Miniaturized Active RFID Sensor Tags for use in a Robust Container Monitoring System

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Increasingly, valuable and/or security sensitive goods require both identity and condition monitoring (movement, temperature, tampering, etc.), especially during transcontinental shipment and containerized item transport. These goods need robust miniaturized RFID sensor tags for effective tracking and monitoring. Our research will enable the development of a high throughput miniature RFID sensor tag for deployment in these crucial applications.

We are currently researching and developing miniaturized active RFID tags at the 2.4 GHz active RFID band which contain sensors for vibration and temperature monitoring. Various antenna miniaturization methods are being examined to find the best design since there are a variety of tradeoffs between size, bandwidth, pattern coverage, and platform sensitivity. These include the use of metamaterials, magnetic dielectrics, and novel geometric configurations to reduce the resonant frequency of the antenna. The miniaturized tag under development will be smaller than 2 cm x 2 cm and will be robust to all tag platforms. Simulations are being performed with various tag antenna designs when they are "loaded" to test for platform robustness. The simulated platforms include metal, cardboard, liquid, and other materials with varying dielectric constants and conductive properties. Radiation pattern and shift in resonant frequency (i.e. return loss in the bandwidth of interest) will be studied to determine platform dependency characteristics of each tag antenna design.

These miniaturized RFID tags, or micro tags, will be used in the development of a container monitoring system as a long term research goal. The deployment and benchmarking of the miniature wireless vibration and temperature sensor nodes will be investigated so that optimal throughputs as well as signal fidelity can be realized for container monitoring applications using multi-hop connectivity among RFID tags on the container pallets and packages, and exterior larger tags that have access to nearby commercial cell tower networks (see Fig. 1).

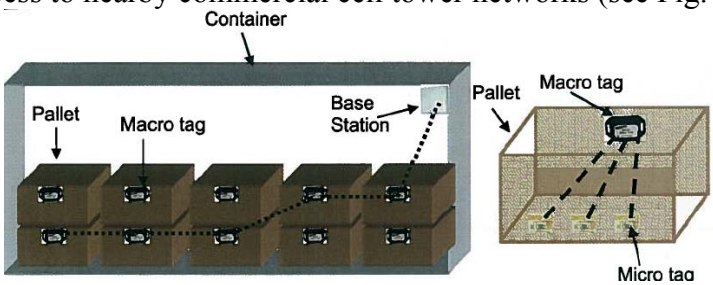

Figure 1: Schematic of the envisioned communication structure. Macro tags transfer information in a multi-hop fashion to the base station. Macro tags communicated directly to the micro tags inside the pallets.