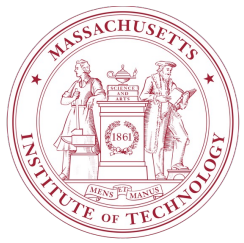


Towards High Throughput and High Accuracy RFID Localization for Logistics Network

B☺ Liang [1, 2]

Purui Wang [3], Renjie Zhao [4], Heyu Guo [1], Pengyu Zhang [2], Junchen Guo [2],

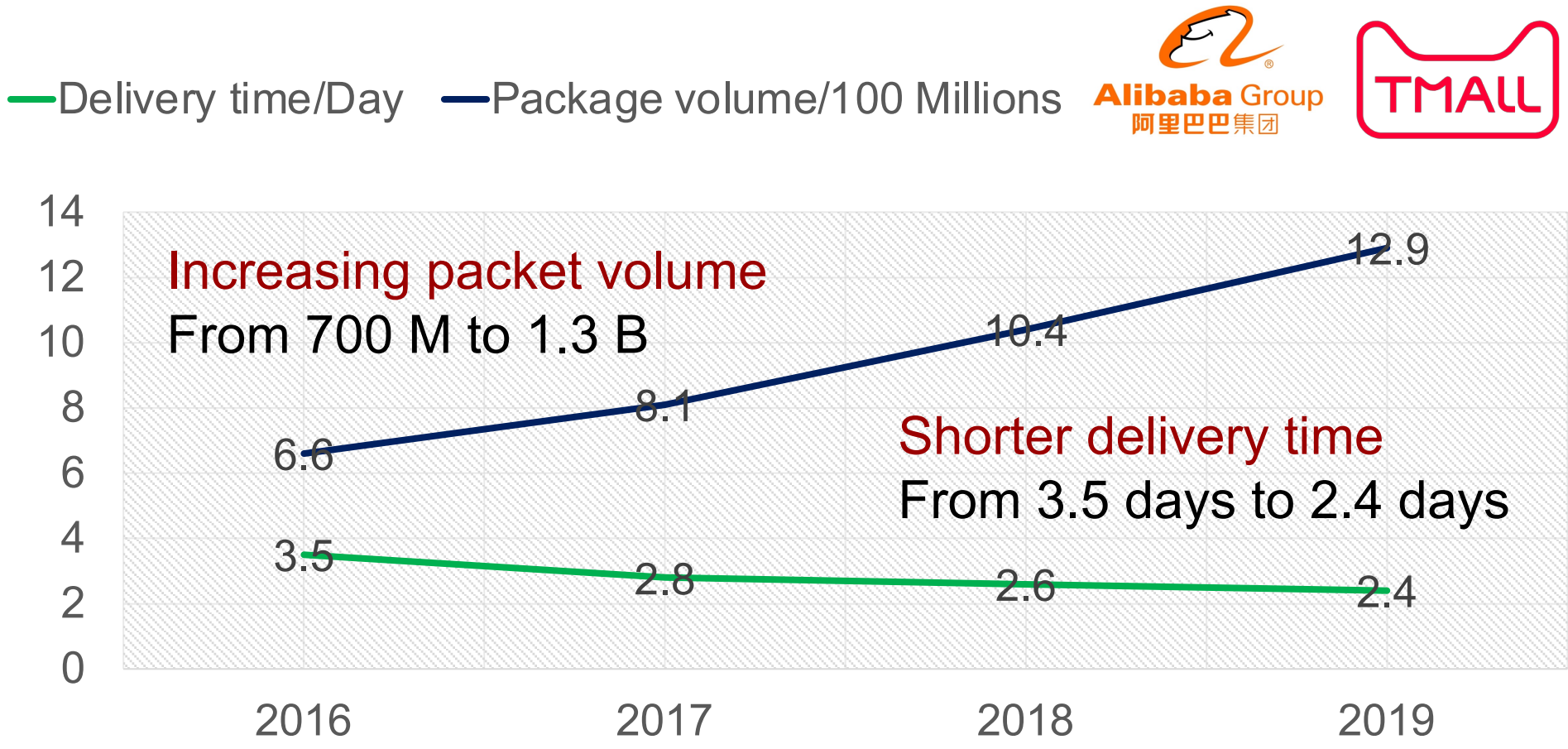
Shunming Zhu [2, 5], Hongqiang Harry Liu [2], Xinyu Zhang [4], Chenren Xu [1,6]

[1] *Peking University* [2] *Alibaba Group* [3] *Massachusetts Institute of Technology*

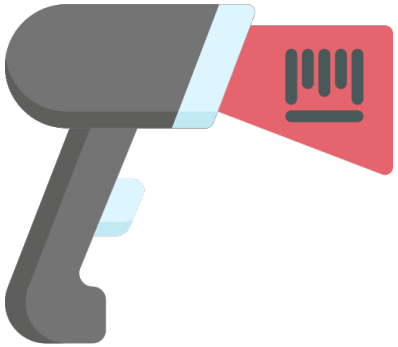
[4] *University of California San Diego* [5] *Tsinghua University*

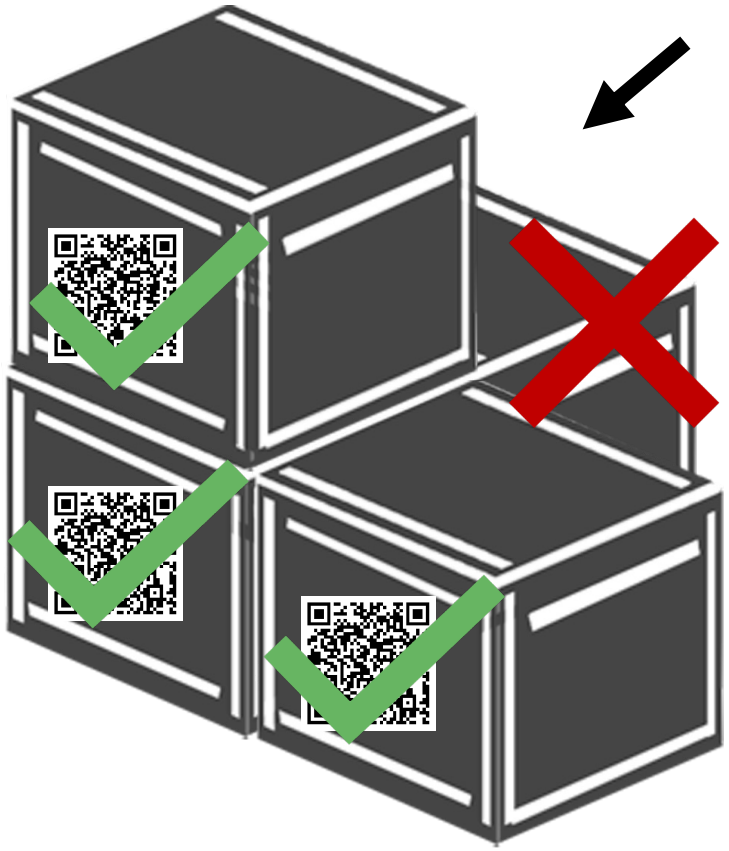
[6] *Key Laboratory of High Confidence Software Technologies, Ministry of Education (PKU)*

Booming ToConsumer Logistics

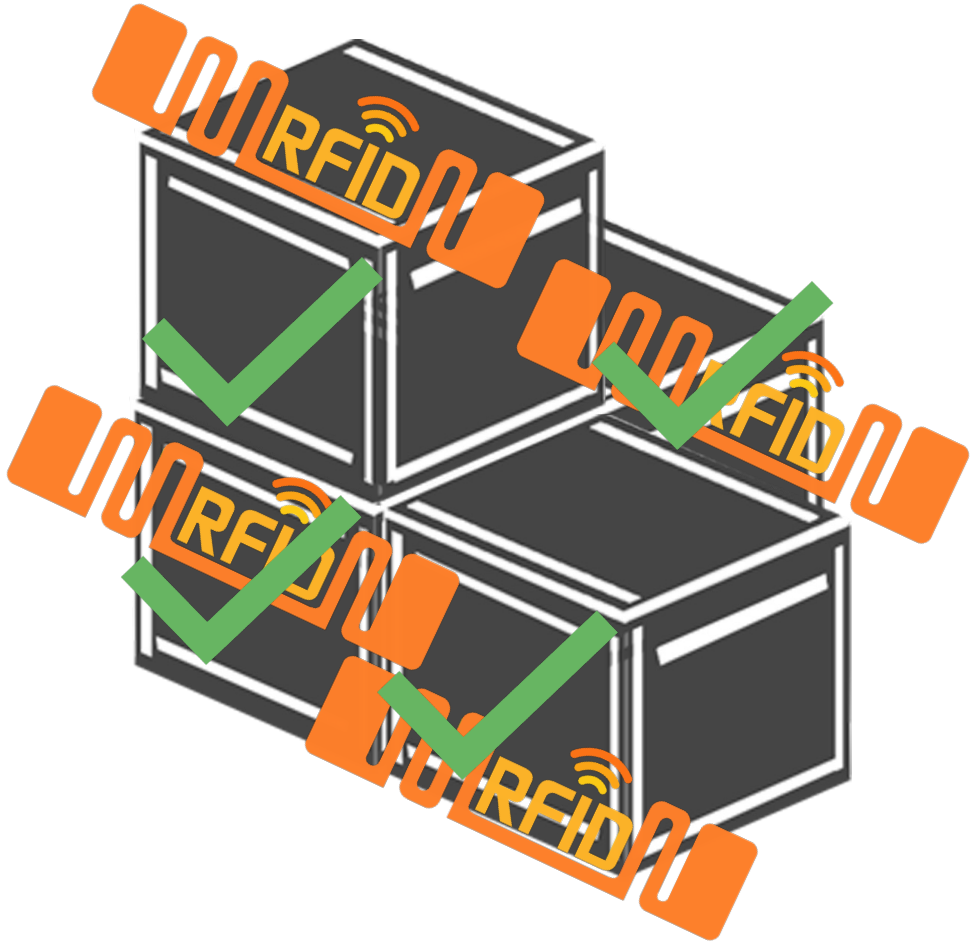


QR-code Suffers from Occlusion

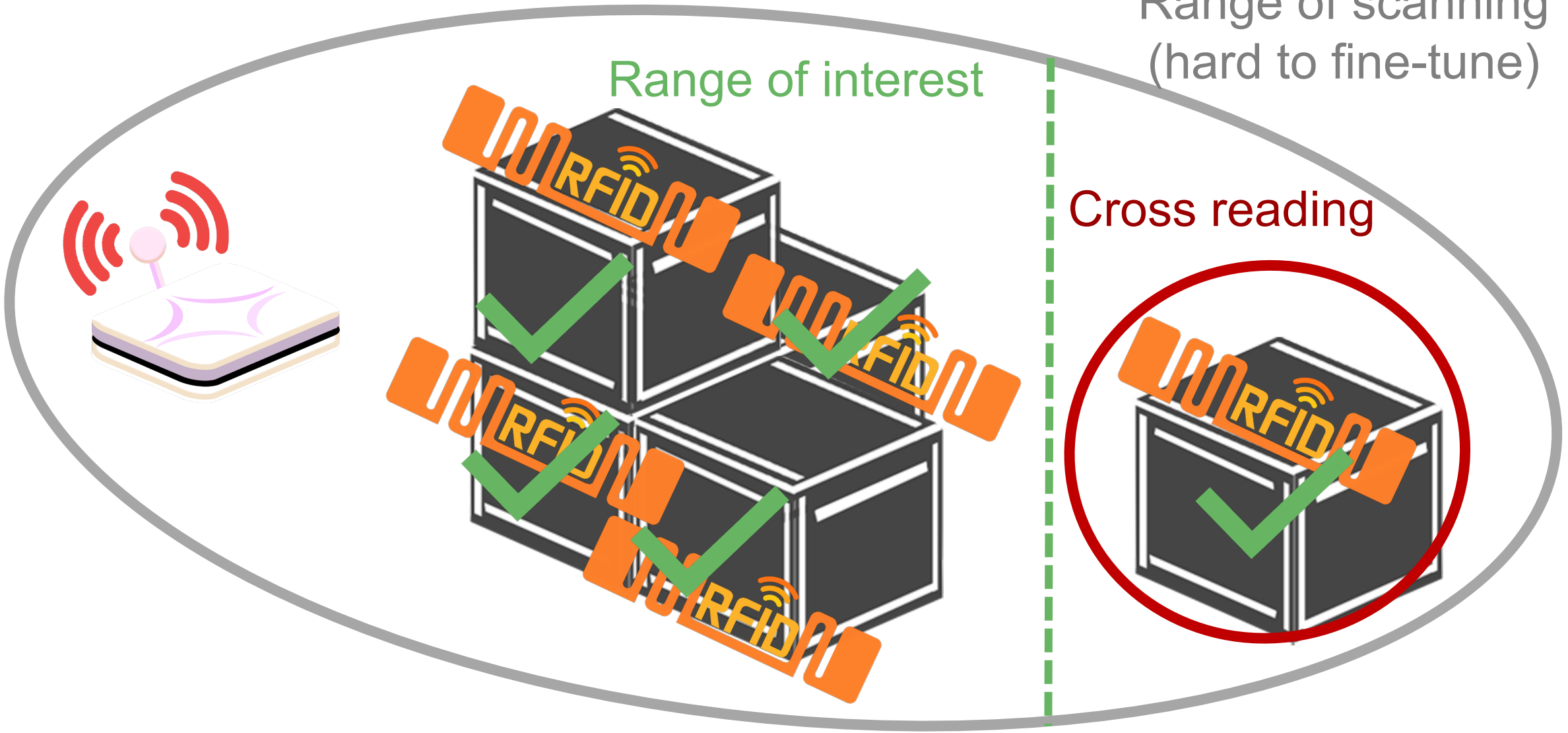




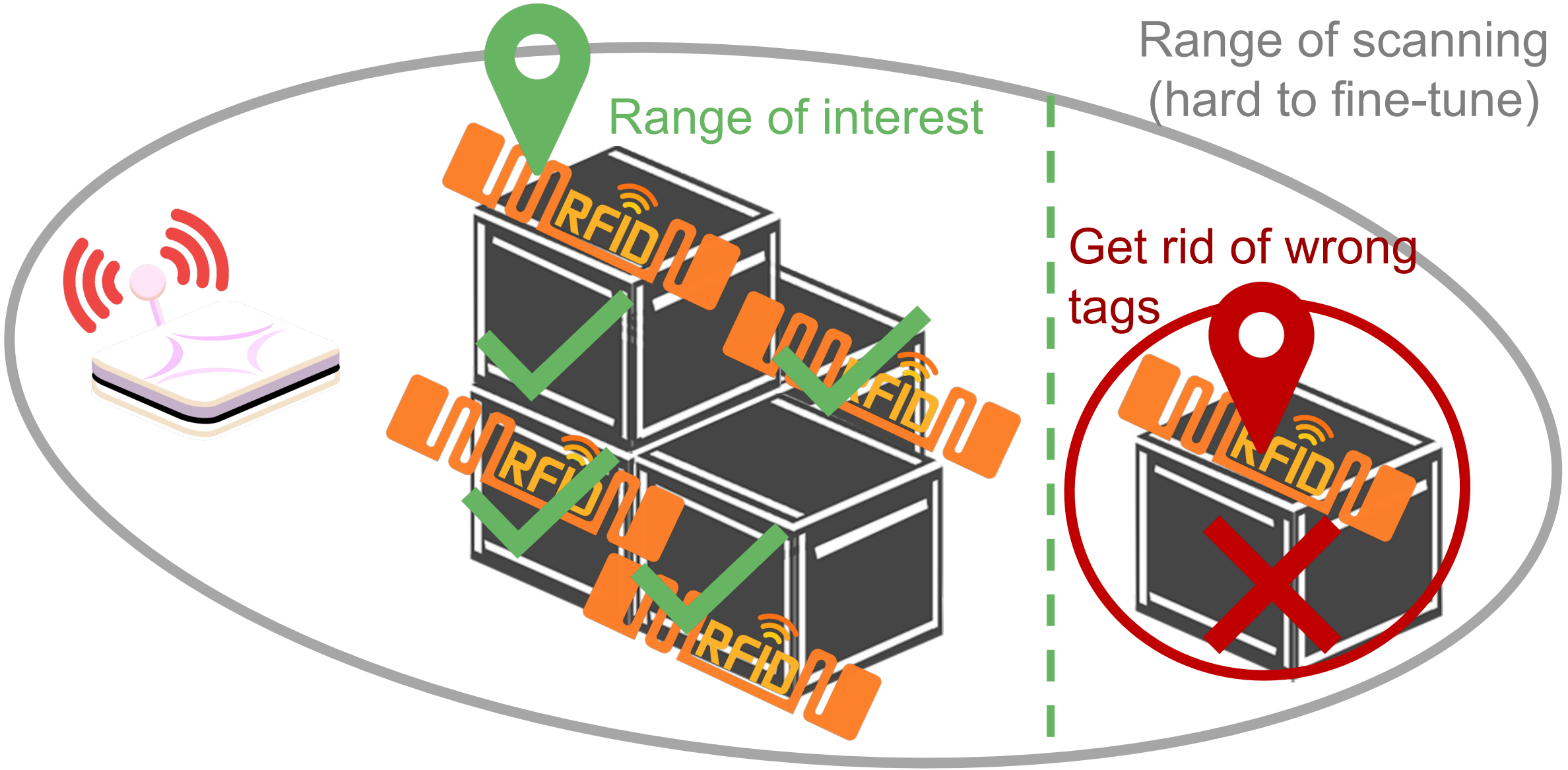
RFID → High Throughput



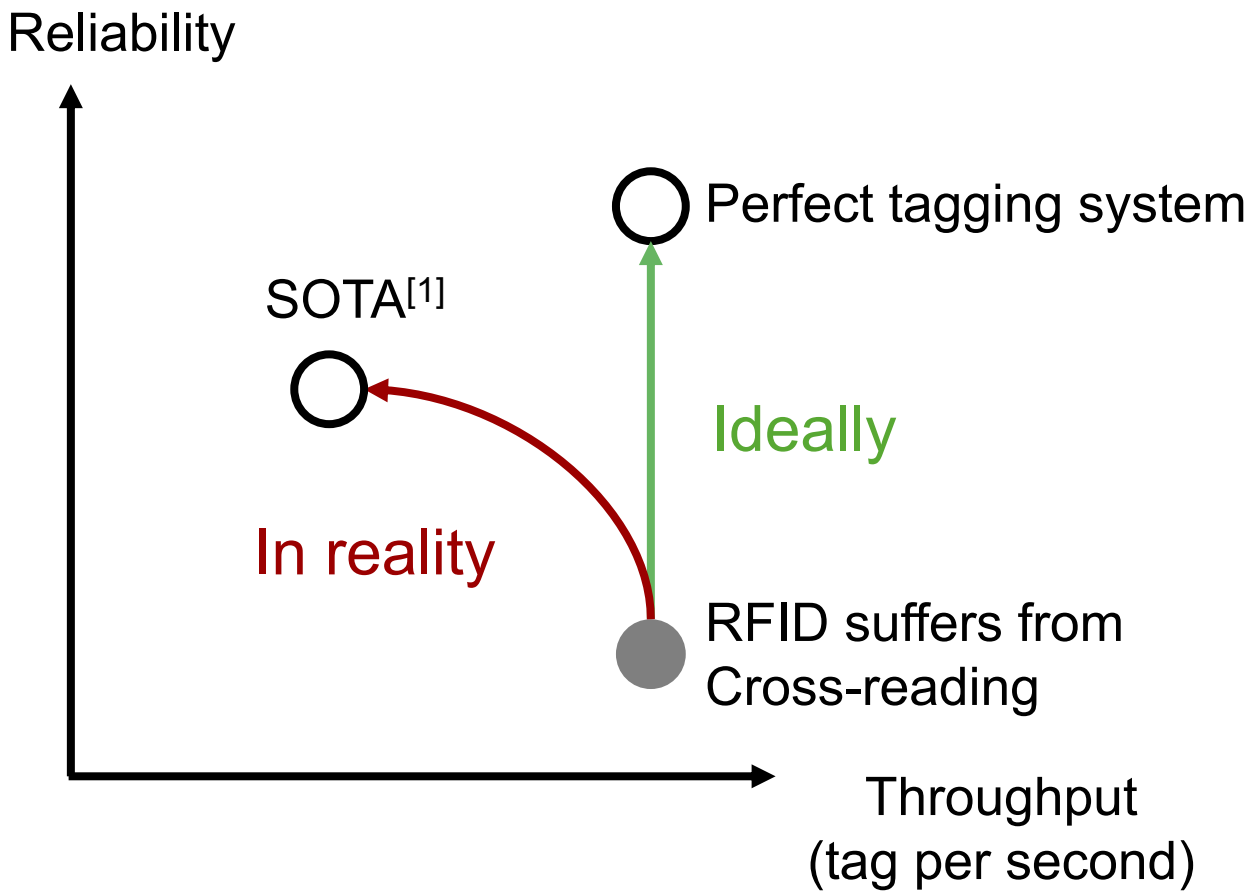
Cross Reading Problem → Low Reliability



Localization Kills Cross Reading

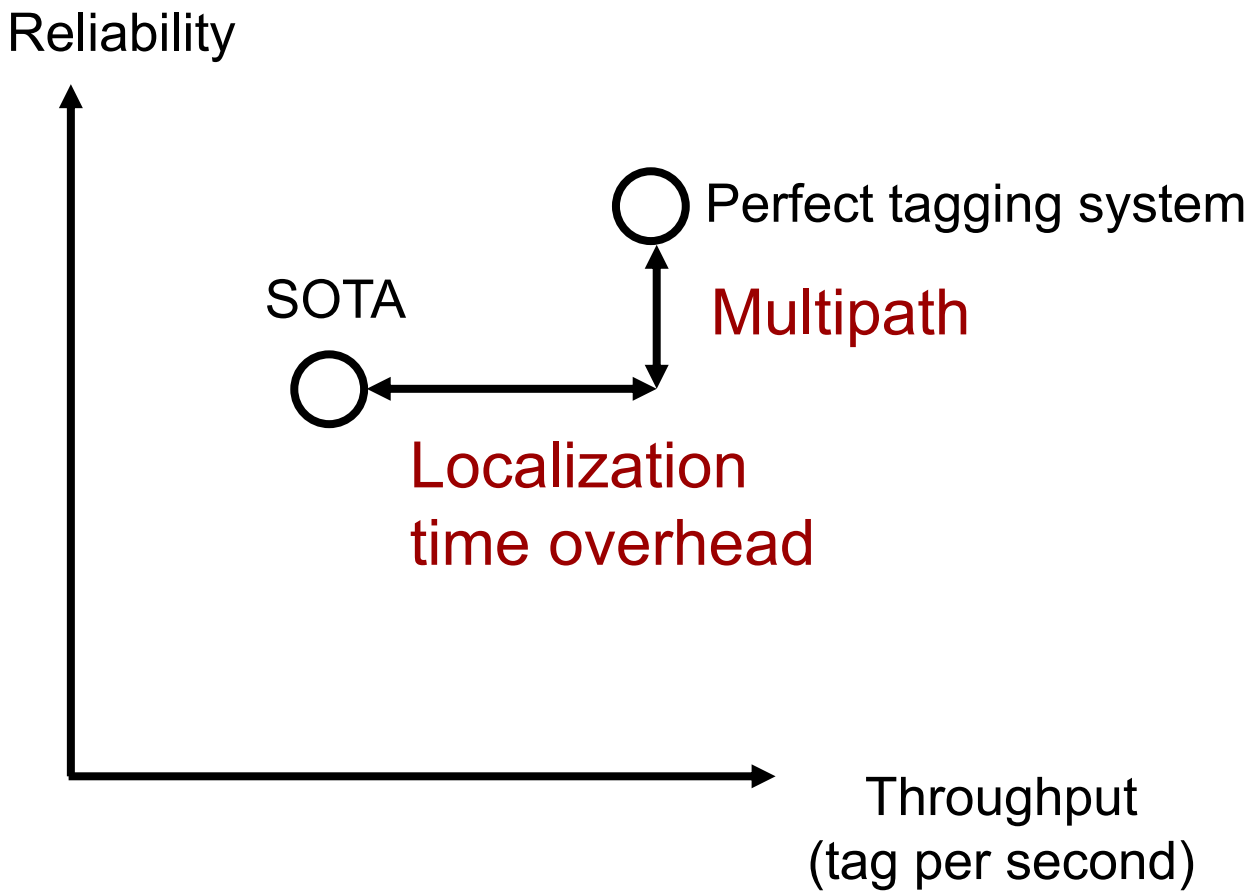


Do we already have the perfect tagging system?

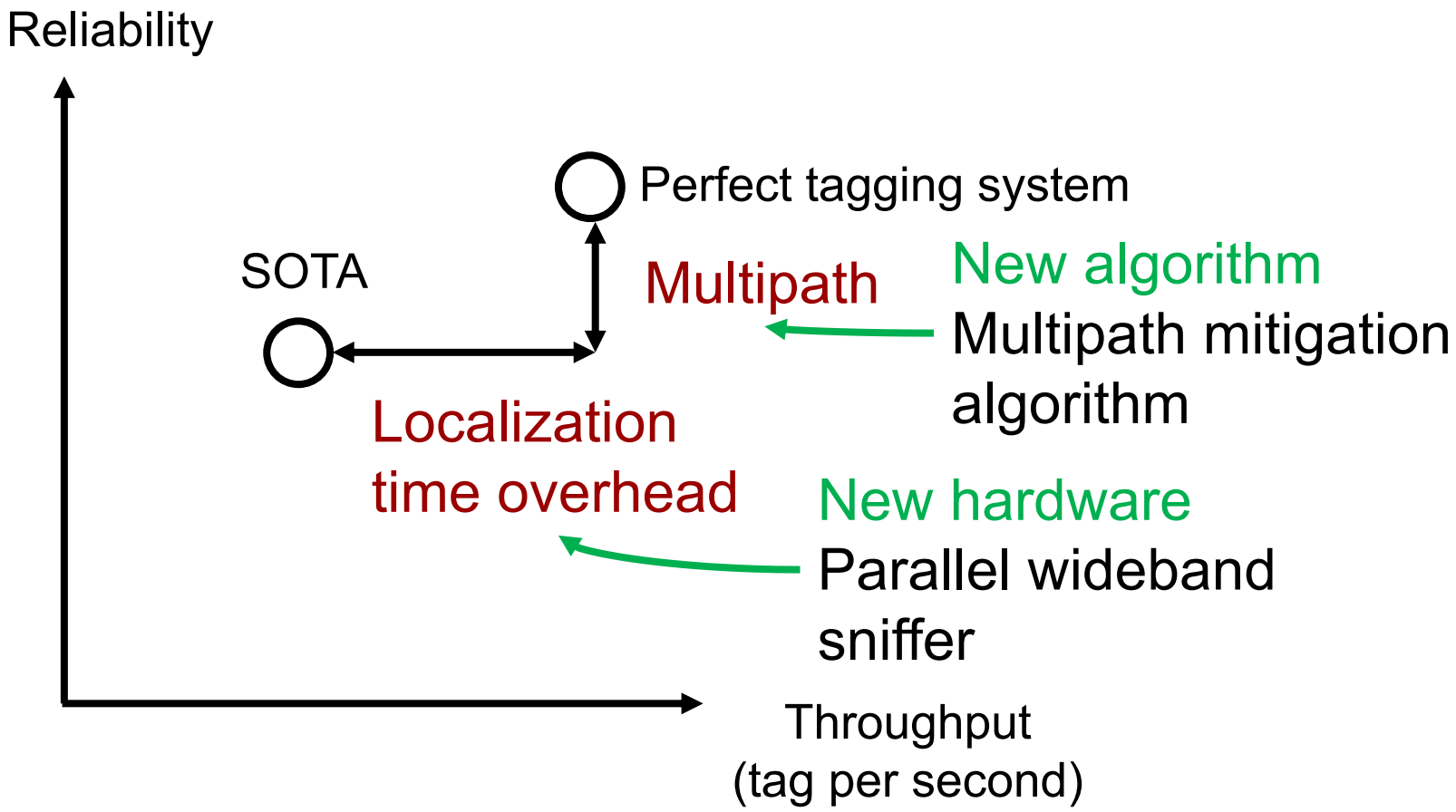


[1] Luo, Zhihong, et al. 3D backscatter localization for fine-grained robotics. NSDI. 2019.

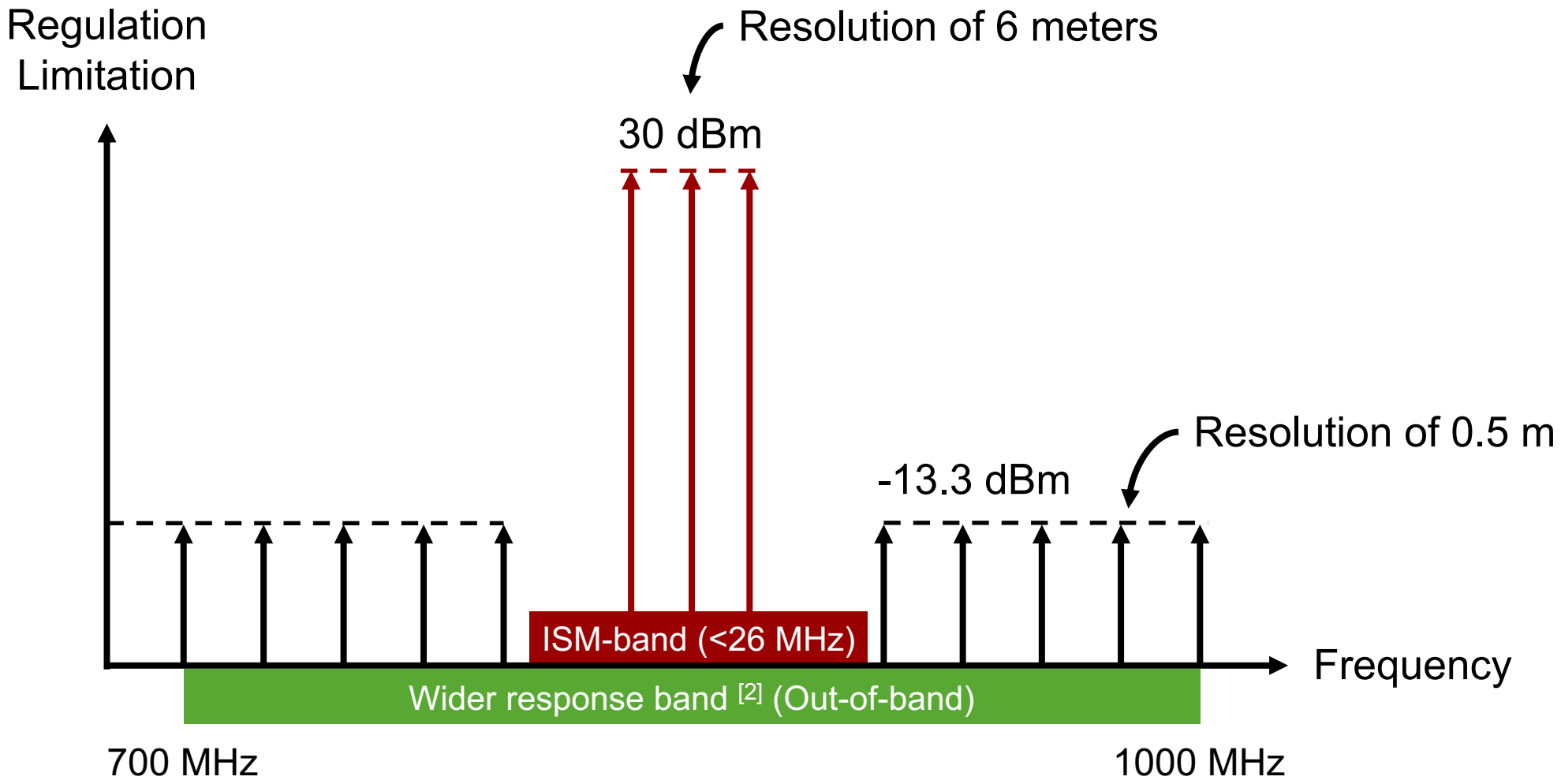
Challenges


Reliability
Perfect tagging system
SOTA
Multipath
Localization
time overhead
Throughput
(tag per second)

Our Approach



Localization Based on Out-of-band



[2] Ma, Yunfei, Nicholas Selby, and Fadel Adib. Minding the billions: Ultra-wideband localization for deployed rfid tags. MobiCom'17.

Only Use ISM-band Reader

ISM-band signal

High power!

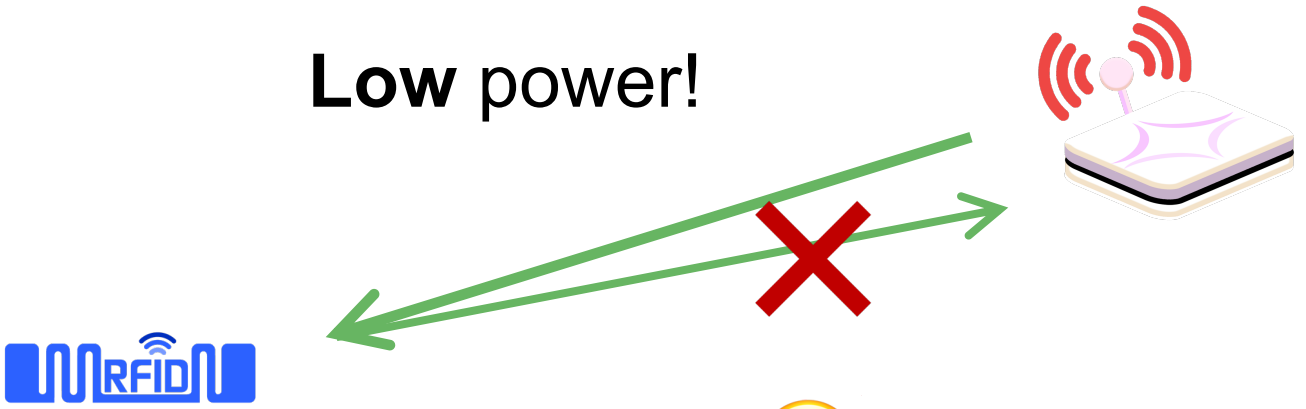
😊 Successful scan

😭 But no localization

Only Use Wideband Reader

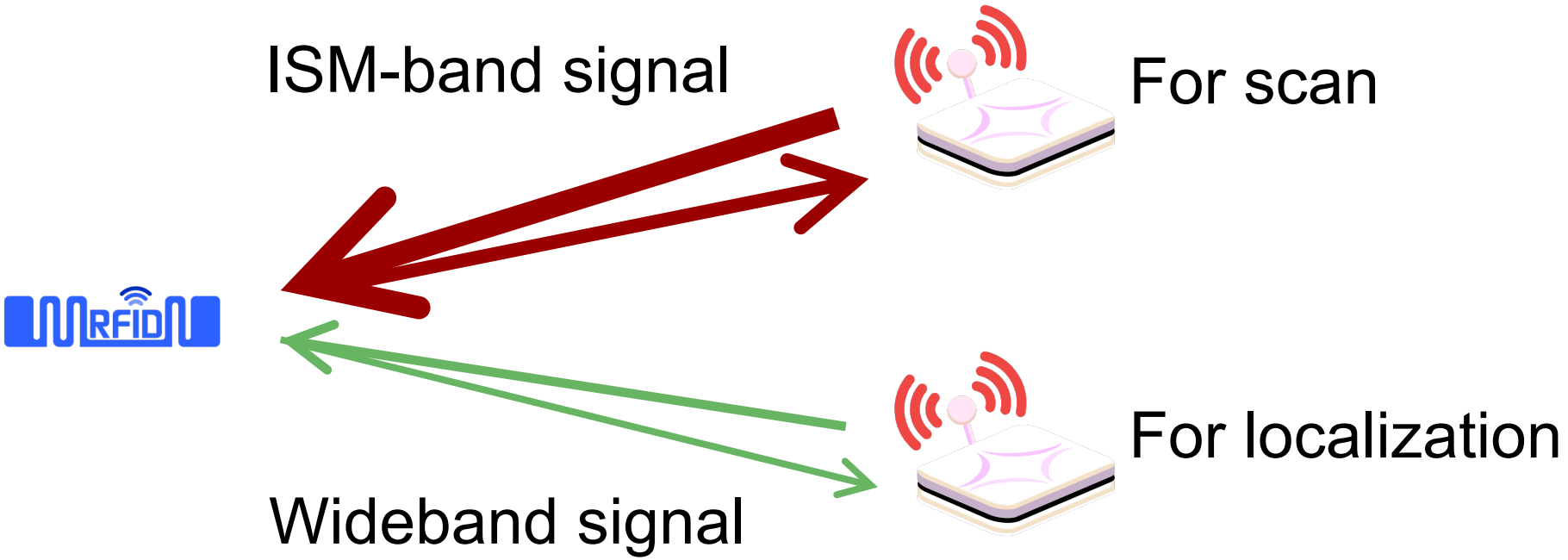
Wideband signal

Low power!



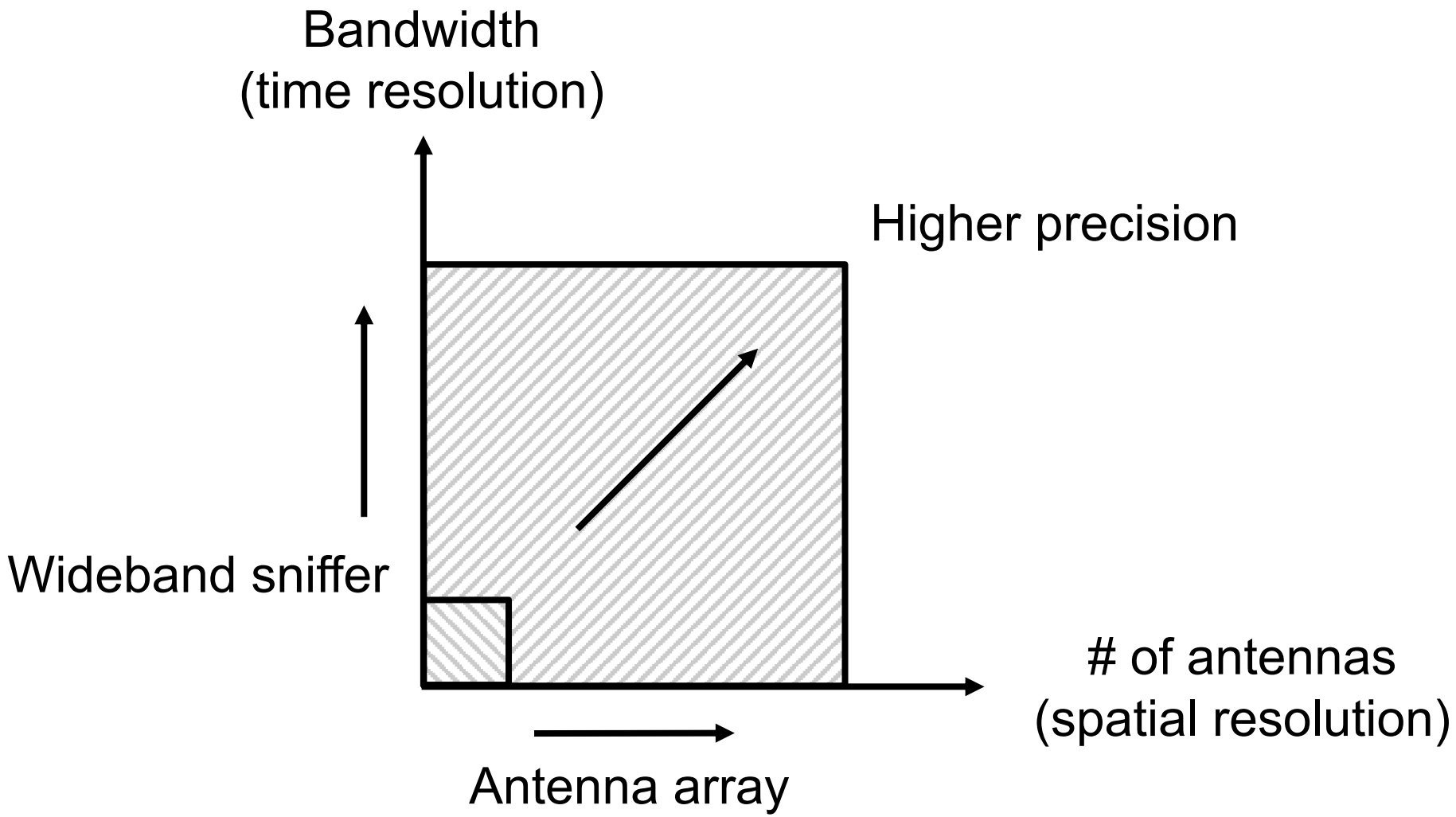
😭 Failure to activate RFID tag

Put ISM-band Reader and Wideband Reader Together

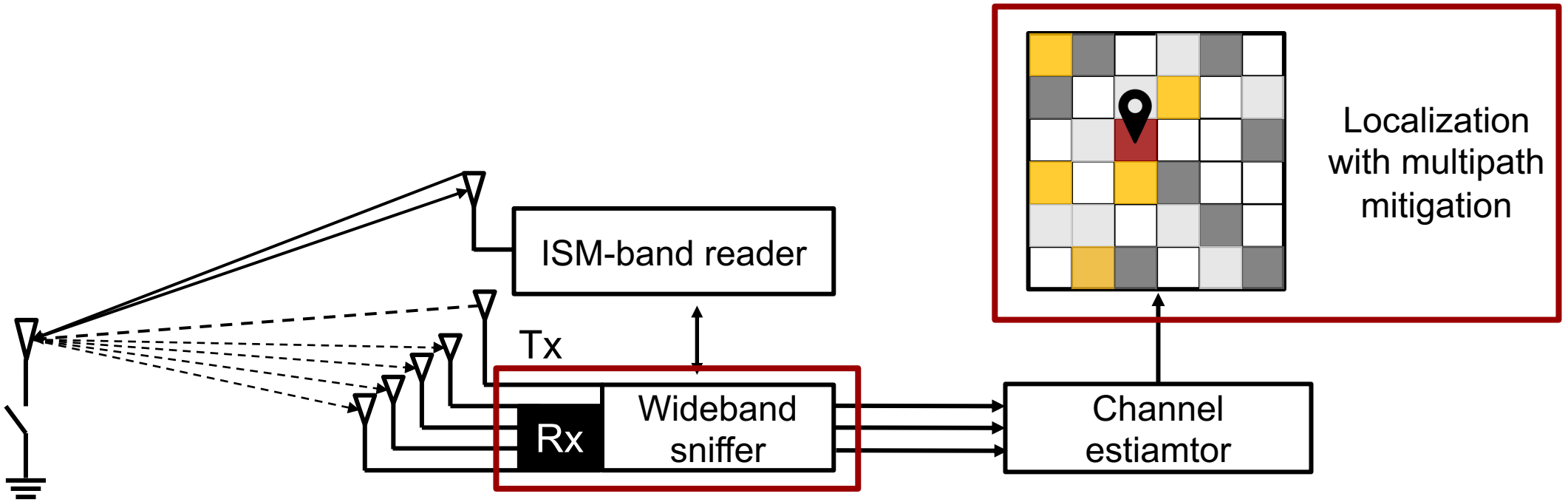


😊 Successful scan and localization

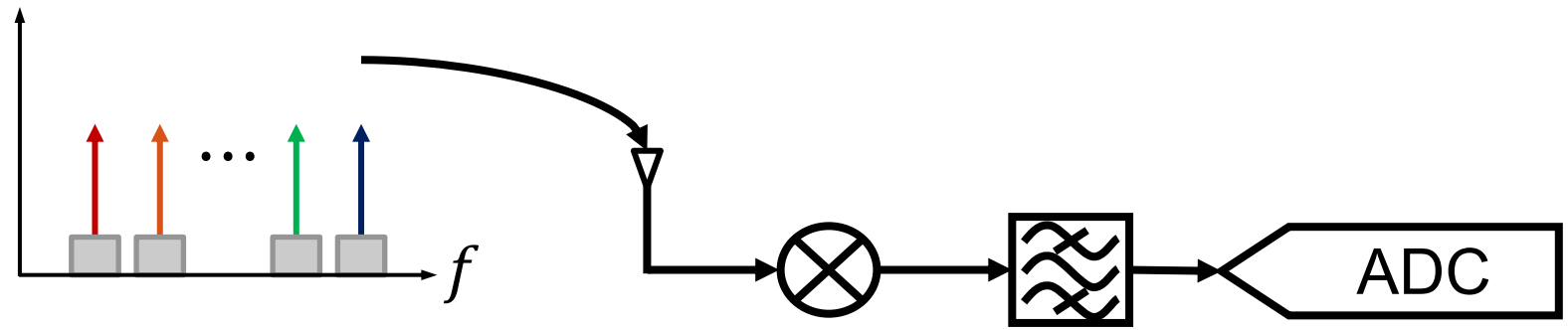
Array + Sniffer for High-precision Localization



System Overview

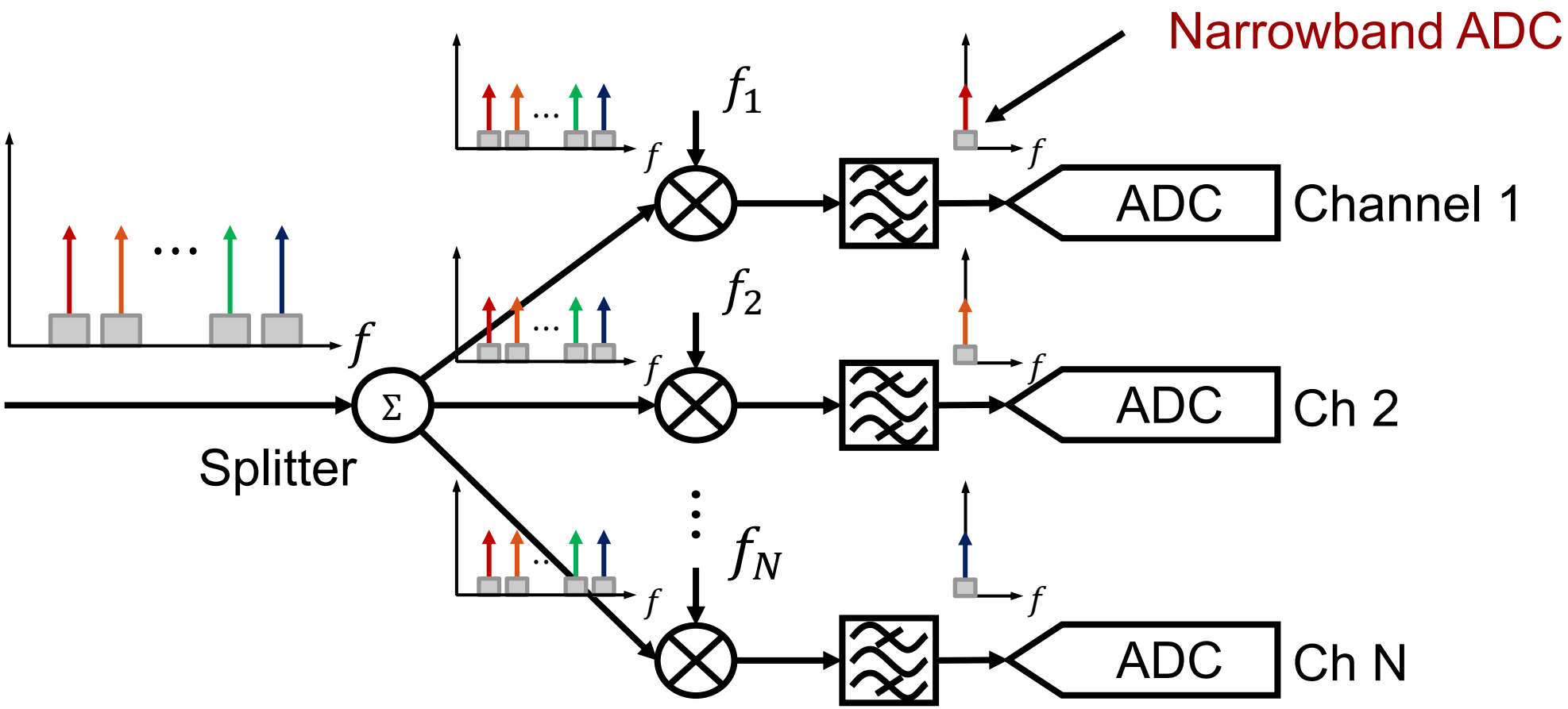


Hardware Architecture Design

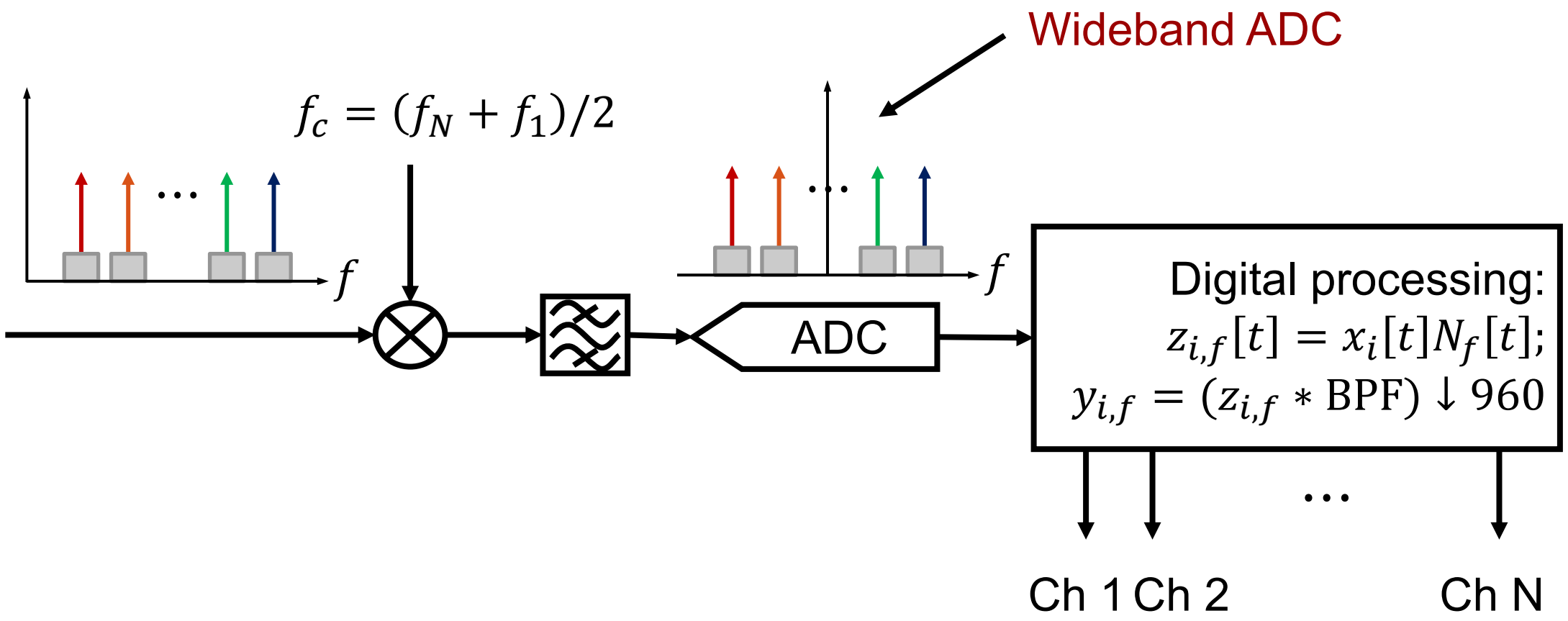


Hundreds of MHz

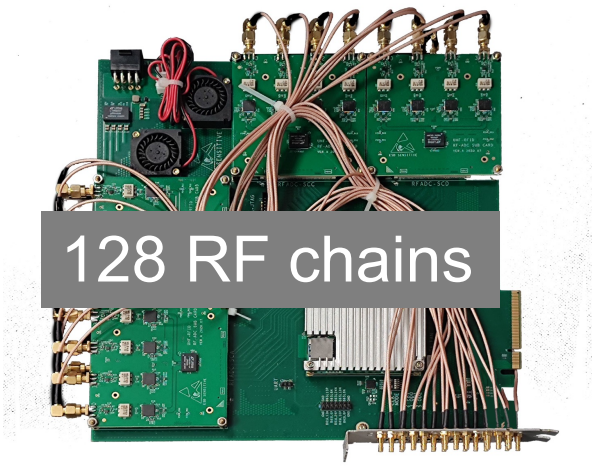
Architecture Candidate 1: Analog

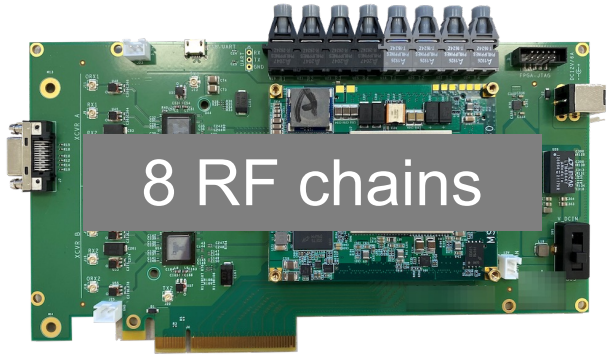


Architecture Candidate 2: Digital



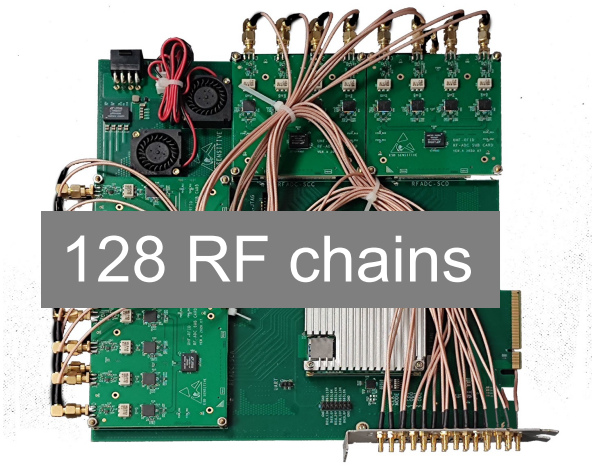
Architecture Design

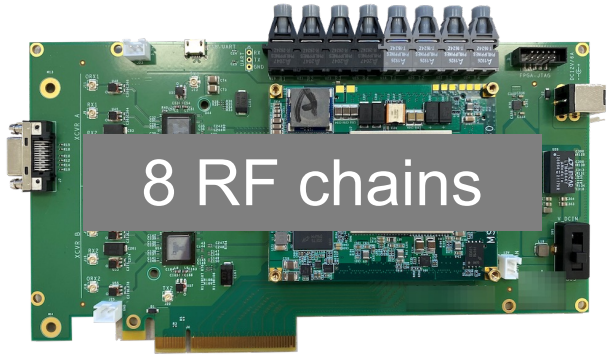




	Analog	**Digital**
Advantages	Low bandwidth requirement High frequency flexibility	Good scalability

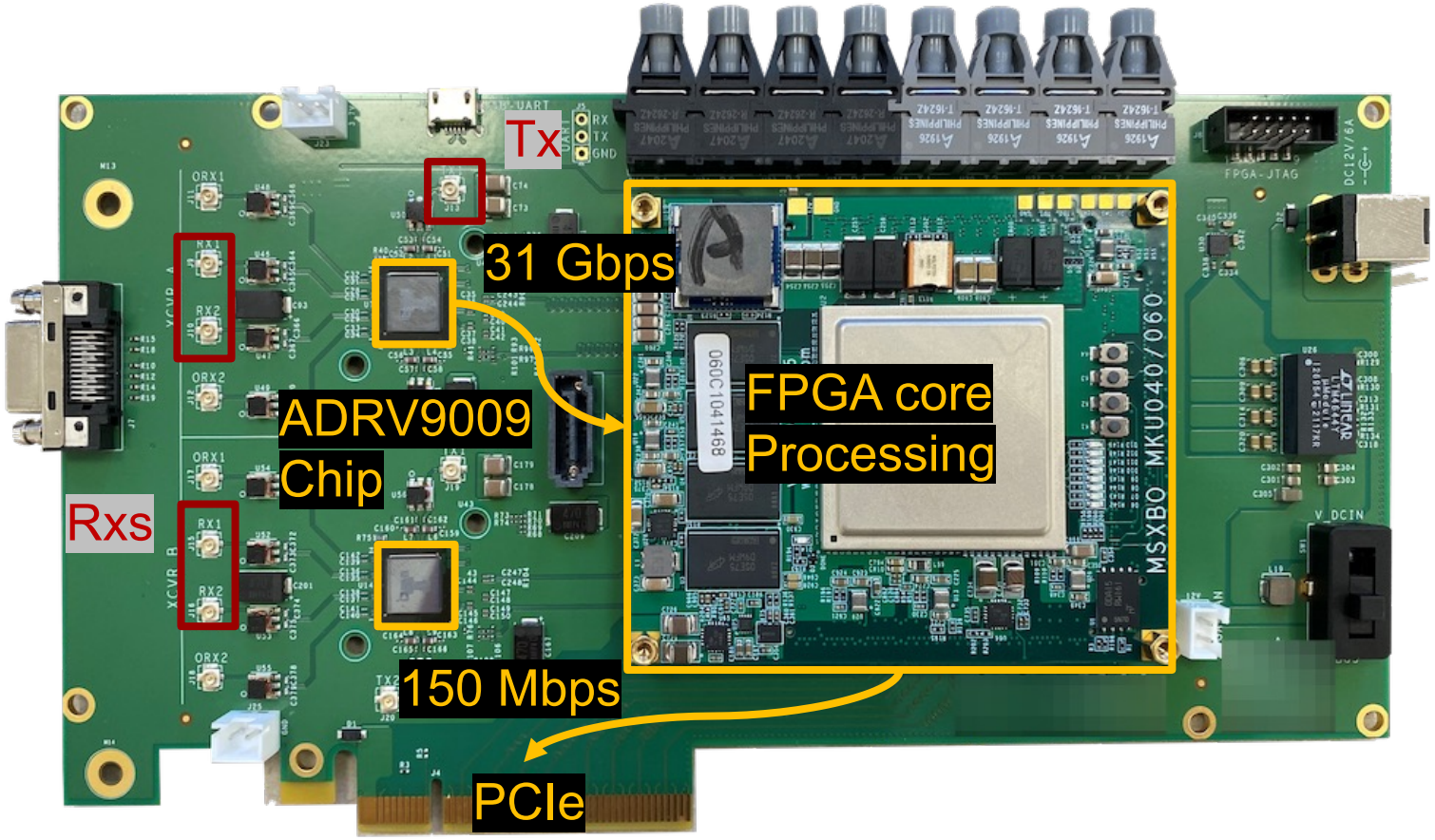
Architecture Design



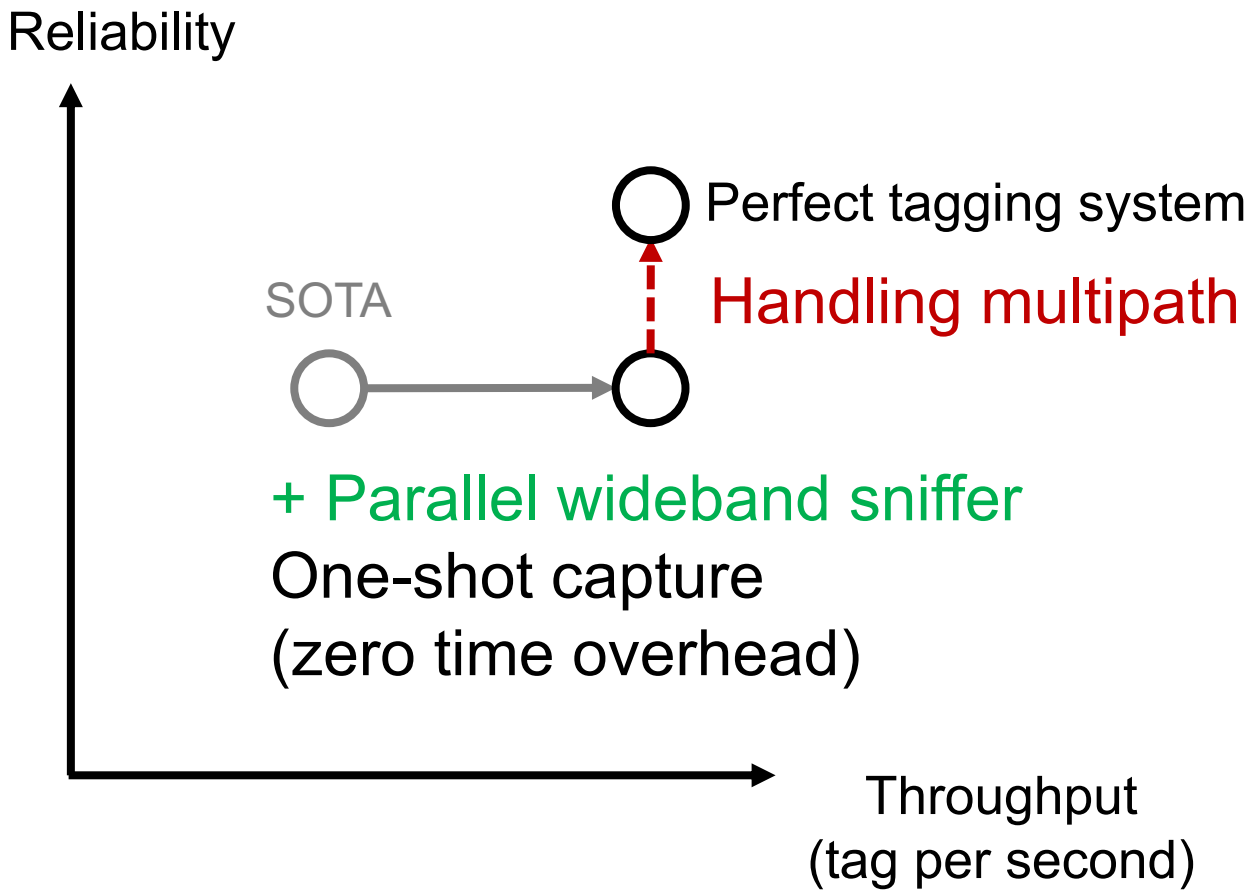


	Analog	**Digital**
Advantages	Low bandwidth requirement High frequency flexibility	Good scalability

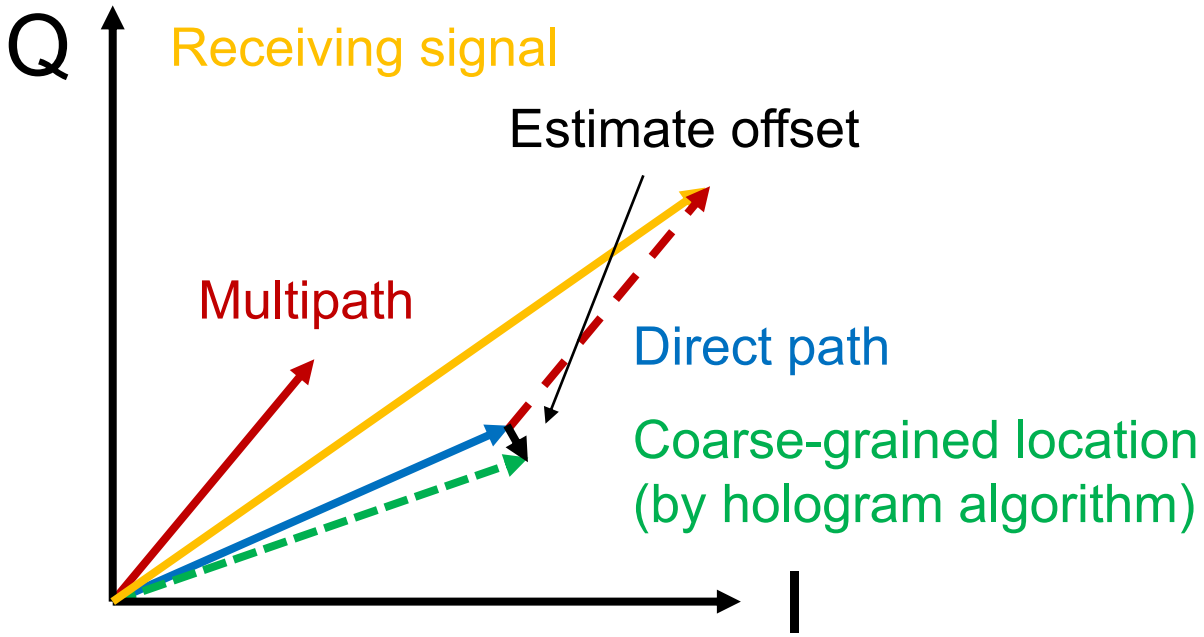
Hardware Platform: RF-Chord



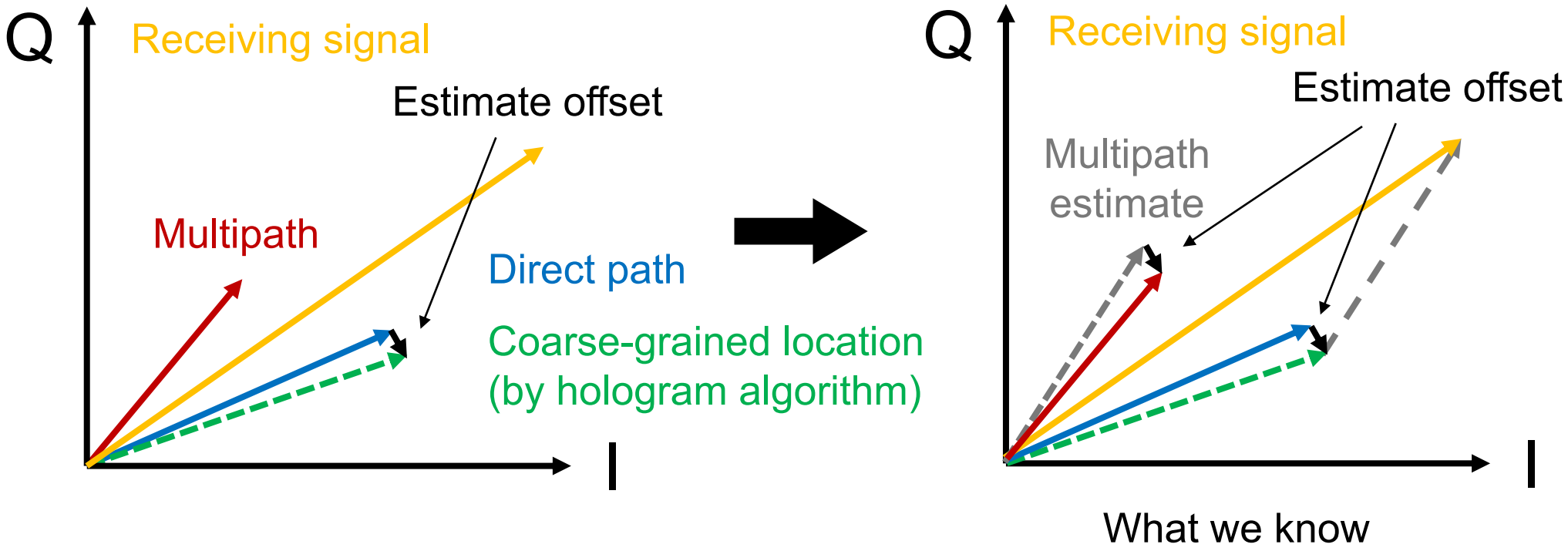
Next Step: Handling Multipath



How Multipath Influences localization



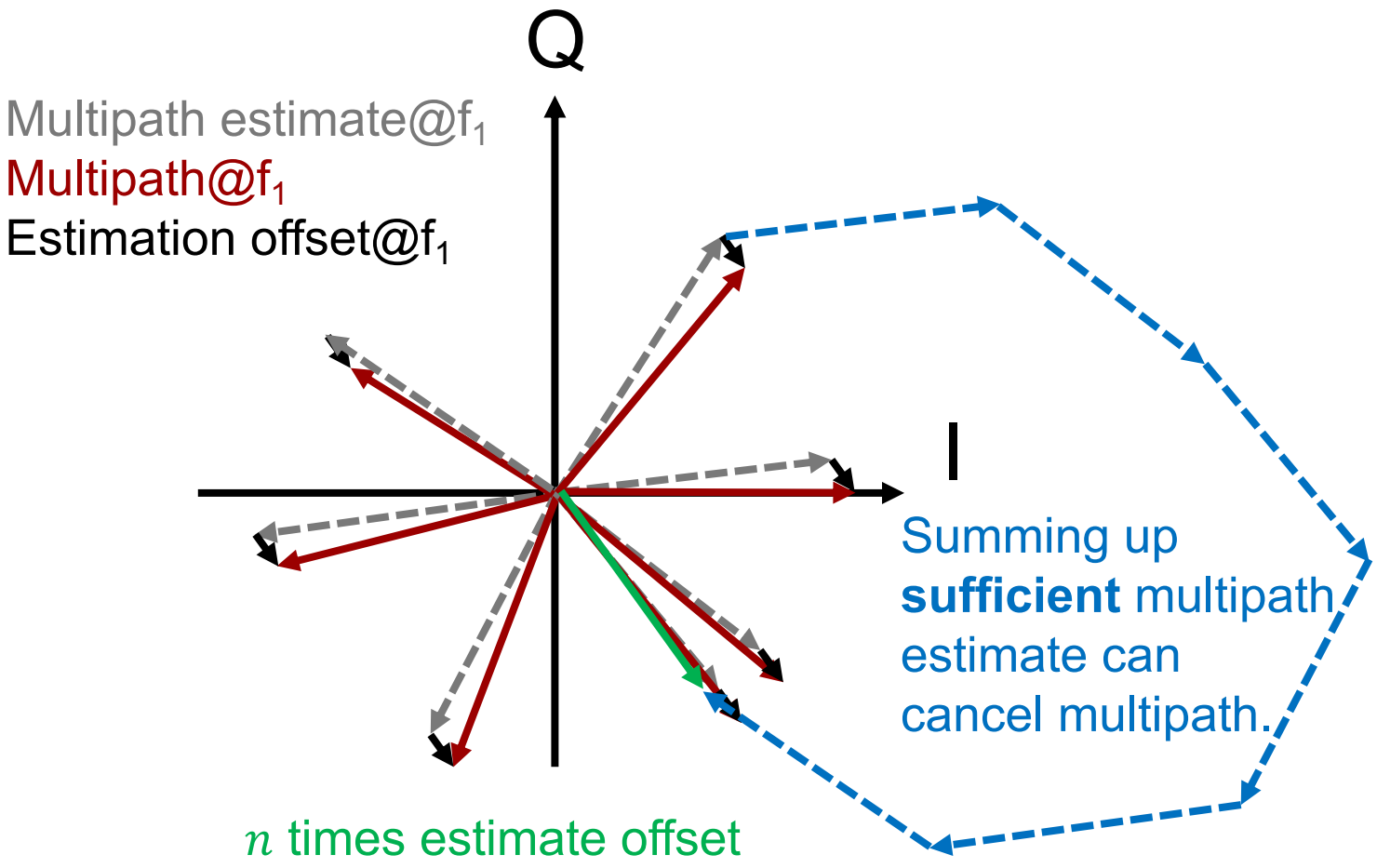
Equivalence Relationship Bridged by Estimate Offset



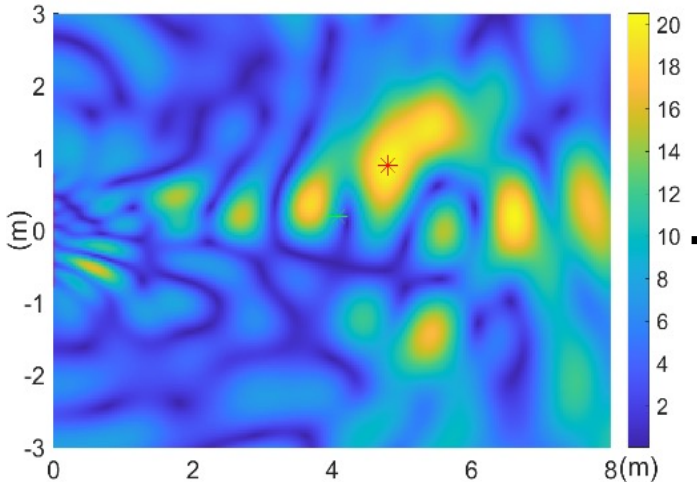
Coarse-grained estimate + Multipath estimate = Receiving signal = Direct path + Multipath

Coarse-grained estimate – Direct path = Multipath – Multipath estimate = Estimate offset

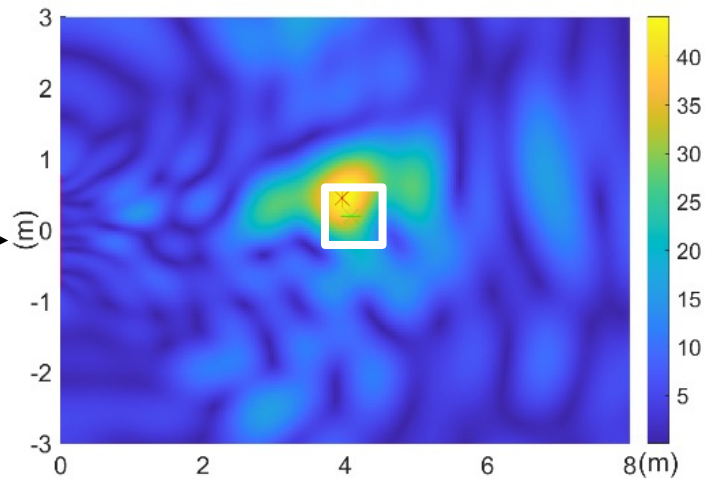
Key Insight: Multipath Vectors are Dispersive



Algorithm Performance

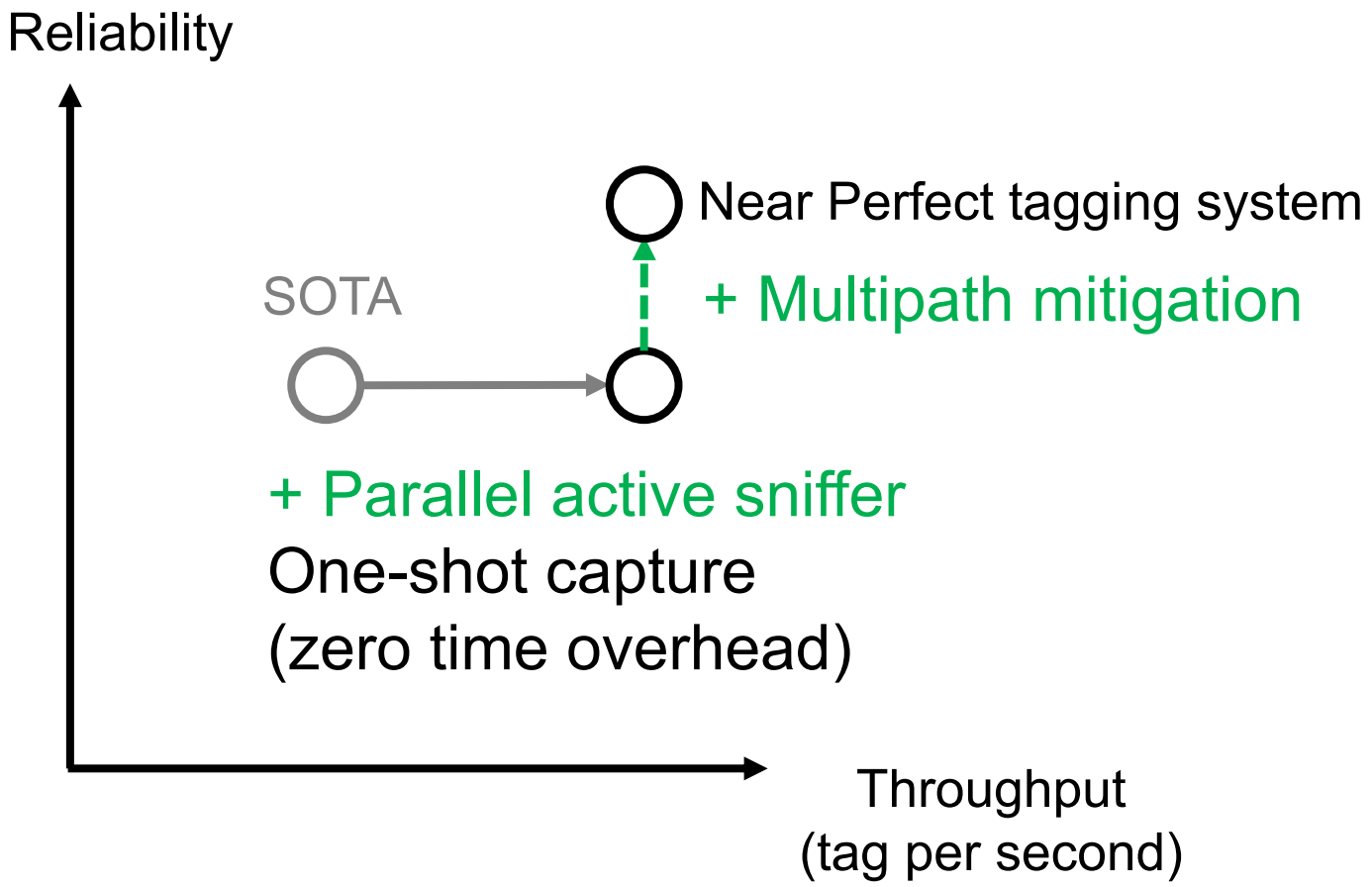


Baseline algorithm [hologram]
@Error 1.4 m

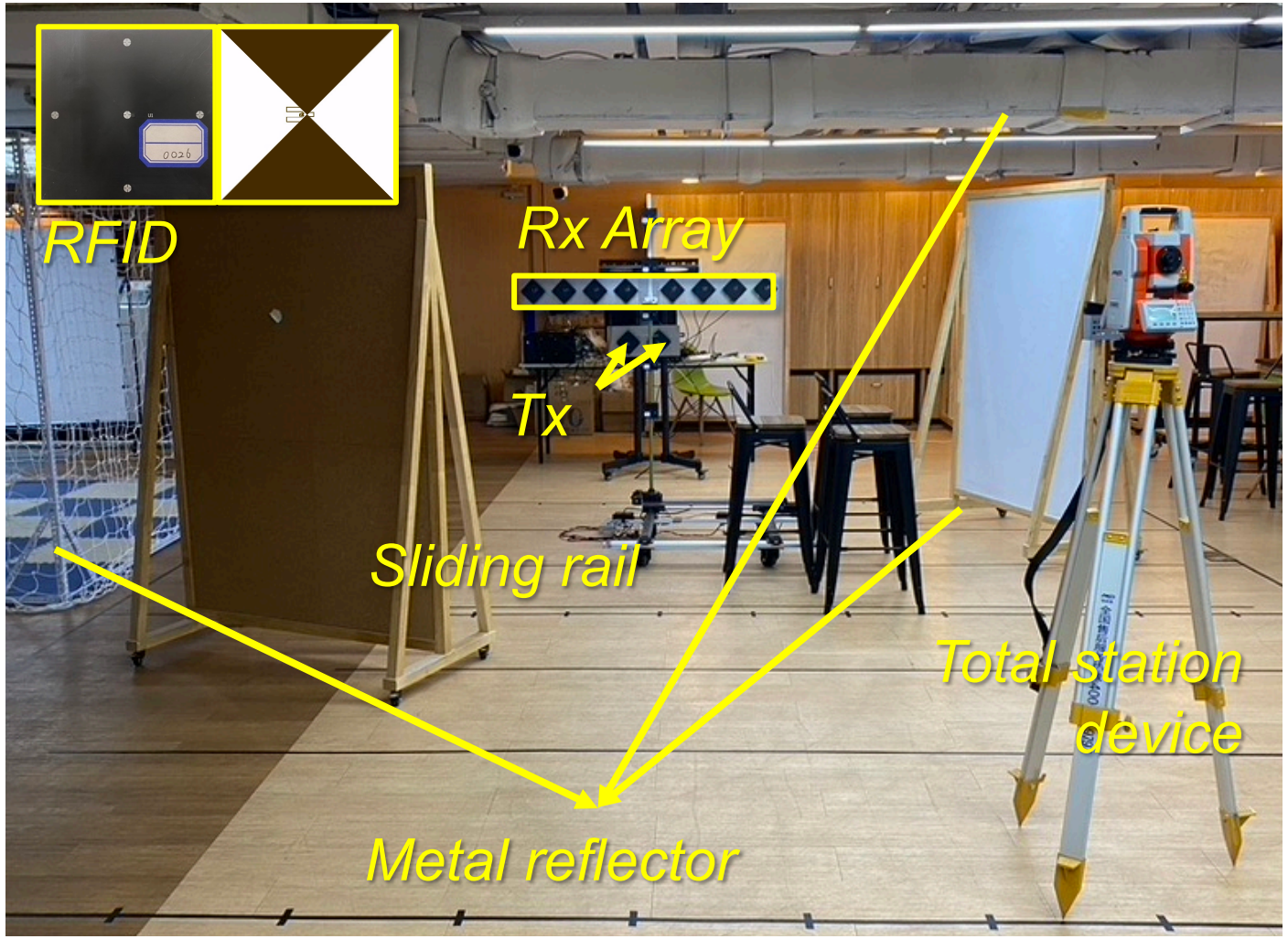


After multipath mitigation
@Error 0.4 m

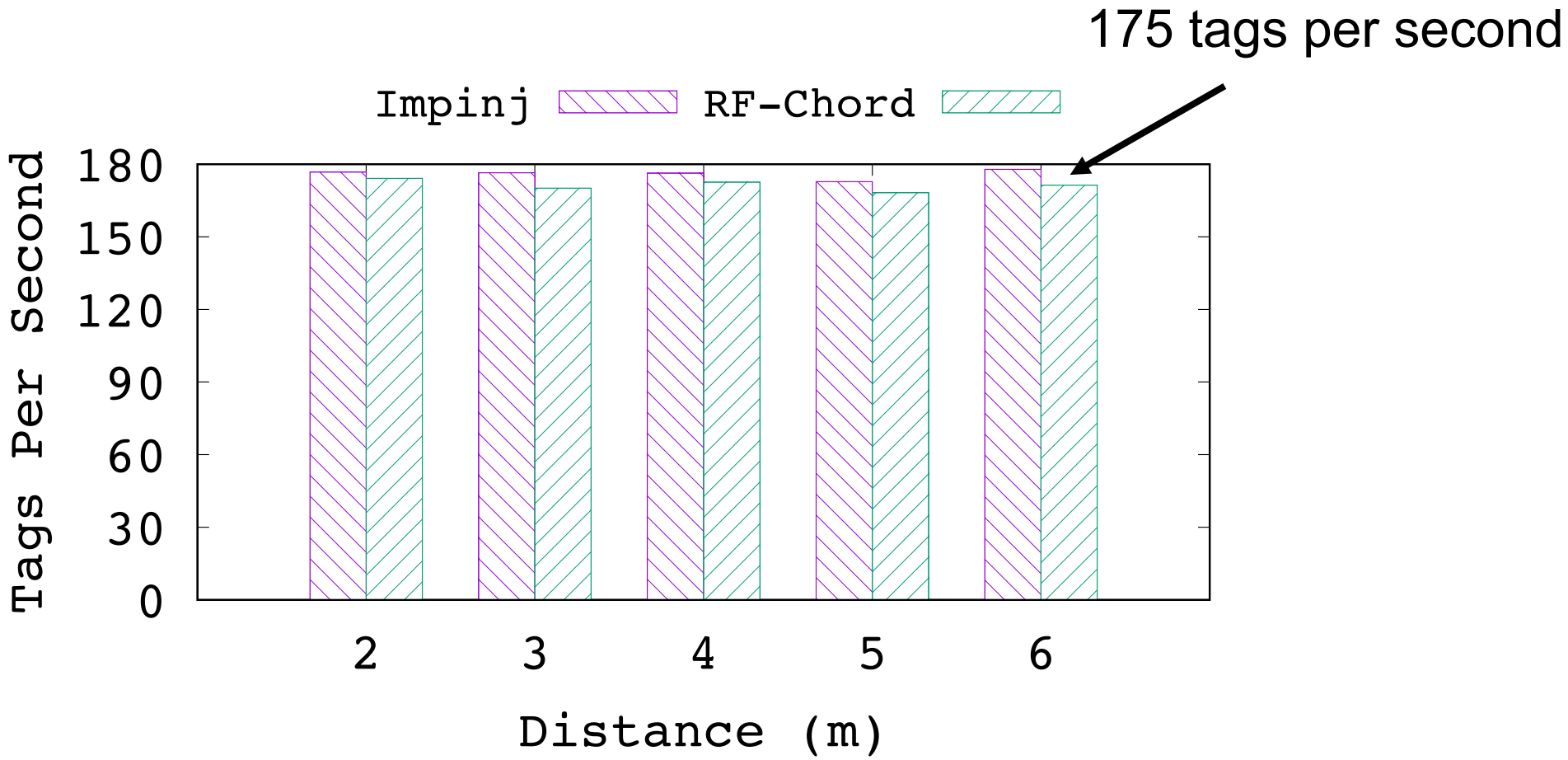
Towards to Ideal Tagging System



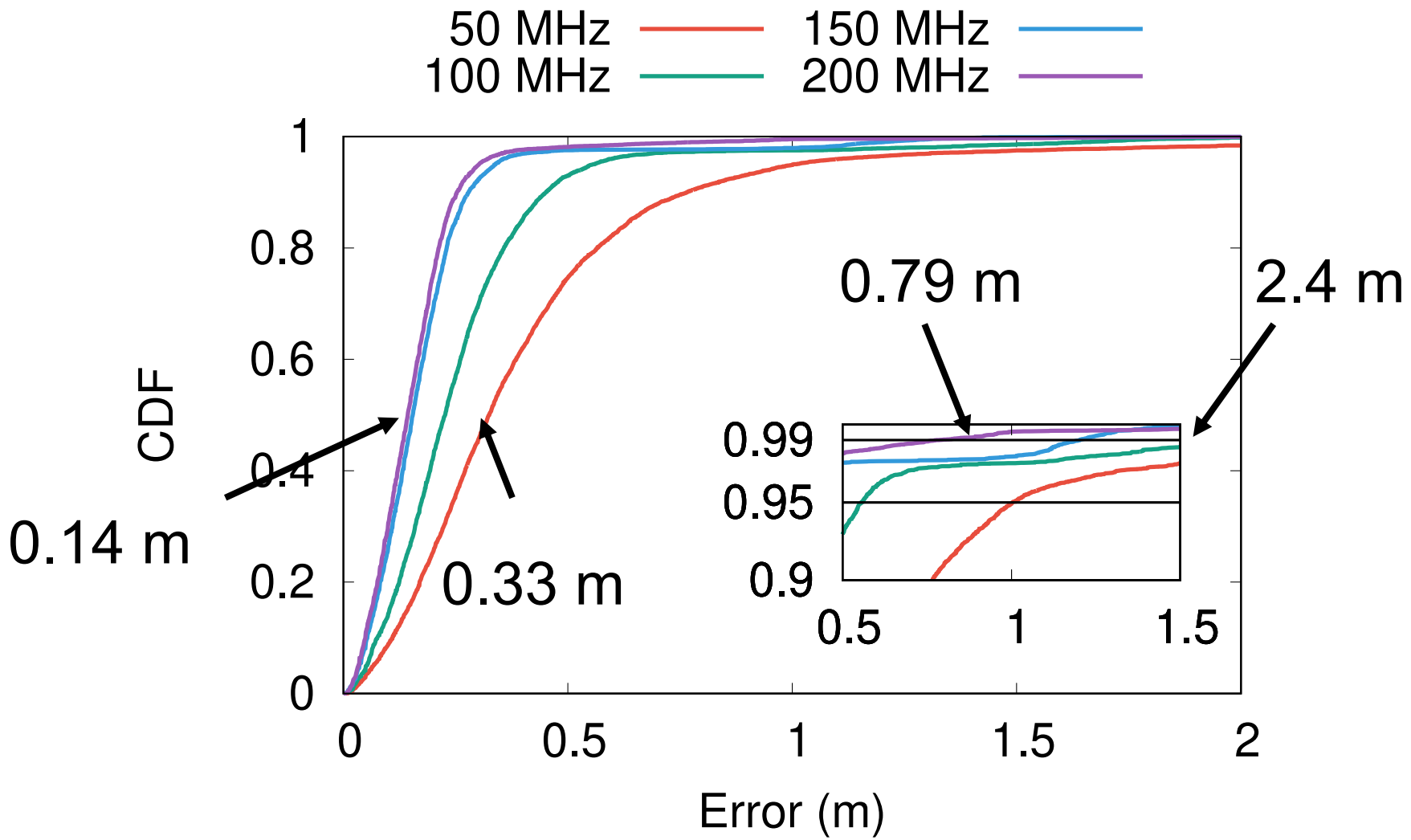
Evaluation Setup



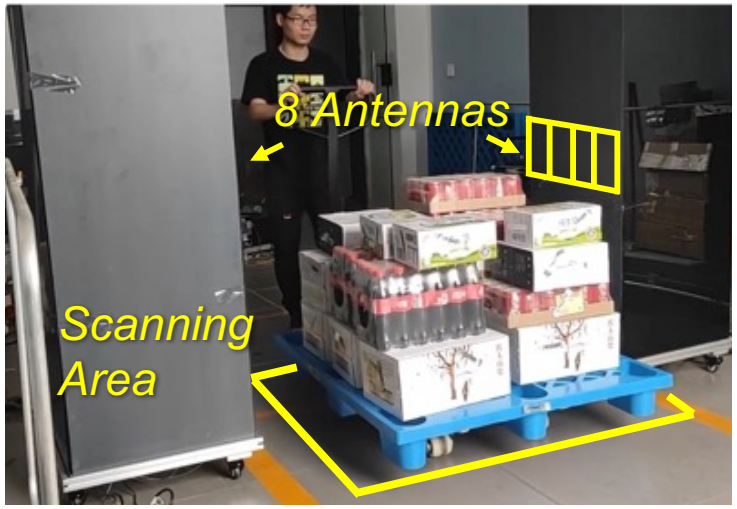
Throughput Evaluation

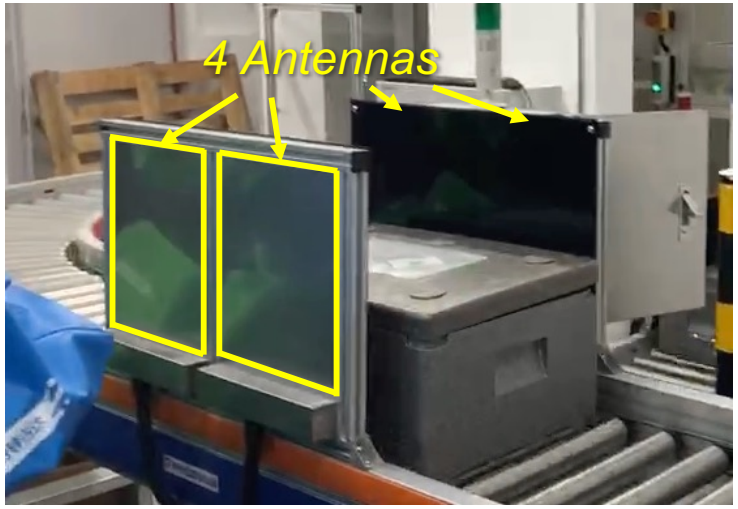


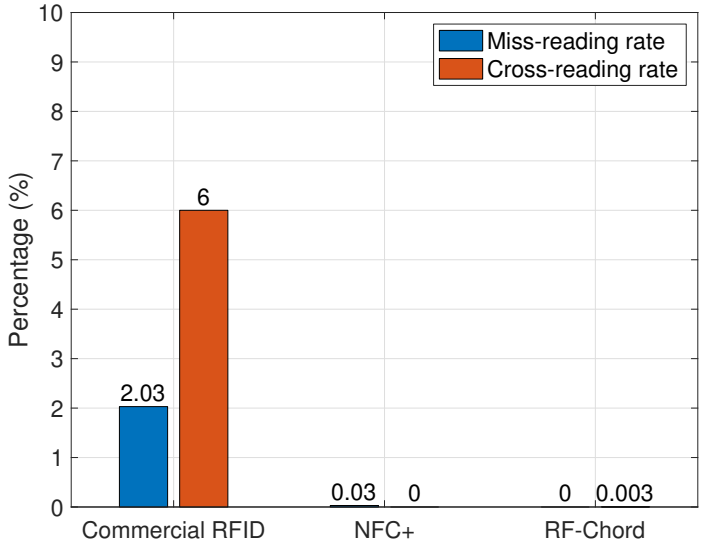
Reliability Evaluation



Deployment Performance



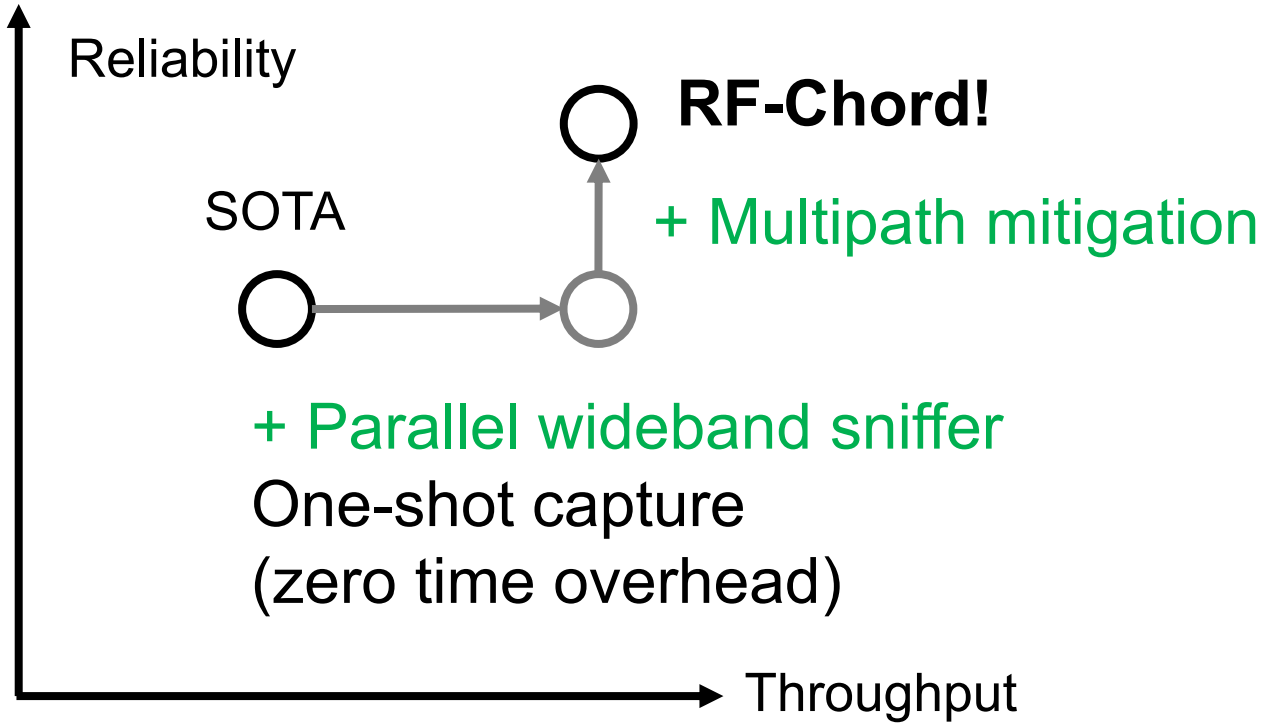




- RF-Chord meets the requirements of practical logistics networks
  - RF-Chord achieves the throughput of >100 tags/s, 10x improvement comparing to SOTA.
  - The cross-reading rate is 0.003%, 1000x improvement comparing to current RFID readers.

Take-away Messages

- Localization kills RFID cross-reading in logistics network.
- First high-reliability & high-throughput RFID localization system.
- Open source at *https://soar.group/projects/rfid/rfchord*.



Try our open source code and dataset!