Wireless Sensor Network Utilizing RF Energy Harvesting for Smart Building Applications

The team Trielectric: Oskar Björkqvist, Oskar Dahlberg, Gustaf Silver

Supervised by: Christos Kolitsidas, Oscar Quevedo-Teruel, and B.L.G. Jonsson

Introduction & Scope of the Present Work

Motivation

- Large increase of connected devices – almost 25 Billion at the moment
- Radio frequency harvesting a viable approach for supplying power
- Rid need of batteries and cables to external power supplies
- "Free" input power

Field strength assessment in KTH campus

Scope of the work:

- Develop a modular system able to adapt in different RF input signals and harvest the available ambient RF power. The harvested power will be utilized in small sensors

System Description

- Designed for high gain at KTH-campus
- GSM, 3G and Wi-Fi target frequencies
- A total of 16 small, high gain antennas
- Modular system: WiFi subsystem and cellular subsystem
- Dual-band rectification for the cellular for the bands 1.8GHz and 2.1GHz
- 2.45 GHz WiFi band rectification
- A novel MISO differential rectification approach.
- Leakage diodes to control voltage drops

Testing scenarios

Five tested scenarios

Indoors, where there is mainly Wi-Fi but also some cellular.

Outdoors, where there is only cellular.

Underground Labs, only Wi-Fi.

Table 1. System measurements for the tested scenarios, available input power and output voltage and power with 10KOhm load

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>WiFi dBm</th>
<th>Cellular dBm</th>
<th>Voltage mV</th>
<th>Output Power µW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoors</td>
<td>-22</td>
<td>-27</td>
<td>220</td>
<td>5.2</td>
</tr>
<tr>
<td>Semi - indoors</td>
<td>-30</td>
<td>-25</td>
<td>140</td>
<td>2.1</td>
</tr>
<tr>
<td>Outdoors</td>
<td>-</td>
<td>-20</td>
<td>130</td>
<td>1.7</td>
</tr>
<tr>
<td>Semi - outdoors</td>
<td>-40</td>
<td>-23</td>
<td>170</td>
<td>3.2</td>
</tr>
<tr>
<td>Underground</td>
<td>-20</td>
<td>-</td>
<td>210</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Successes RF energy harvesting

Conclusions

- Developed an RF energy harvesting system as a power supply for small sensing devices
- Successful modularity for system adaptivity depending on the ambient RF input frequencies
- Five successful tested scenarios for the developed system in KTH campus