MITOCW | MITRES_LL-004S22_3_Bluetooth.mp4

[MUSIC PLAYING] The global health crisis that began in 2019 brought new uses for existing technology.

For example, some smartphones have a find my phone feature that uses phone to phone Bluetooth signals to locate the missing phone.

Scientists and engineers realized that this feature could be used to let phones estimate whether they were too close for too long to someone who later tested positive for COVID.

This would help extend the ability of public health teams to conduct contact tracing efforts at a time when they were overwhelmed with the number of new cases that they needed to trace.

In March of 2020, Lincoln Laboratory established the Private Automated Contact Tracing, or PACT program, to develop a Bluetooth-based contact tracing and exposure notification system for COVID.

The PACT team was a partnership among cryptographers, physicians, privacy experts, scientists, and engineers.

Efforts like PACT, which touched thousands of lives, work because of collaboration between many organizations and between teams within each of these organizations.

The PACT design provided a secure and anonymous way of determining whether you, well your phone, was recently in contact with someone who later reported having COVID.

Apple and Google decided to adopt the PACT protocol and build support for this functionality into the iOS and Android phone operating systems.

The service they deployed is called exposure notifications, and it is in use in many regions around the world. One of the major challenges the team faced was to quantify how well Bluetooth in cell phones works for exposure notification.

Lincoln Laboratory developed test strategies that modeled real life situations to evaluate the success and limits of contact tracing.

For example, they considered where participants were located, how the phone's microenvironment might affect its signal strength, and how the notification system worked.

The question we run into is what is the science behind being able to tell how close people are based on Bluetooth signals?

Let's talk about the science of radio signals.

You know how cell phones get 5 bars sometimes and other times, only one?

Or if you go to a place where cell service is weak, you might not get any bars and your phone may even tell you it can't connect at all.

This happens because radio frequency energy gets weaker the further away you are from a tower.

In urban areas, there are many towers available to your phone, so even when you move around, you're always pretty close to a tower.

In some remote areas, the coverage is spotty because you might be too far away from the nearest tower.

This phenomenon is called propagation loss.

The longer the distance between radios or cell phone and tower in our example, the weaker the energy.

If the RF energy is too low, the receiver can't detect the specific pattern of energy.

The signal from the energy in the background, the noise, or the static.

We can take this observation and turn it into a game.

By looking for signals from radios, we can tell whether they are nearby or far away.

By looking at how much RF energy we're receiving from a specific radio or its signal strength, with this we can play hide and seek, trying to find people hiding by looking at the amount of RF energy that their Bluetooth beacon is transmitting to our device. Engineers call the signal strength measurement a Receive Signal Strength Indicator, or RSSI for short.

The RSSI number tells us how strong or weak a signal is compared to background energy.

Signal strength is proportional to distance, so we can tell how close or far away someone is by looking at the RSSI value.

However RSSI isn't foolproof.

RF signals can actually be blocked by buildings or terrain making things appear further away than they actually are.

For our experiments, rather than using a cell phone, we will be duplicating a Bluetooth hide and seek game using Adafruit circuit boards.

We'll walk you through how to set up and program your boards, so that you can try out a modern version of hide and seek with your friends.

The goals for this experiment are to work hands on with a small development board, become familiar with and even write code for a development board, start to understand the physics of radio frequency or RF propagation, collaborate with the team to enact an experiment, learn about game development.

What else can you do with these supplies?

And have fun.

Best of luck and happy hunting.