On Limits of Constructive Interference in Backscatter Systems

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Internet of Energy Neutral Things
Backscatter Communication

Communicate by reflecting existing RF

Backscatter device

Receiver

Carrier generator
Backscatter Communication

Communicate by reflecting existing RF

- Receiver
- Backscatter device
- Carrier generator
Frequency-shifted Backscatter

Separate the carrier from the signal

$$2 \sin(f_c t) \sin(\Delta f t) = \cos((f_c + \Delta f) t) - \cos((f_c - \Delta f) t)$$

Motivation

- Low energy consumption
- Short communication range
- Susceptible to cross-technology interference
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Constructive Baseband Interference

Glossy

Challenges in Achieving Constructive Interference

- Same frequency
- Synchronized baseband
- Adequate phase offset
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Constructive Interference with Two Transmitters

Constructive Interference is More Likely

Diagram showing the relationship between received signal amplitude and phase offset, indicating regions where constructive interference is more likely.
Experiment with Two Transmitters

Receiver

Tag B

Tag A (fixed)

Carriera generator

0.5m 3.0m
Experiment with Two Transmitters
Experiments with Five Transmitters
Experiment with Five Transmitters
Experiment with Five Transmitters

Transmitter combination

Normalized RMS amplitude

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
Experiment with Five Transmitters

Transmitter combination

Normalized RMS amplitude

A B C D E

A B C D E

A B C D E

A B C D E

A B C D E

A B C D E

A B C D E

A B C D E

A B C D E

A B C D E

A B C D E
Summary

1. Experimental evaluation of constructive baseband interference in backscatter communications
2. Need for careful selection of concurrent tags
3. Only low gains are achieved (∼ 3dB)