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Network Improvement Through Phase Intercepting Controller (NITPIC)

In warehouses there are lots of wireless machinery being used, from barcode scanners to forklifts to robots. These devices rely on LTE signals to transmit information and receive instructions, and without these signals the machinery can lose data and could even stop functioning entirely. Warehouses are not designed with LTE signal strength in mind. They are usually made out of thick concrete and are packed with tall, metal storage racks that are completely filled with objects. These obstacles lead to interference of the LTE waves and poor signal strength within the building. The problem we are exploring addresses companies that require a consistent internet connection in warehouses they use to perform various tasks. These companies want to maintain a stable cellular internet connection for all their employees/machines operating in the warehouse. The companies are experiencing a loss of productivity due to interrupted cellular internet connection resulting from scattering and interference.

A common approach to fixing this problem is the installation of more “base stations” to transmit LTE signals. This approach is based on providing more coverage throughout the warehouse. Unfortunately, adding base stations in the warehouse causes the effective ranges of the base stations to overlap, which can cancel the signals out causing a dead zone. To rectify this, the company can hire an IT team to calculate where the locations of the base stations should be to minimize the cancellation. However, this is not optimal for small businesses as it can come with a hefty price tag. The largest downside of both of these options is that base stations use more precious metals and plastics. These excess base stations do not allow for a sustainable environment as they will end up in landfills once their end of life has been reached. Whereas the NITPIC will work on the preexisting base stations and use less harmful plastics and metals than the manufacturing of the base stations.

The Network Improvement Through Phase Intercepting Controller (NITPIC) helps companies who rely on consistent LTE connection in their warehouses more reliably connect to the internet by adding dynamic beamforming capabilities to the radios, thereby reducing signal loss and increasing productivity. To achieve the goal of a better antenna device that can alleviate the impact of interference on signal strength in order to significantly reduce dead zones and diminish the number of LTE base stations to lessen the impact of the materials needed to manufacture these base stations, the device needs to track the strongest signal in accidental dead

zones found within the effective range of the base station while maintaining the quality of service as defined by the provided LTE service the warehouse is using.

To implement the objective, the device must use a linear array to beam form with a minimum beamwidth of 22.5° within ± 5° with a packet delay greater than 300ms per LTE industry standards for non-guaranteed bit rate services to maintain the quality of service the customer is use to operating with. The received signal strength from the NITPIC to the customers equipment must be than -22dBm as to not damage the customers equipment as well as not exceed a radiated power within 500 microvolts per meter as to not interfere with other emitting equipment. Lastly, the NITPIC device will be user friendly to install and will be powered with a 1 Amp USB connection.

In this project, we completed preliminary testing for the NITPIC. The preliminary testing consisted of verifying the attenuators and phase shifters proved that they can meet specifications to form our desired beam patterns. We also tested a two antenna array and proved that we can form beams and alter their shape with the attenuators and phase shifters. These are significant steps toward building the completed device. From these successful tests, we have moved onto preparing for our final tests of the device. The final tests can be summarized into three categories. The first being calibrating the received signal strength indicator. The second is an empty environment test, where we verify that the beam is adjusting as the device moves around the room. The final is the multipathing environment where we test that the device can connect to the base station in a location within the effective range of the base station where the customers equipment, without the antenna replacement, drops connectivity.

This technology has great potential as it isn't just limited to being used in warehouses but can greatly impact LTE use in every part of our community. This device would greatly save on the material cost of base stations in every building, from commercial workplaces to residential housing. Not only that but its ability to connect to signals where other antennas can’t means that the NITPIC can be used in forestry and land inspections, or it can help those in the wilderness like hikers and campers keep phone signals which could potentially save their lives in emergency situations. The NITPIC will also make it possible for more rural communities to connect to LTE signals without having to build as many antenna towers. It can be difficult for underprivileged communities to gain access to LTE antenna towers and this affects multiple aspects of their lives. This project gives them an affordable alternative where they can still have quality signal strength without having to move or fight to have antenna towers built in their area, and this means that everyone will have equal opportunity to use LTE technology no matter their living environment. The NITPIC can also be utilized by emergency services. As more people have cell phones there has been a push to build more 5G towers so that emergency services can always have signal even in network congested areas but it is hard to find land where these new towers can go. With the NITPIC device they will be able to keep a signal even in areas of lower connectivity without the need to build more towers.