

RFID Reliability

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- Ahmad Rahmati (Rice University, AT&T summer intern)
- Lin Zhong (Rice University)

RFID Overview

RFID = Radio Frequency Identification

RFID tags/ids can be read over a distance of several meters.

Active tags: battery powered, more complex processing (encryption, authentication), longer range.

Passive tag: no battery; powered by the signal from the RFID reader.

Numerous proposed applications: supply-chain management, US passports, boarding passes, luggage tags, euro bank notes, ...

Security and privacy issues have gained a lot of attention, reliability challenges not so much.



Reliability challenges

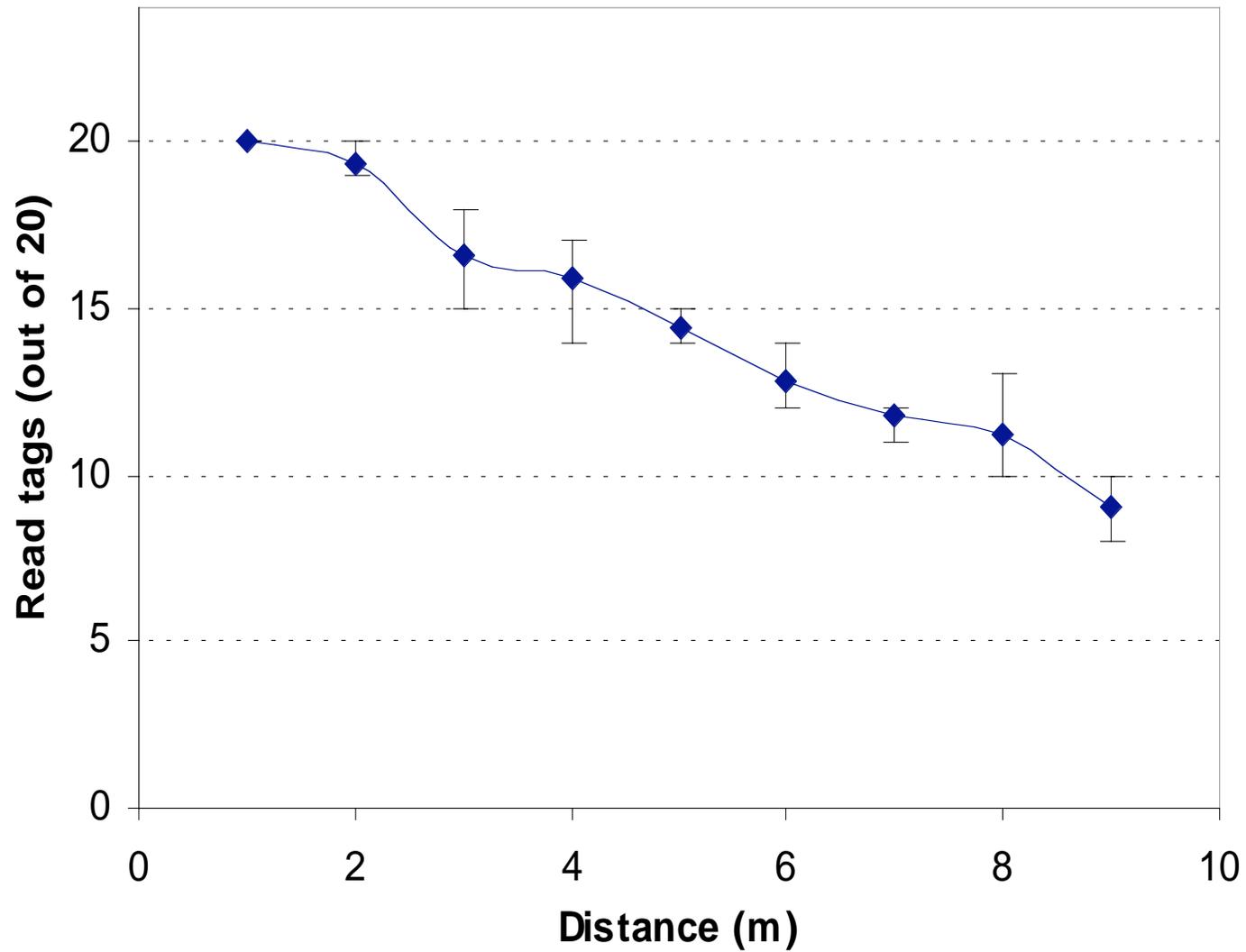


False negatives the main problem.

Read reliability affected by:

- distance between reader and tags, number of tags,
- distance between tags, speed, tag orientation, ..
- materials (metals, liquids): grounding, blocking, reflection

Impact of distance to antenna



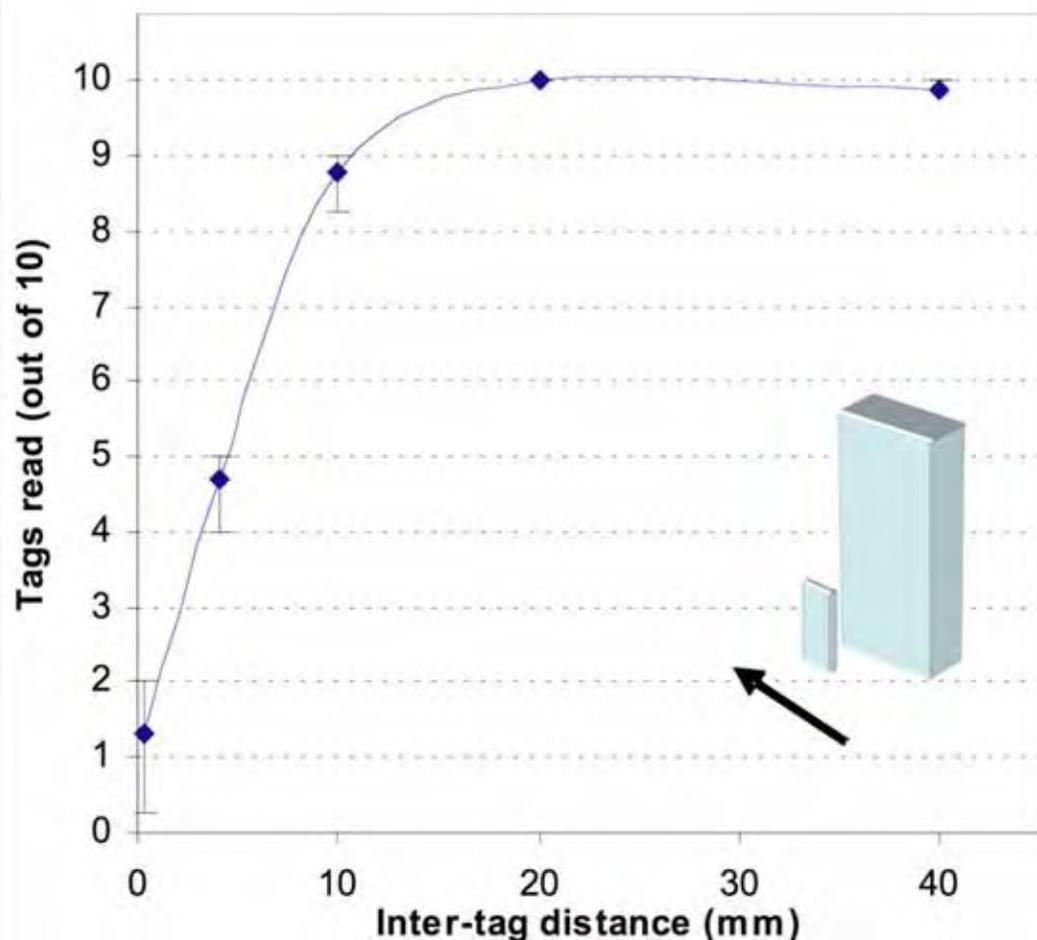
Evaluation scenario

Unobtrusive identification of moving objects (inc. humans, pallets with products). Passive Generation 2 tags.

Speed ~ 1 m/s. Minimum distance to antenna 1 m.



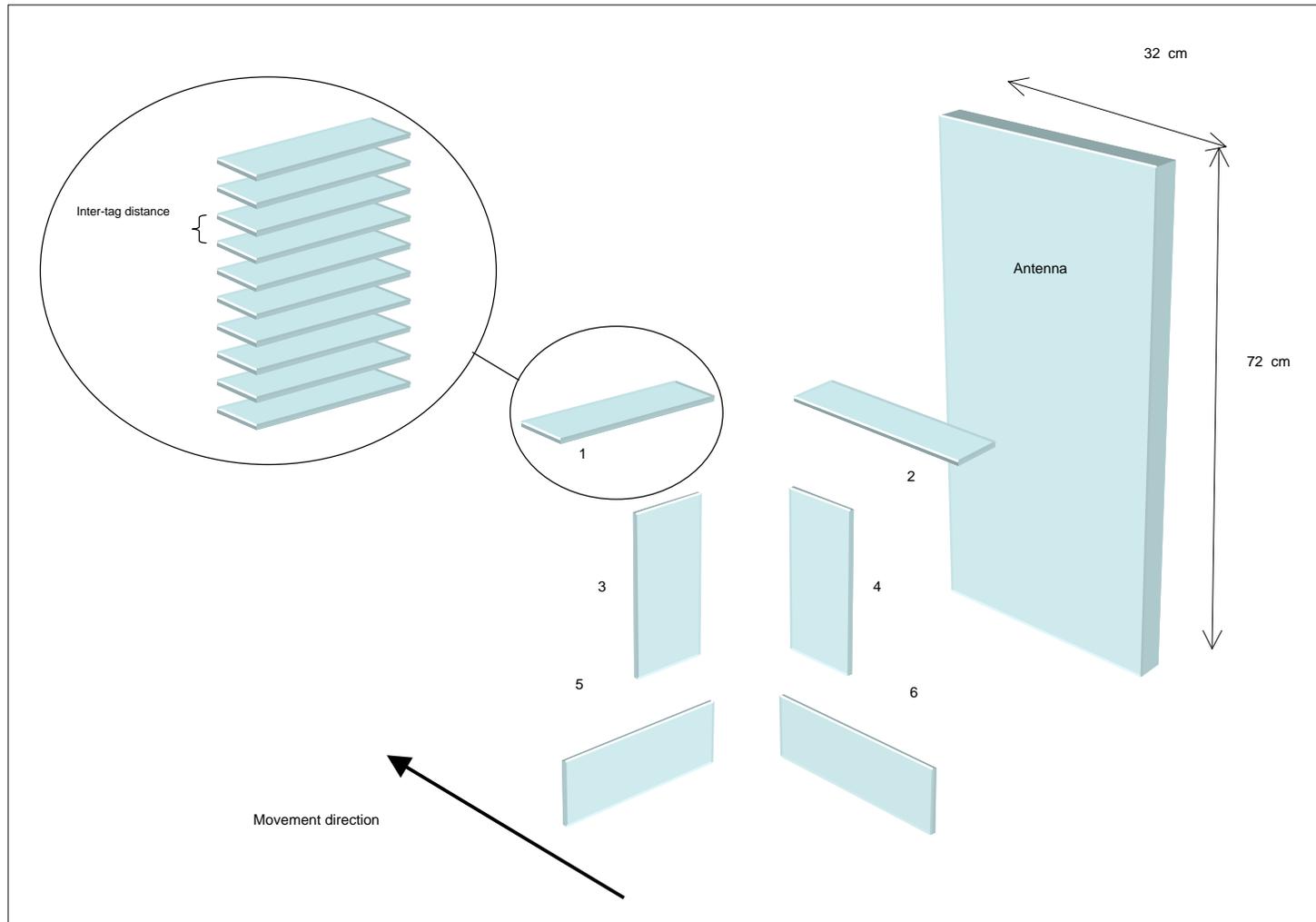
Impact of distance between tags



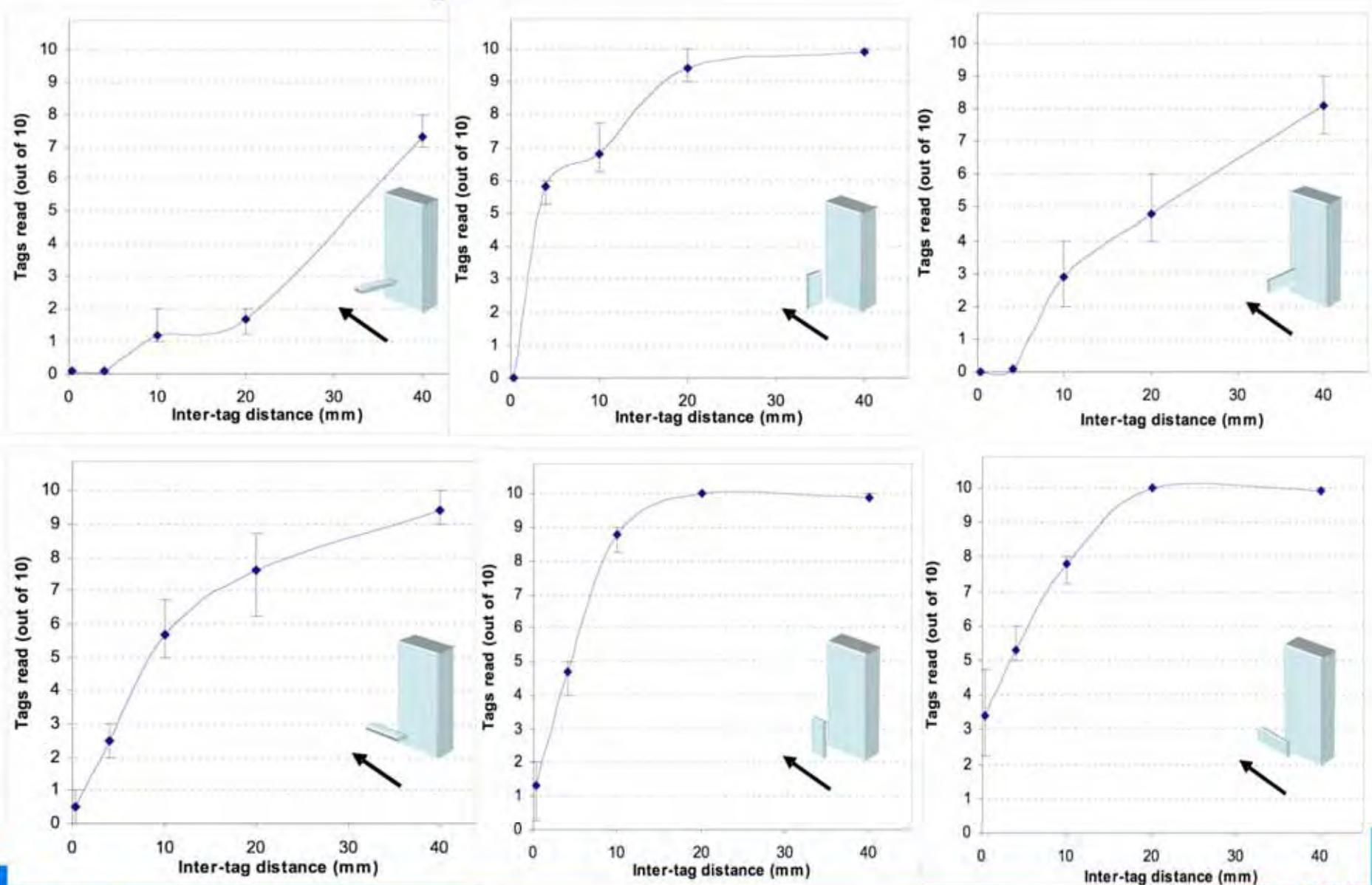
Care must be taken when multiple tagged objects are on the same pallet/shopping cart/bag/etc

If multiple tags are used per object, they need to be located carefully.

Impact of orientation



Impact of orientation



Read reliability for tags on objects

Moving pallet with 12 wireless routers in original packaging, stacked 2 high in 2 rows. One antenna.

Tag location	Reliability
Front	87%
Side (closer)	83%
Side (farther)	63%
Top	29%
Average	63%

Location makes a big difference due to blocking (metal or liquid).

Read reliability for tags on humans

One tag/person, located away from skin (hanging from belt). One antenna. Multiple subjects pass antenna at the same time. Speed 1 m/s.

Tag location	One subject	Two subjects		
		Closer	Farther	Average
Front / Back	75%	90%	50%	70%
Side (closer)	90%	90%	50%	70%
Side (farther)	10%	30%	0%	15%
Average	63%	75%	38%	56%

How to improve reliability?

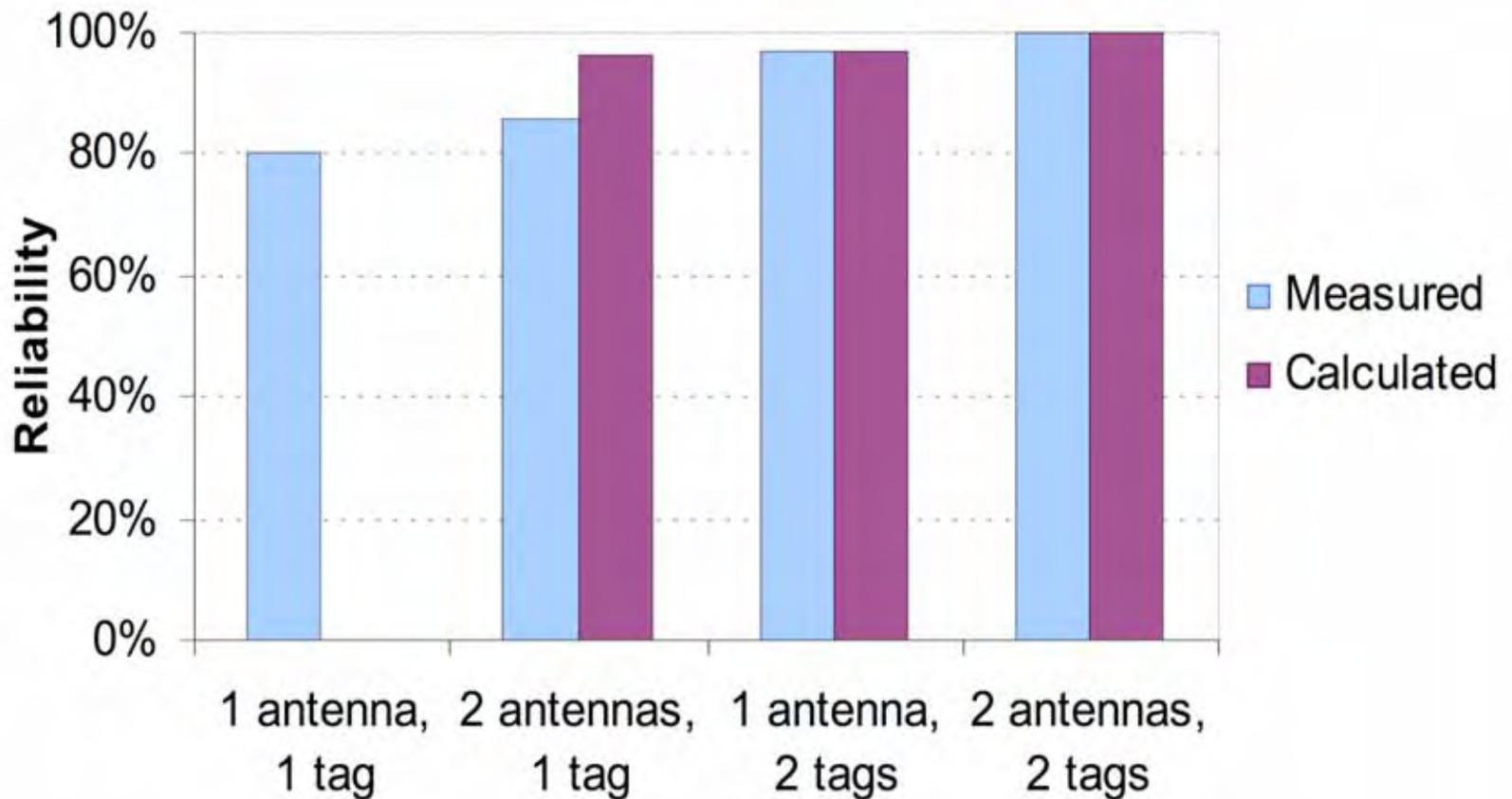
Redundancy: multiple readers per portal, multiple antennas per reader, multiple tags per object.

Results:

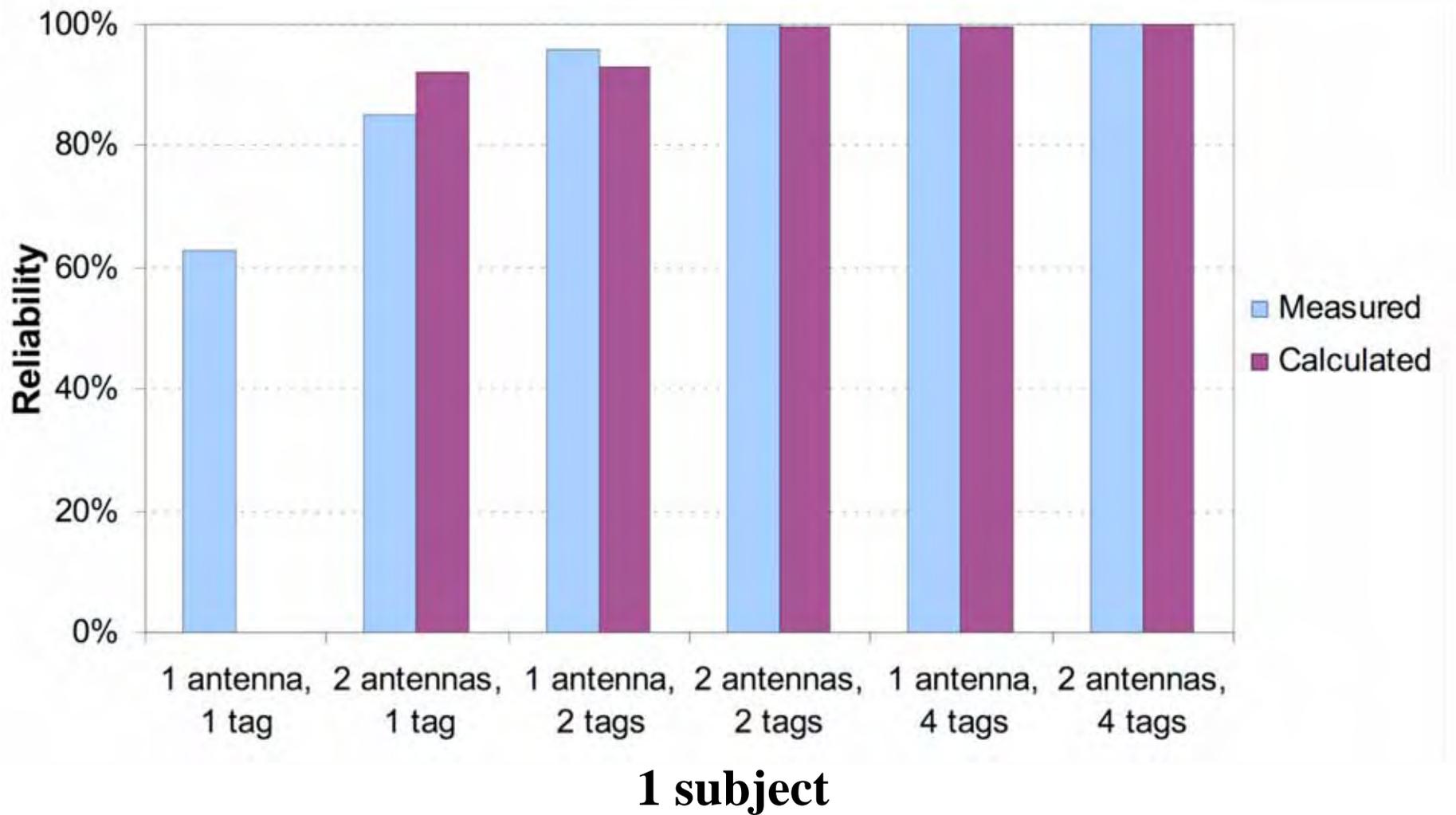
1. Multiple readers/portal => reduced reliability!
2. Multiple antennas/reader => ok, but not quite as good as expected.
3. Multiple tags/object => ok, when tags separated far enough.

Object tracking with redundancy

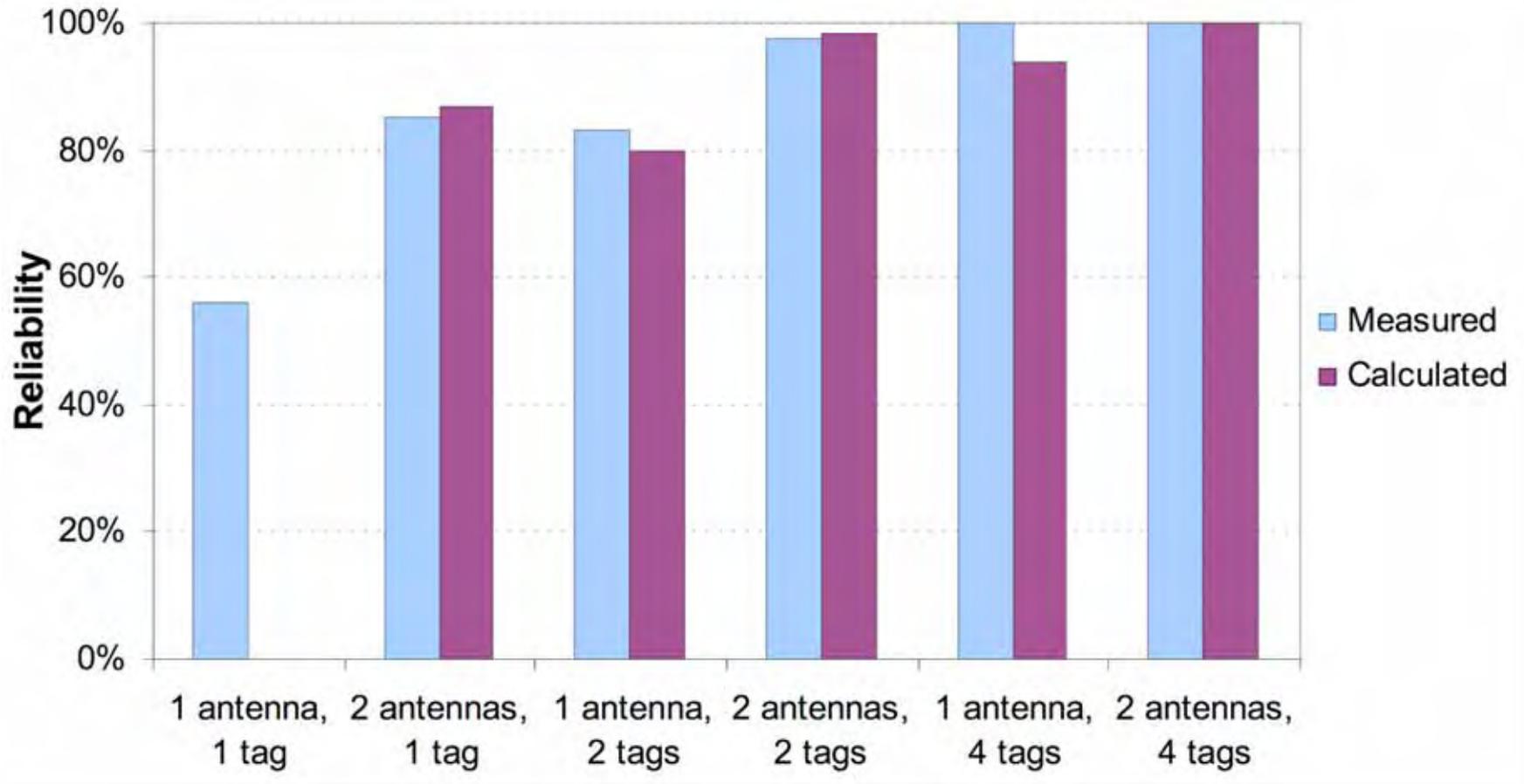
Same experiment with 12 routers.



Human Tracking with Redundancy



Human Tracking with Redundancy



2 subjects

Lessons learned

Do not assume unobtrusive RFID tag detection will be 100% reliable in any system.

Reliability can be increased through engineering and redundancy techniques.

- Redundant tags are effective when placed carefully.
- Redundant antennas help with blocking.
- Redundant readers (in the same location) may decrease reliability (depending if dense-reader mode is implemented by the reader).