Surface-Wave Networks for Communication and Power Transmission

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A surface-wave network (SWN) is a two-dimensional wireless network of communication nodes that communicate with each other via surface-waves propagating on a metasurface.

We have demonstrated a point-to-multipoint SWN that has the capability to simultaneously power and communicate with a network of surface-wave nodes on a 120 cm x 240 cm metasurface. The metasurface is fabricated with an array of metallic Jerusalem crosses, (fill factor = 0.95, pitch = 12mm), printed on 0.05-mm-thick kapton and adhered to a 6.2-mm-thick Plexiglas substrate with a copper ground plane. The SWM supports TM-mode surface waves (SW) in the frequency range from 2 to 4 GHz.

The nodes consist of an external sensor, an 801.15.4 XBee™, a SW coupler, and a power source. The power source is either a battery or a rectenna that converts SW power to DC. The XBee™ operates at 2.45 GHz, is capable of up to 250 kbps data transmission and requires 50 to 200 mW of power depending on the processor and radio loading. The external sensors monitor surface parameters, such as temperature, strain, or pressure. One of the nodes acts as the central hub that controls the other nodes, collects sensor data from them, and is connected to an external computer.

A central power hub broadcasts 2.7-GHz SW into the SWM at levels up to 20W. The SW power is converted to DC and powers the node. In order to simultaneously receive SW power and data transmissions without interference, the data is transmitted at 2.45 GHz, while the power is broadcast at 2.7 GHz, and two separate narrow-band couplers are used to prevent interference between the bands. The nodes also have internal filters that assist in preventing interference from the power signal.

The nodes can be moved anywhere on the SWM and still maintain contact with the control hub. When the nodes are lifted off the surface, they lose the power connection and drop out of the network. When replaced on the surface, they are quickly reestablished as part of the SW network.