create our prototypes. I personally led all design and architecting of the product. Secondly, I was able to connect to potential customers through the program including Electric Power Board of Chattanooga and Tennessee valley Authority. Thirdly, I received awards including Forbes Next 1000, Stu Clark New Venture Challenge, and Startup Day. Fourthly, I was able to further education by using the education/travel fund made available to us. I used this funding to take online business courses and do software consulting education.