Batch localization based on OFDMA backscatter

Project Report

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Outline

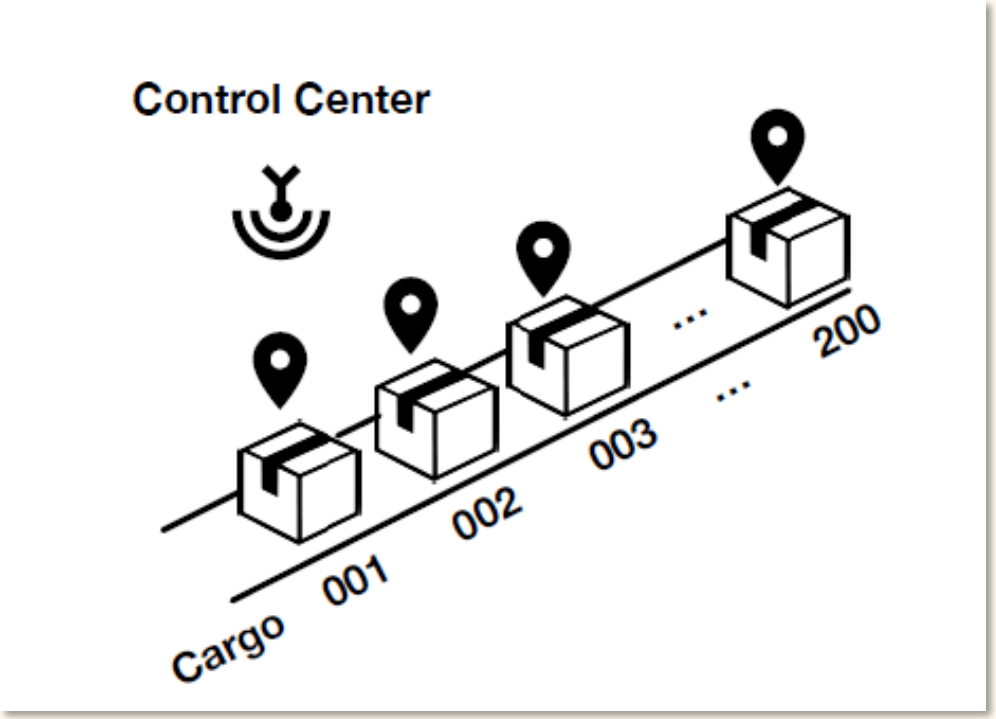
I. Introduction

II. Our proposal and design

III. Experiment results

IV. My contributions (list)

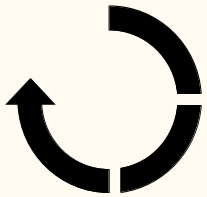
1 Scenario



- Factory
- Track cargos
- Tag attached
- Least channel use

2 Analysis

Solution 1



Cargo 1
Cargo 2
Cargo 3
Cargo 4
……
Cargo 199
Cargo 200

t

Characteristics

- Center control
- Need a schedule
- ? Efficient

2 Analysis

Solution 2

Cargo 1	Cargo 49	…	Cargo 193
Cargo 2	Cargo 50	…	Cargo 194
Cargo 3	Cargo 51	…	…
Cargo 4	Cargo 52	…	Cargo 200
……	……	…	
Cargo 47	Cargo 95	…	
Cargo 48	Cargo 96	…	

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Characteristics

Concurrency

5 time slots == 200

Efficient

OFDMA

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1 System overview

Key points

I. OFDMA

II. CSI/AoA localization

III. Backscatter system

Advantages

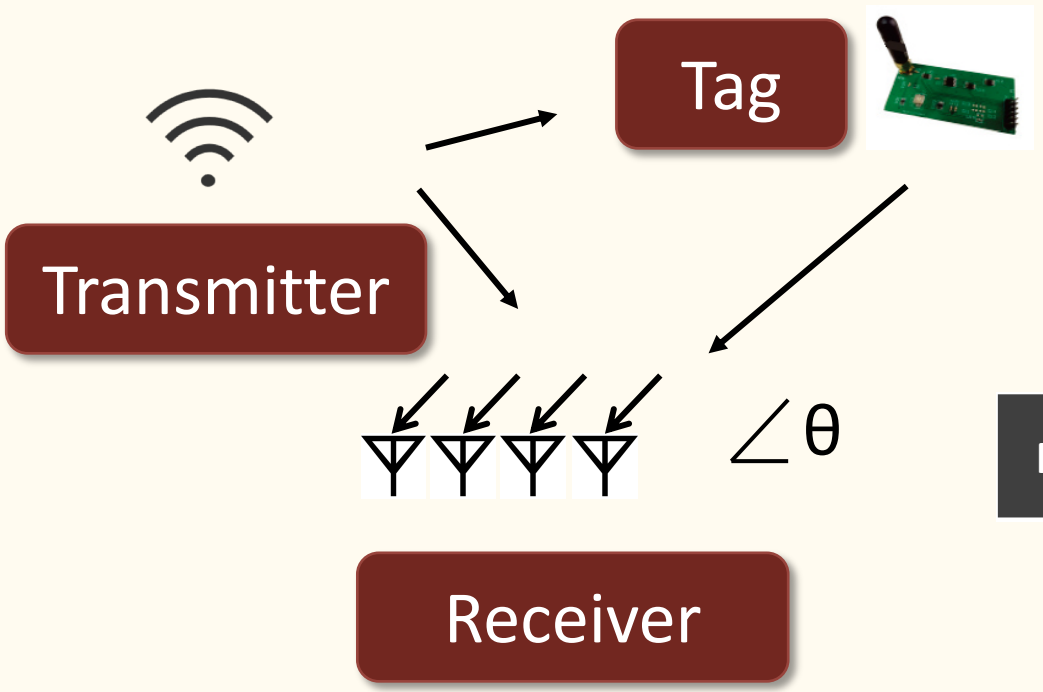
I. Efficiency

II. Accuracy

III. Low power consumption

1 System overview

Target : find θ

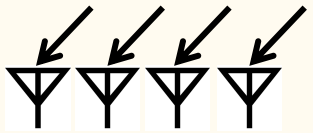


Frame structure

Preamble &PHY header	To-tag frame	Backscatter signal

1 System overview

Basic logic



Receiver

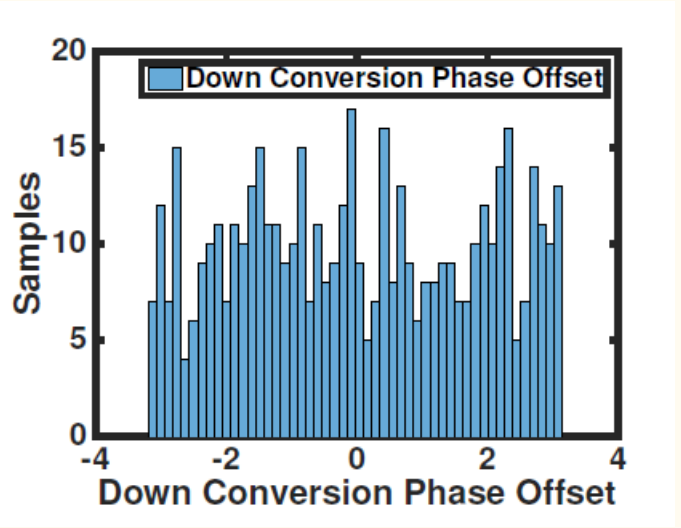
- Collect *CSI* matrix *M* → Raw data
- *3D-MUSIC* algorithm → Optimization
- Calculate *AoA* → Localization

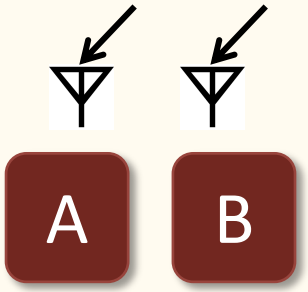
2 Collection of CSI

```
For each antenna
        Channel estimation & equalization
        Fast Fourier transform
        For  each subcarrier
                For each time slot (symbol duration)
                        Obtain CSI
                        Phase offset removal
                end
        end
End
Obtain  CSI matrix M
```

2 Collection of CSI: phase offset removal

Basic logic





$H_A(\omega)$ $H_B(\omega)$

A+Bj C+Dj

The same time slot

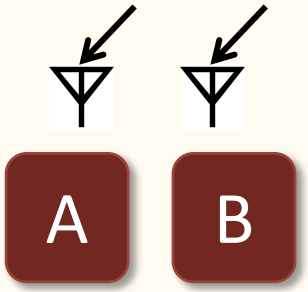
$$tan^{-1}\left(\frac{B}{A}\right) - \tan^{-1}\left(\frac{D}{C}\right)$$

Antennas are not in phase!

Cannot work!

2 Collection of CSI: phase offset removal

Down-conversion Phase offset



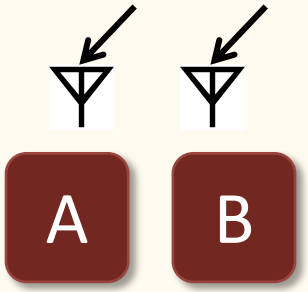
Preamble &PHY header	To-tag frame	Backscatter signal

Calibration?

Dynamic calibration!

→ ‘Relative AoA’

2 Collection of CSI: phase offset removal



Down-conversion Phase offset

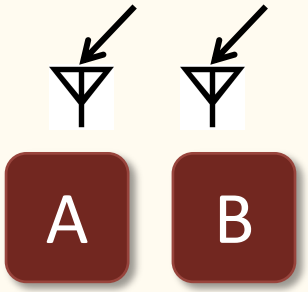
Wrong AoA of TX

Wrong AoA of RX

Correct ‘Relative AoA’

2 Collection of CSI: phase offset removal

Down-conversion Phase offset



Correct ‘Relative AoA’

⊕

Direction of TX

➡

Direction of Tag

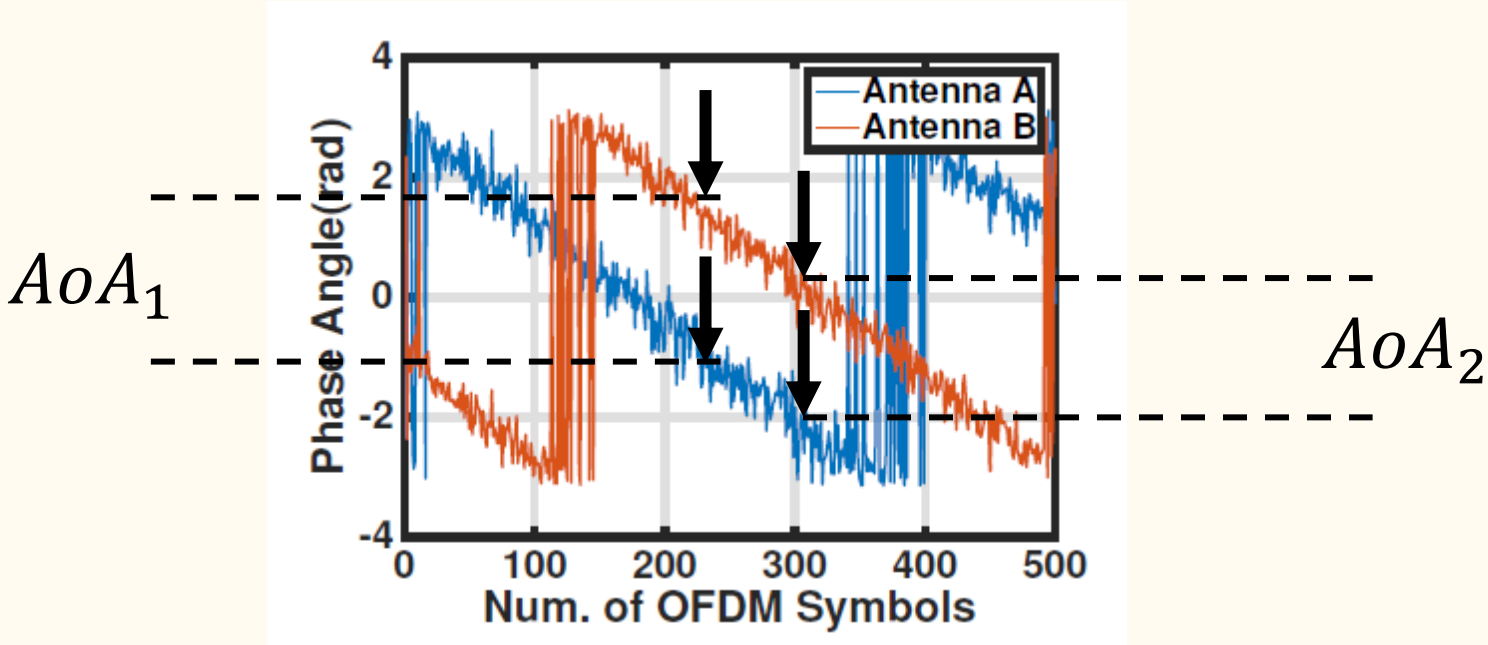
2 Collection of CSI: phase offset removal

Dynamic continuous Phase offset

Carrier frequency offset

A

$$AoA_1 = AoA_2$$



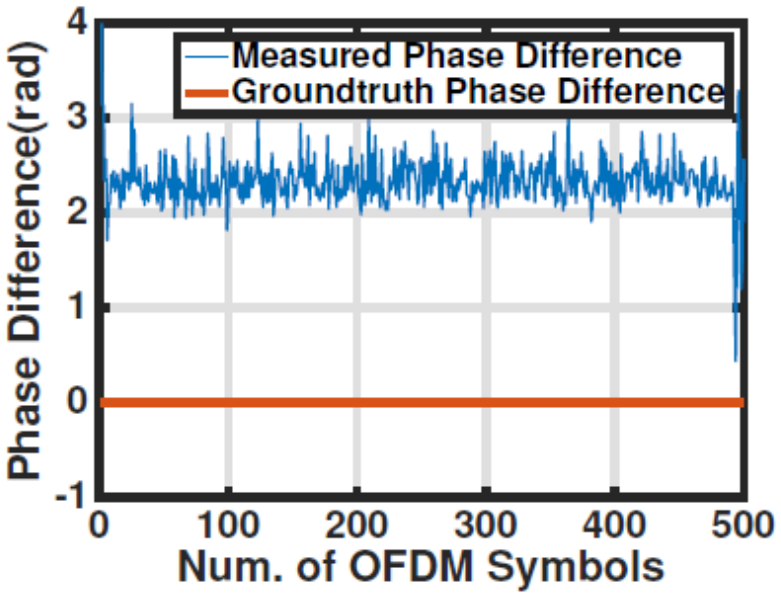
2 Collection of CSI: phase offset removal

Dynamic continuous Phase offset

A

$$AoA_1 = AoA_2$$

After CFO correction



3 3D-MUSIC algorithm

Time/Symbol dimension

Frequency dimension

Physical dimension

→ High accuracy

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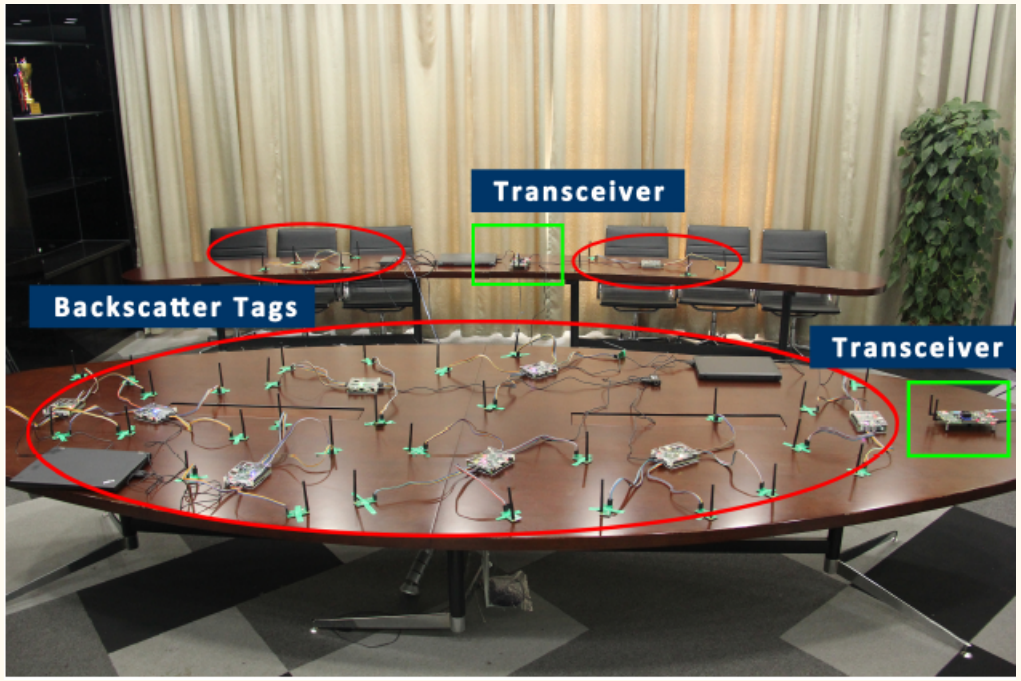
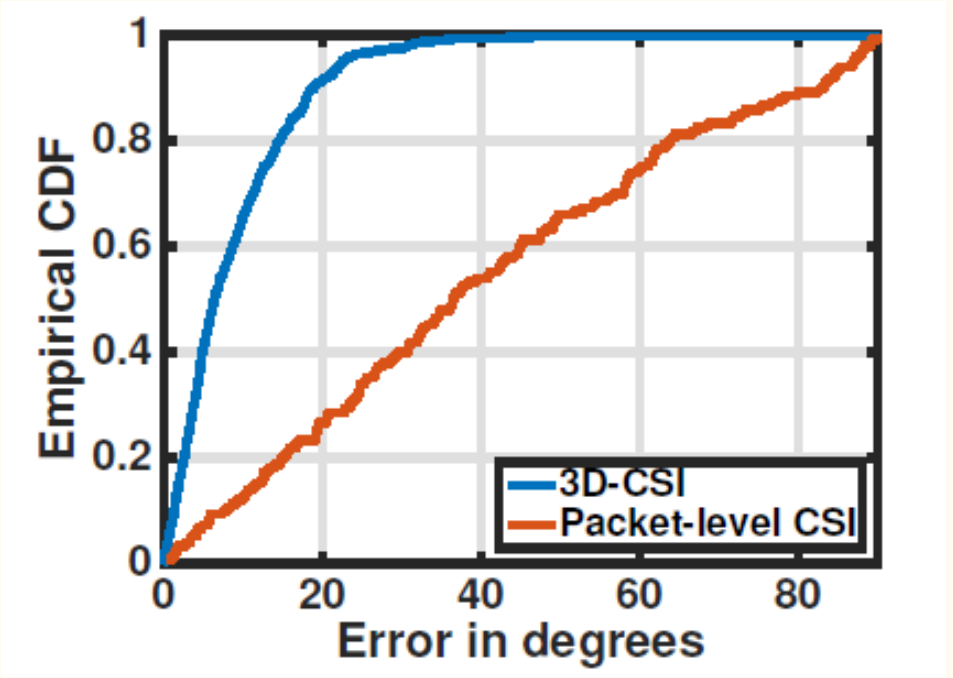
1 Results

Scene

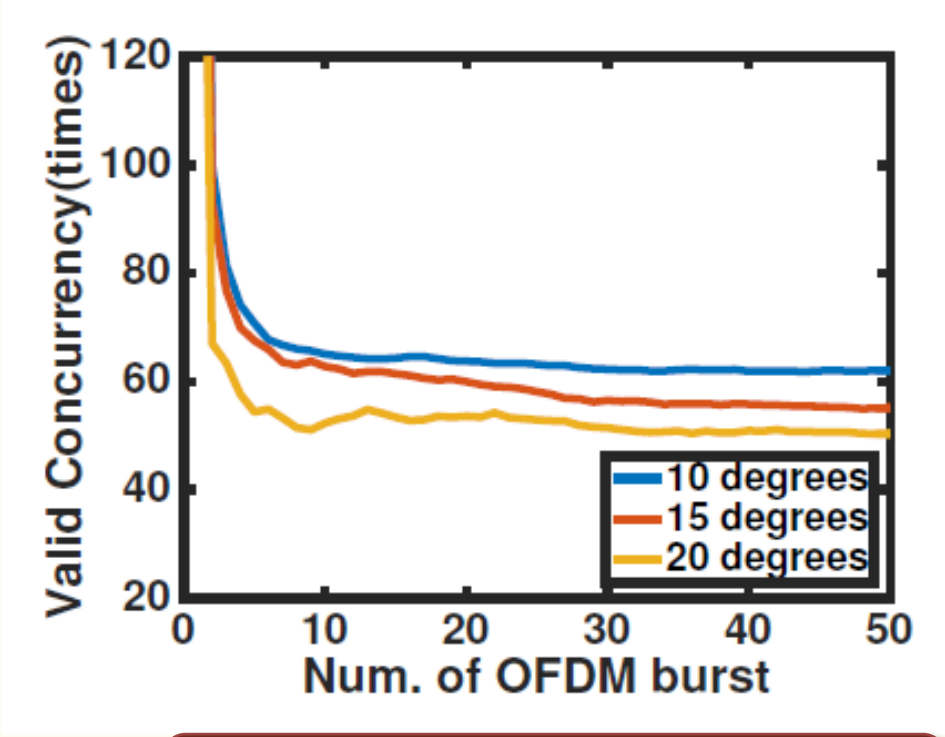


Accuracy



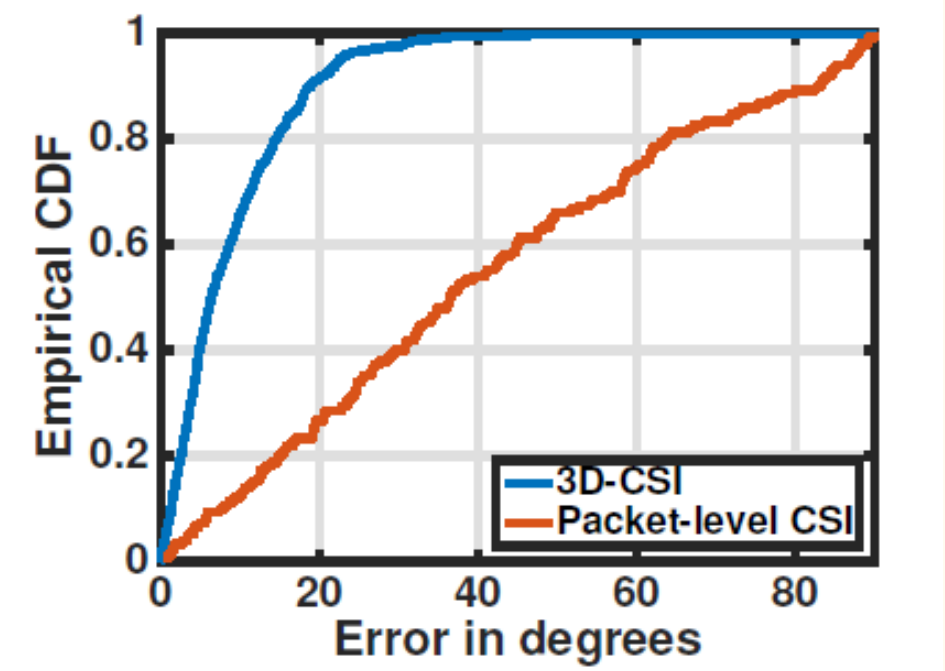
1 Results

Efficiency



60 times in average!

Accuracy



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1 My contributions

1. OFDMA backscatter system
2. Mechanism of phase offset
3. Dynamic calibration
4. Proposal of 3D-MUSIC algorithm

THANK YOU