Quadrature Amplitude Modulation Backscatter for Passive Wireless Sensors

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Outline

- Motivation
- Introduction
- Passive Backscatter WSN with WPT capabilities
- Backscatter High Order Modulation
- Results
- Conclusion
- Future Work

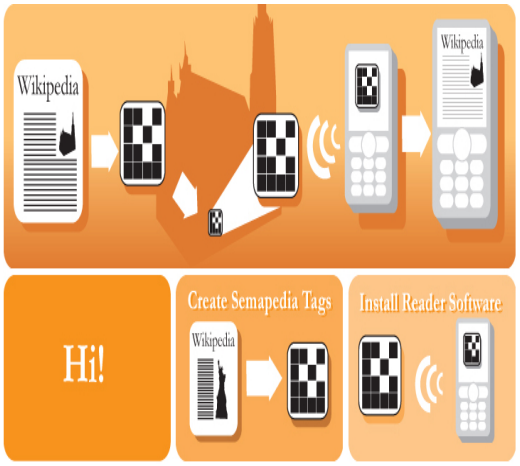
Motivation

RFID Applications are huge, and only now we start to give the first steps in this direction ….

Search & Find

Trust

Linking Information



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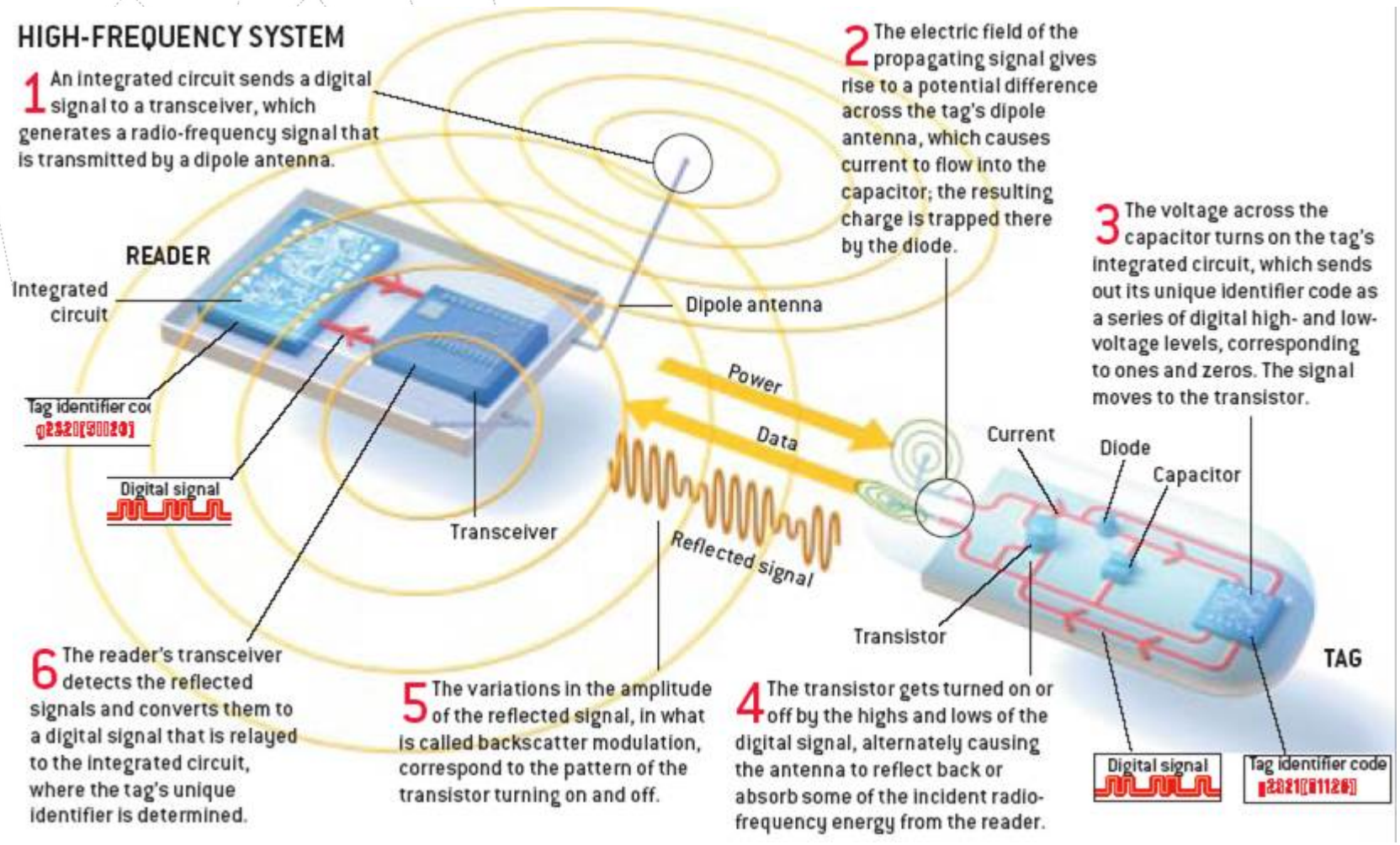
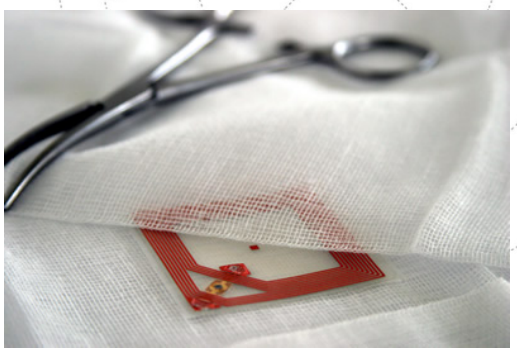
Motivation



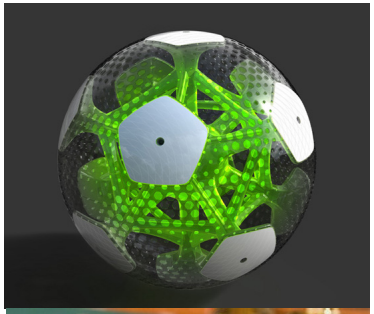
Motivation

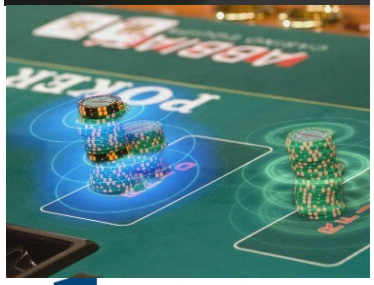
Medical applications



Transports

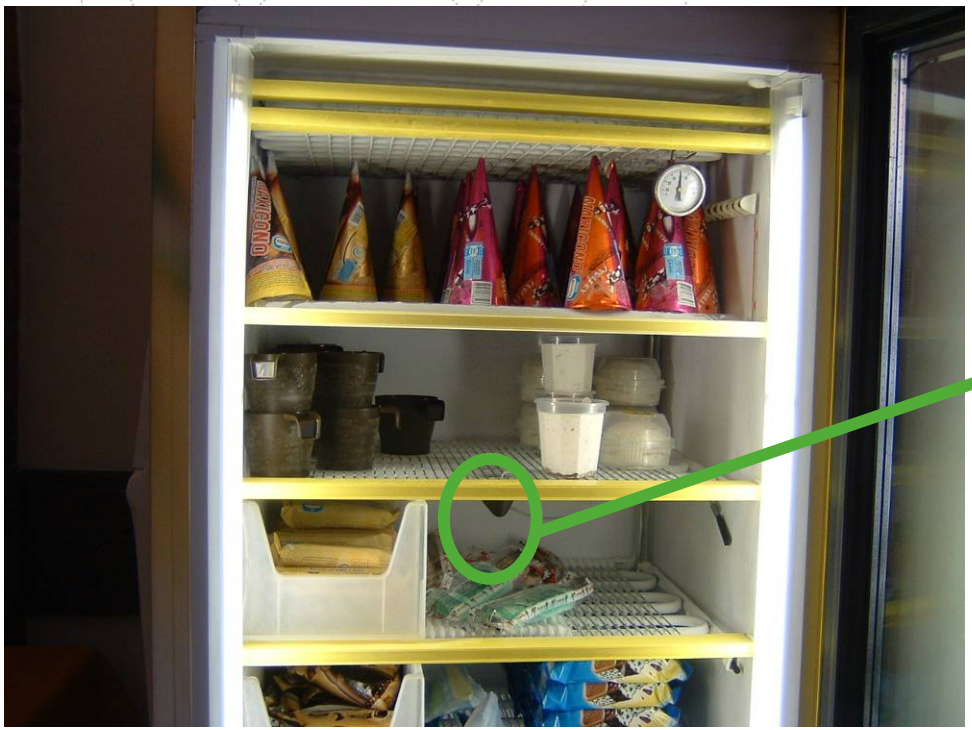
Sports





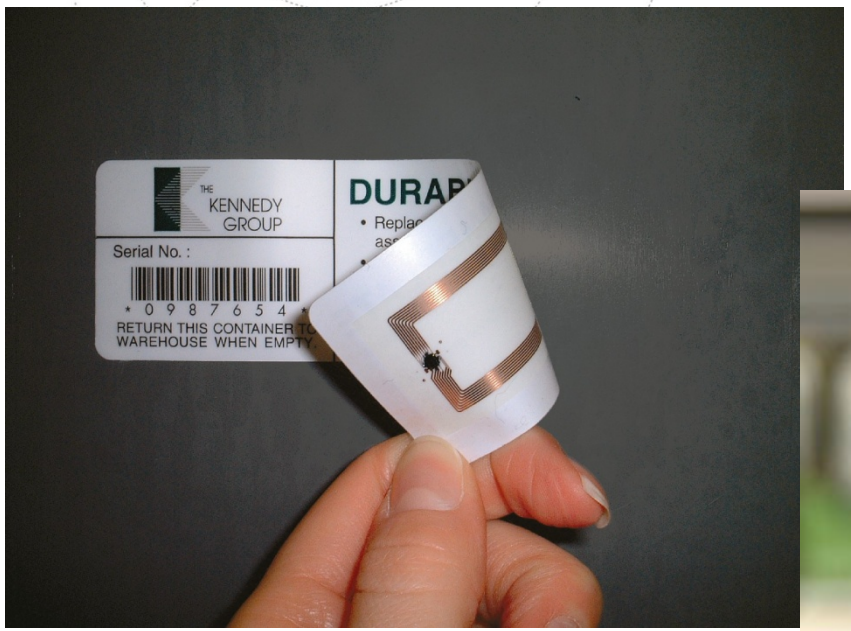
Motivation

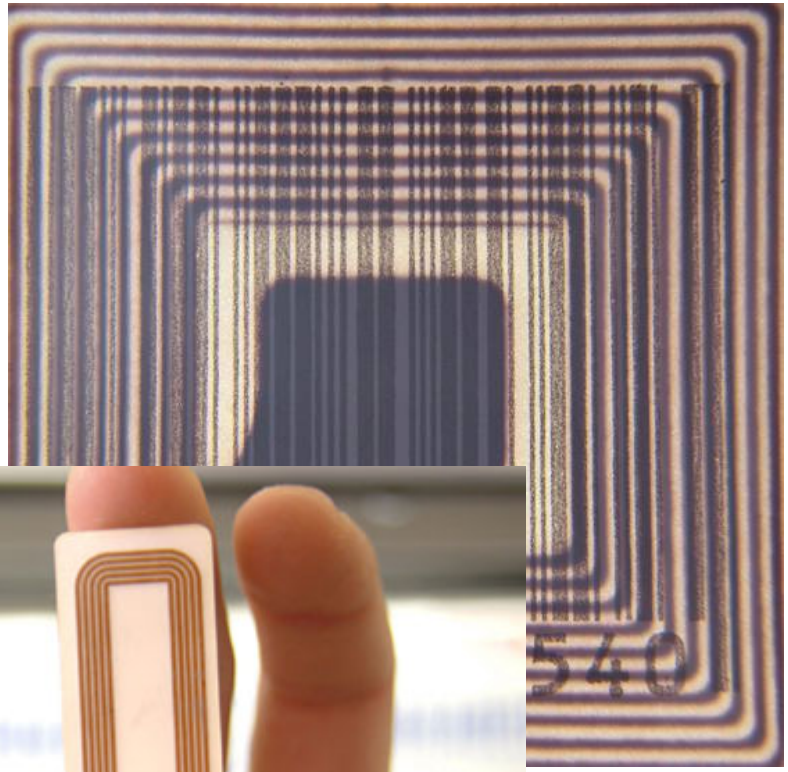
RFID in the kitchen ….



Motivation

RFID is actually a way to identify things and in the future to sense data using Radio Frequency ….





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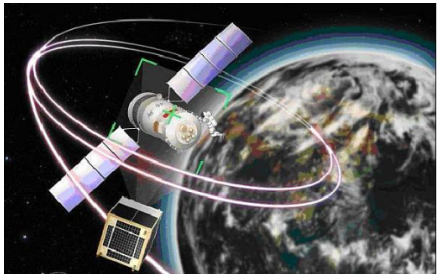
Motivation

- Wireless sensors represent the next stage beyond RFID:
  - Health care
  - Industrial applications
  - Precision agriculture and animal tracking
  - Smart buildings
  - Transportation and logistics

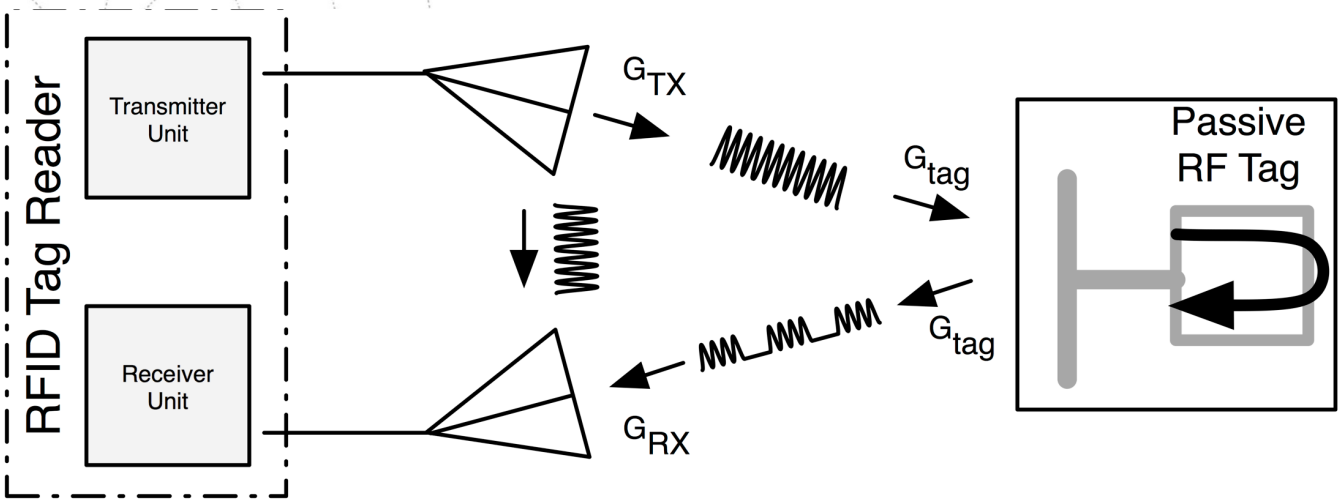
Motivation

The wireless sensor networks depend strongly on the **battery duration**, creating a passive sensor network scheme is one of the key strategies for IoT or space oriented WSN systems.

Backscatter radio

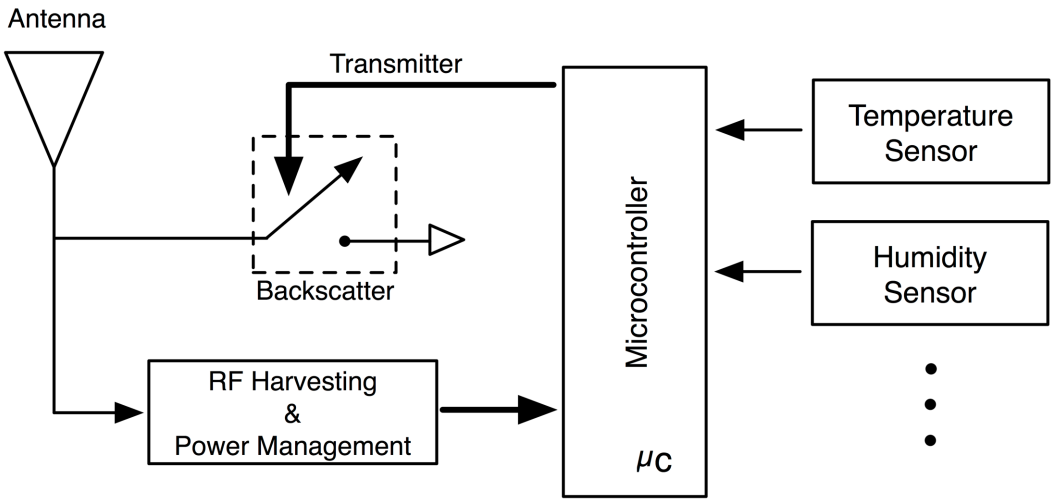


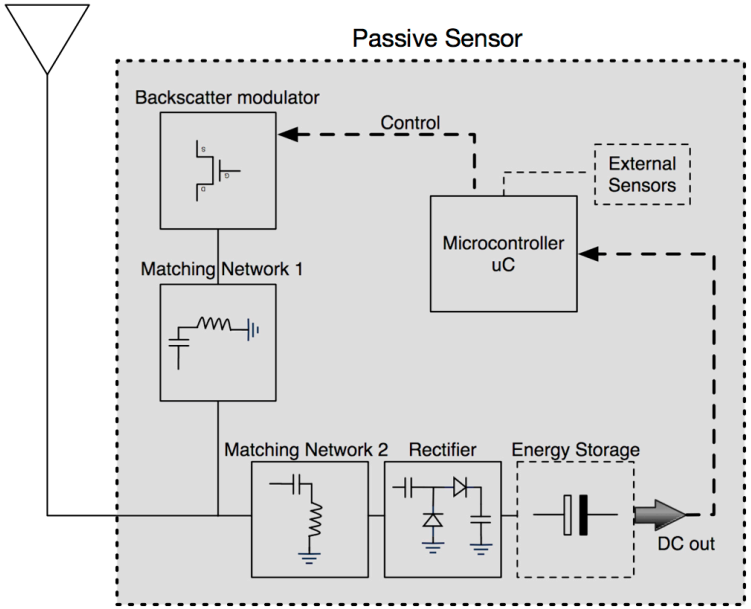
Introduction - Backscatter



- RF tag communicates with a reader, by modulating the electromagnetic fields scattered from the RF tag's antenna.
- The sensor modulates information by controlling a semiconductor device attached to the antenna.

Passive Backscatter WSN with WPT capabilities





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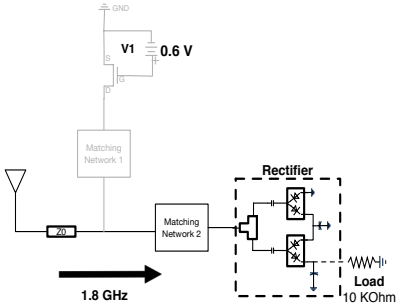
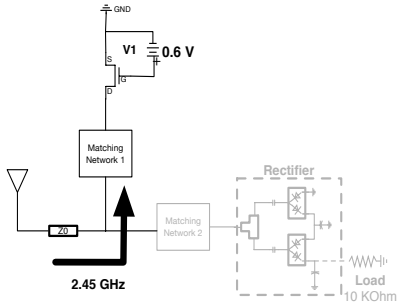
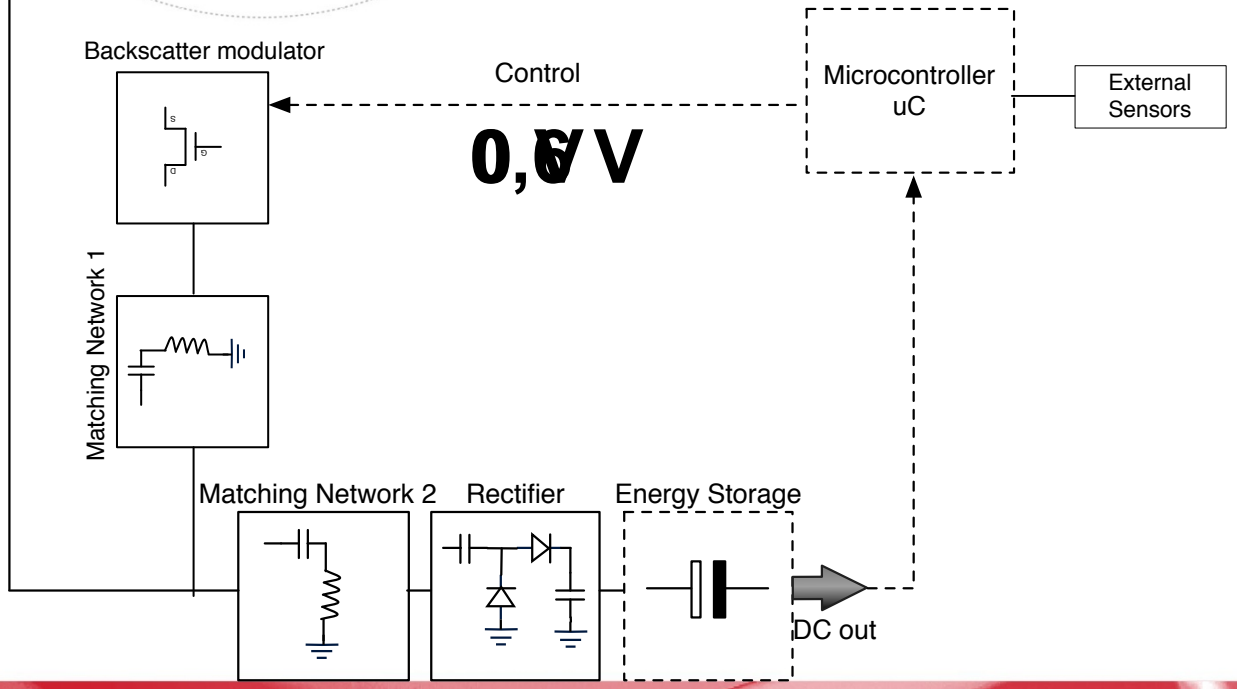
Passive Backscatter WSN with WPT capabilities

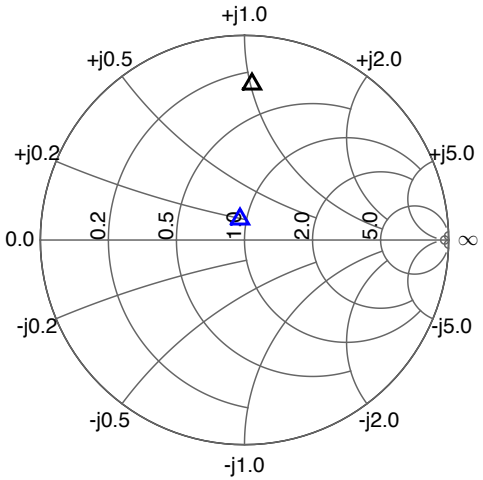
F1 = 1.8 GHz

F2 = 2.45 GHz









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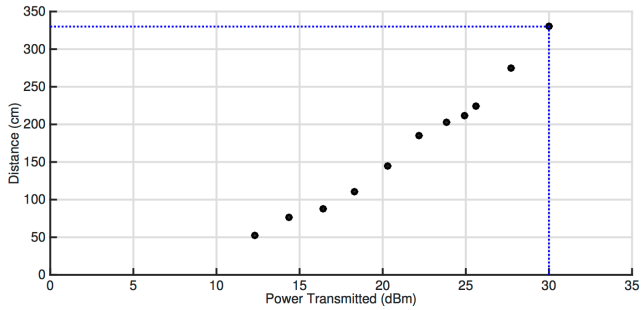
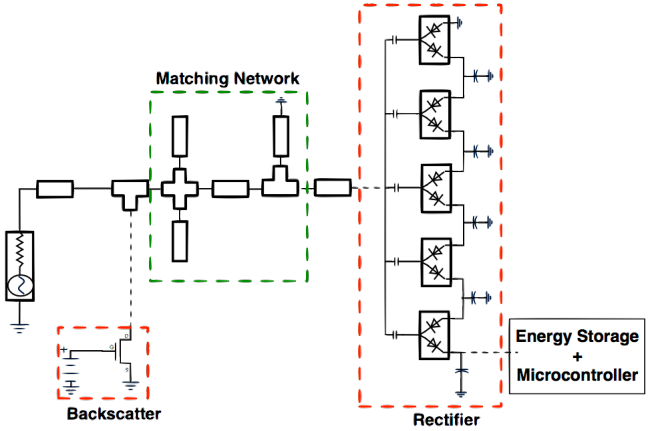
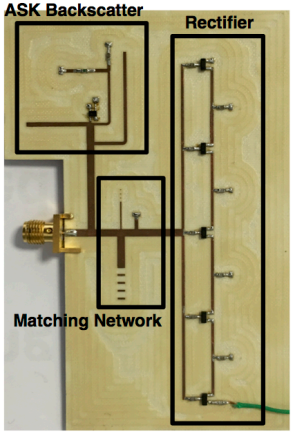
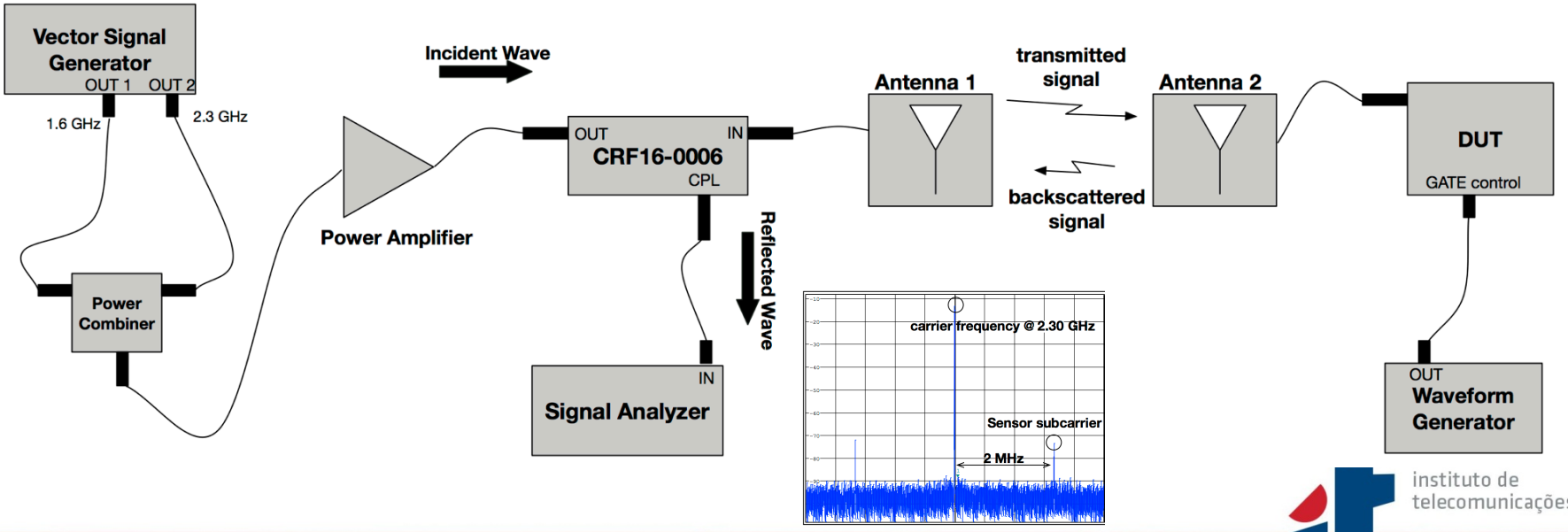
Passive Backscatter WSN with WPT capabilities









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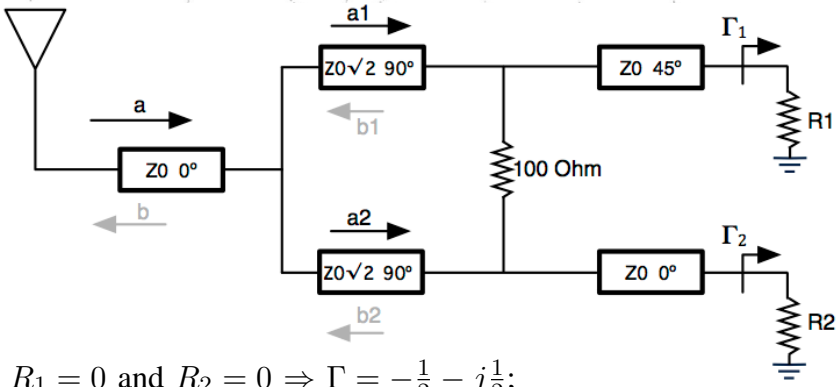
QAM backscatter modulator



$$b = \frac{b1}{\sqrt{2}} + \frac{b2}{\sqrt{2}} = \frac{a_1\Gamma_1 e^{j\frac{\pi}{2}}}{\sqrt{2}} + \frac{a_2\Gamma_2}{\sqrt{2}} \qquad \Gamma_1 = \frac{R_1 - Z_0}{R_1 + Z_0}; \quad \Gamma_2 = \frac{R_2 - Z_0}{R_2 + Z_0}$$

$$\Gamma = \frac{b}{a} = \frac{\Gamma_1 \frac{1}{\sqrt{2}}}{\sqrt{2}} e^{j\frac{\pi}{2}} + \frac{\Gamma_2 \frac{1}{\sqrt{2}}}{\sqrt{2}} \Rightarrow \Gamma = \frac{\Gamma_2}{2} + j\frac{\Gamma_1}{2}$$

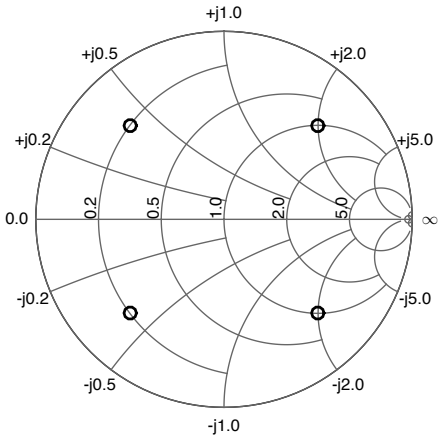
$R_1 = 0$ and $R_2 = 0 \Rightarrow \Gamma = -\frac{1}{2} - j\frac{1}{2}$;

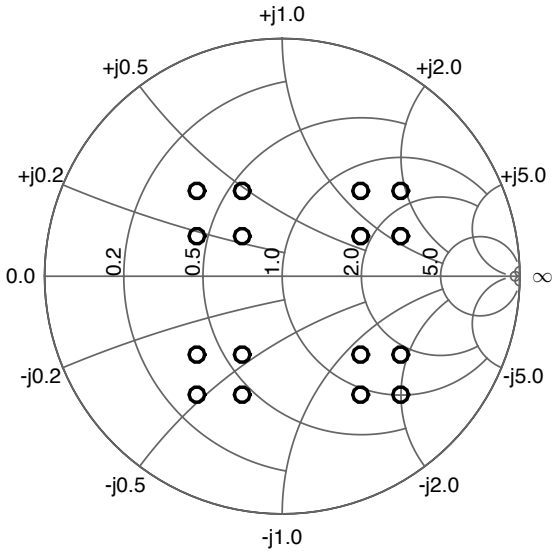
$R_1 = 0$ and $R_2 = \infty \Rightarrow \Gamma = \frac{1}{2} - j\frac{1}{2}$;

$R_1 = \infty$ and $R_2 = 0 \Rightarrow \Gamma = -\frac{1}{2} + j\frac{1}{2}$;

$R_1 = \infty$ and $R_2 = \infty \Rightarrow \Gamma = \frac{1}{2} + j\frac{1}{2}$.

Using more impedances : 0 Ω, 10 Ω, 100 Ω, 300 Ω





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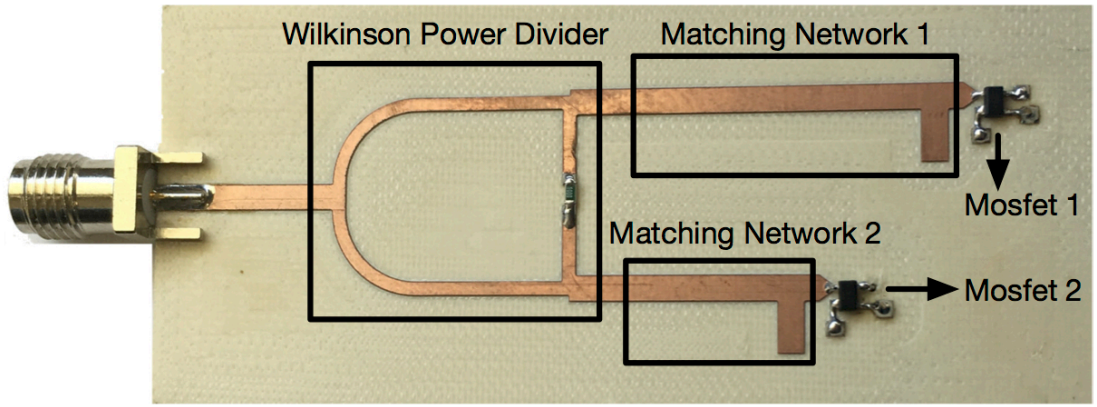
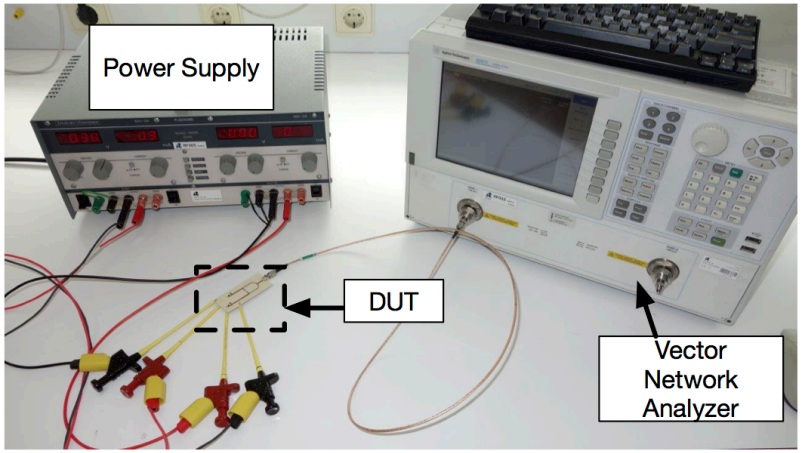
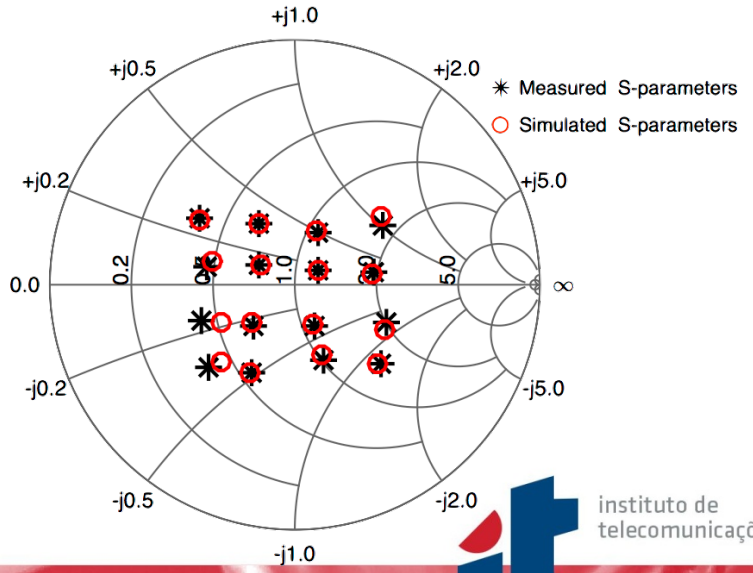
Results







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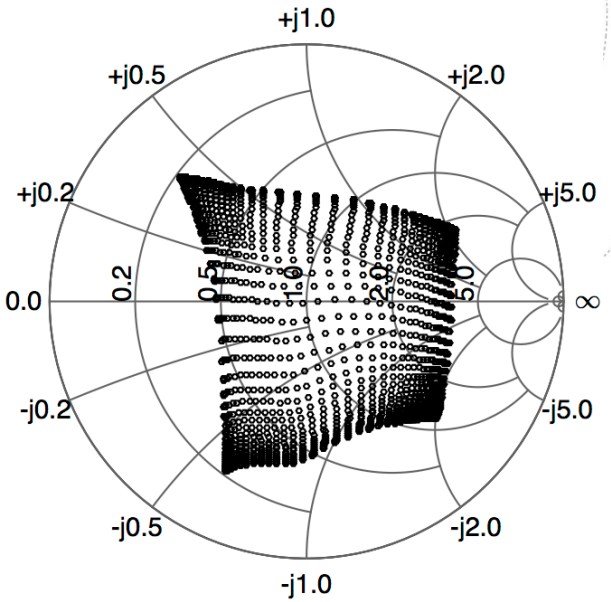
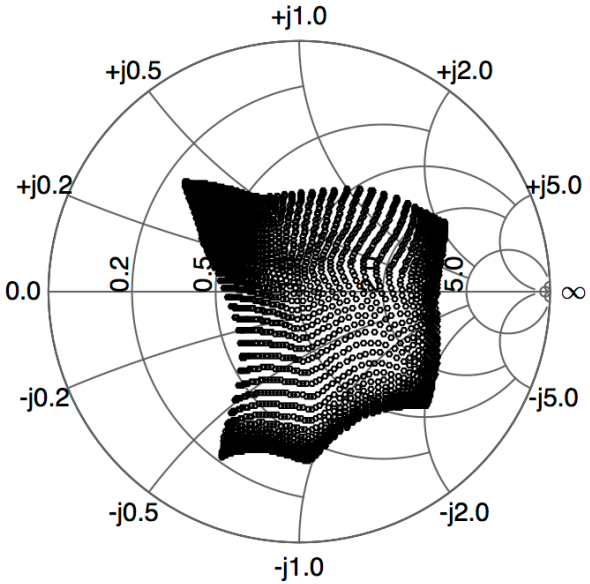
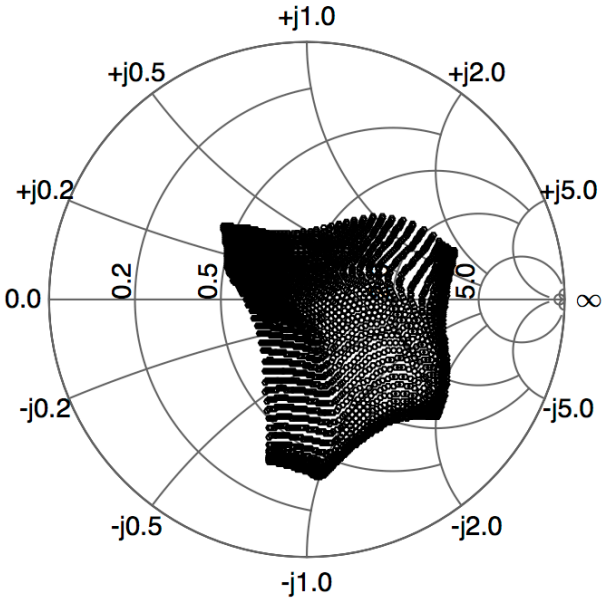
Results – Input power variation



-10 dBm



0 dBm



5 dBm

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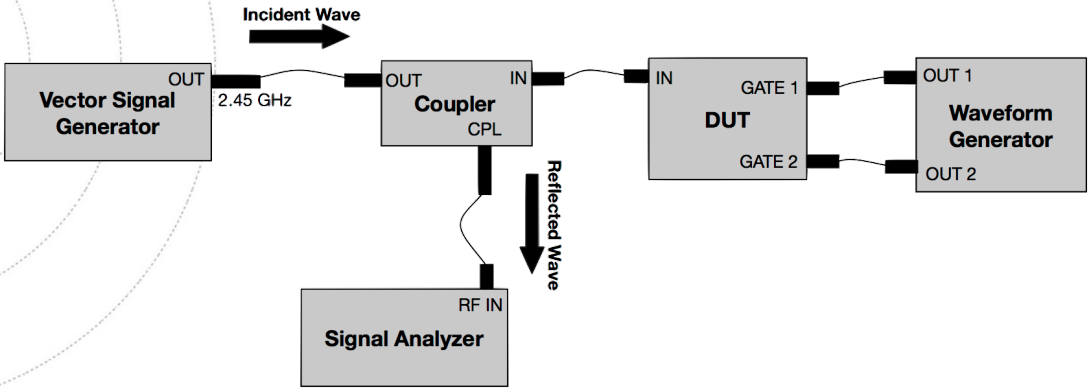
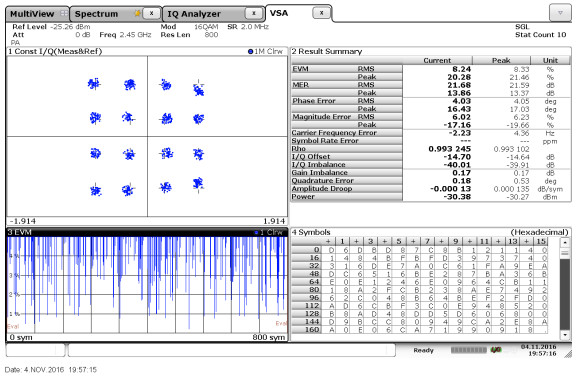
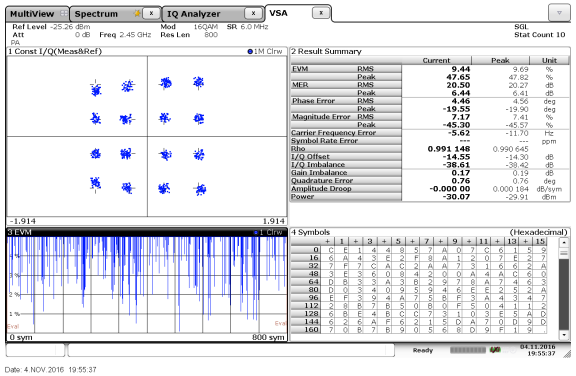
Results - demodulation and potential data rates





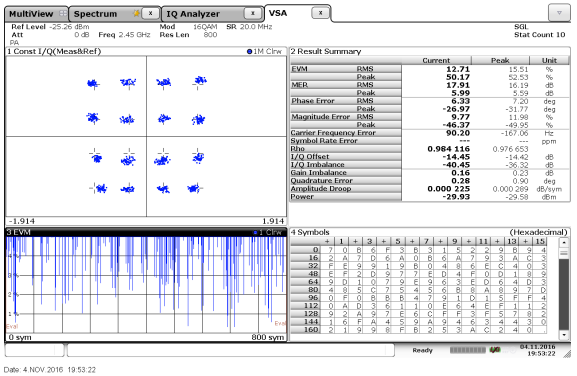
8 Mb/s

EVM = 8.24 %



24 Mb/s

EVM = 9.44 %



80 Mb/s

EVM = 12.71 %

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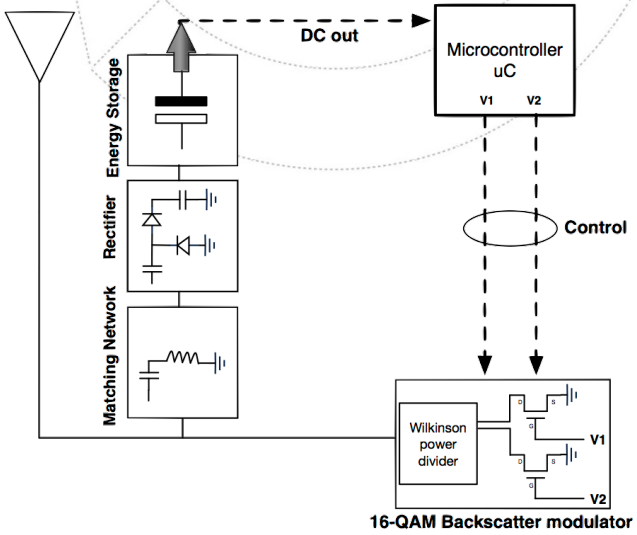
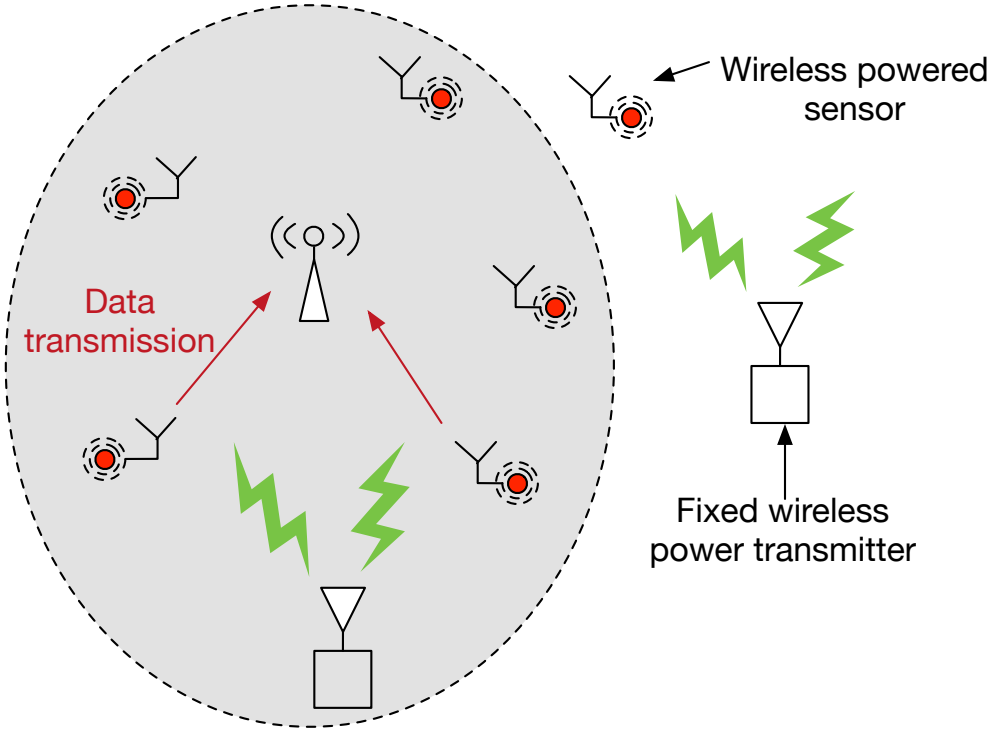
Conclusions

- Combination of WPT and backscatter can provide a continuous power flow to the wireless sensor and this way the sensors can be continuously powered during the operation mode.
- The solution combined with a WPT scheme can actually be used to increase bit rate in fully passive WSN and be one of the enablers of the IoT paradigm.
- From the results it was proved that this solution is clearly a potential solution for fully passive high bit rate WSNs – low-power wireless applications that require high bandwidth such as remote camera sensors or wireless audio.

Future Work



Passive WPT WSN



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Thank you!

Questions?

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