

# İç Ortam Konumlama Sistemleri

Tuba Ayhan

6 Eylül 2018

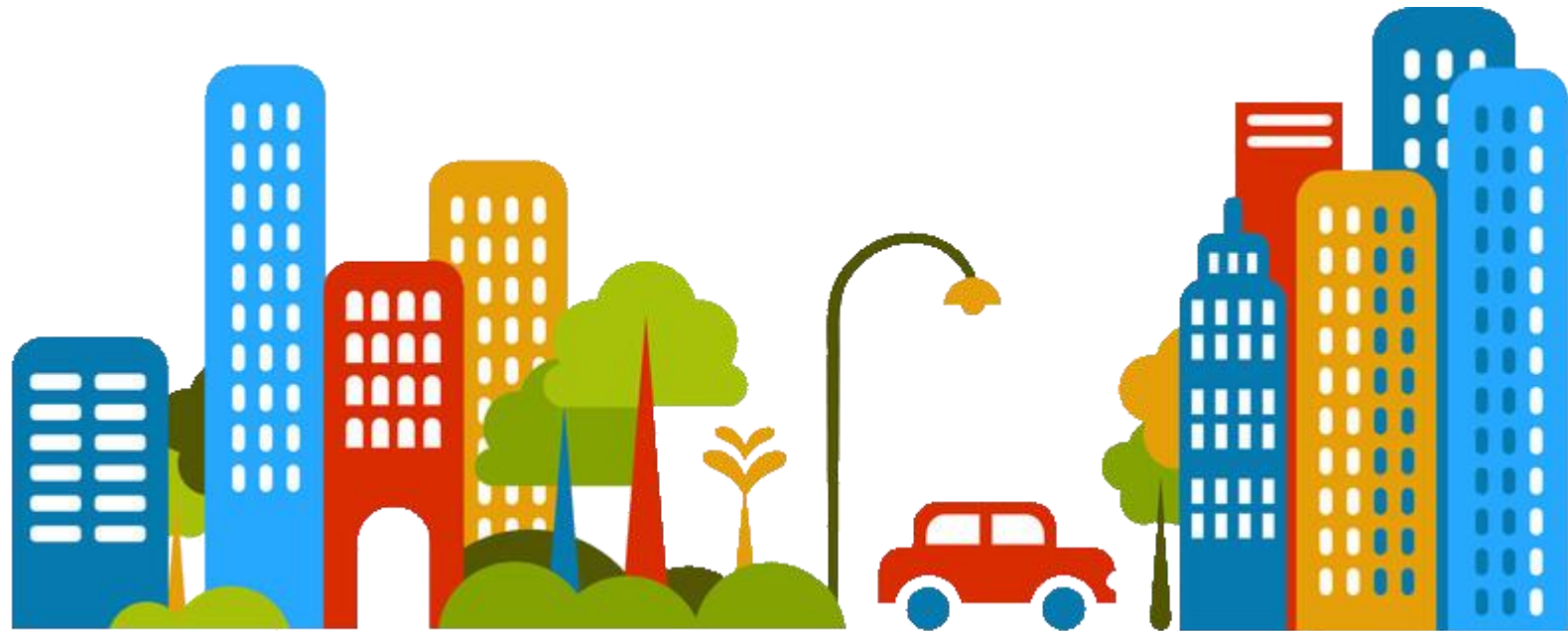
EMO İstanbul Şube



Design and implementation of  
mm-precise ranging  
for indoor positioning systems

Tuba Ayhan  
Promoter: Wim Dehaene  
Co-Promoter: Marian Verhelst

22.02.2016









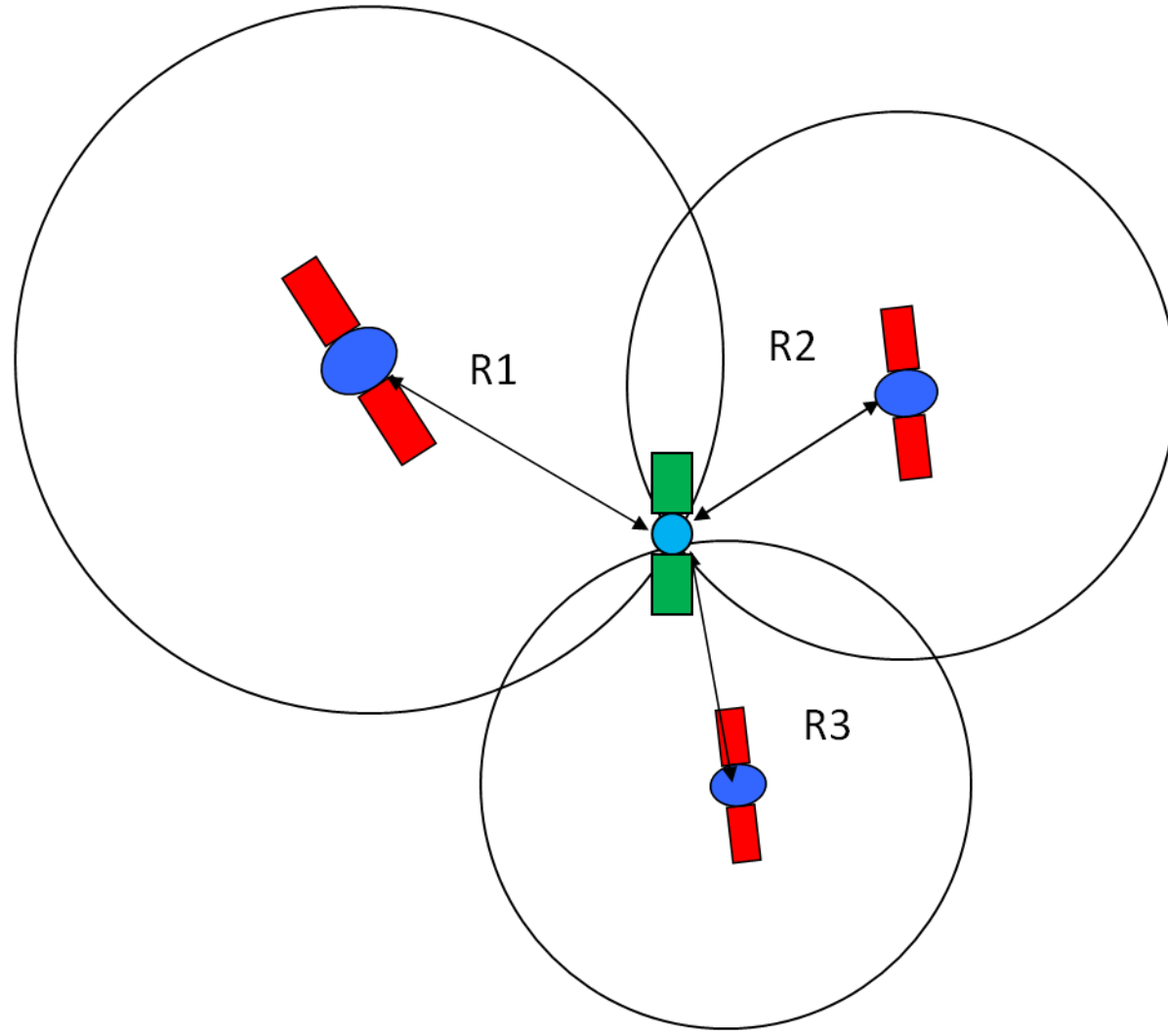
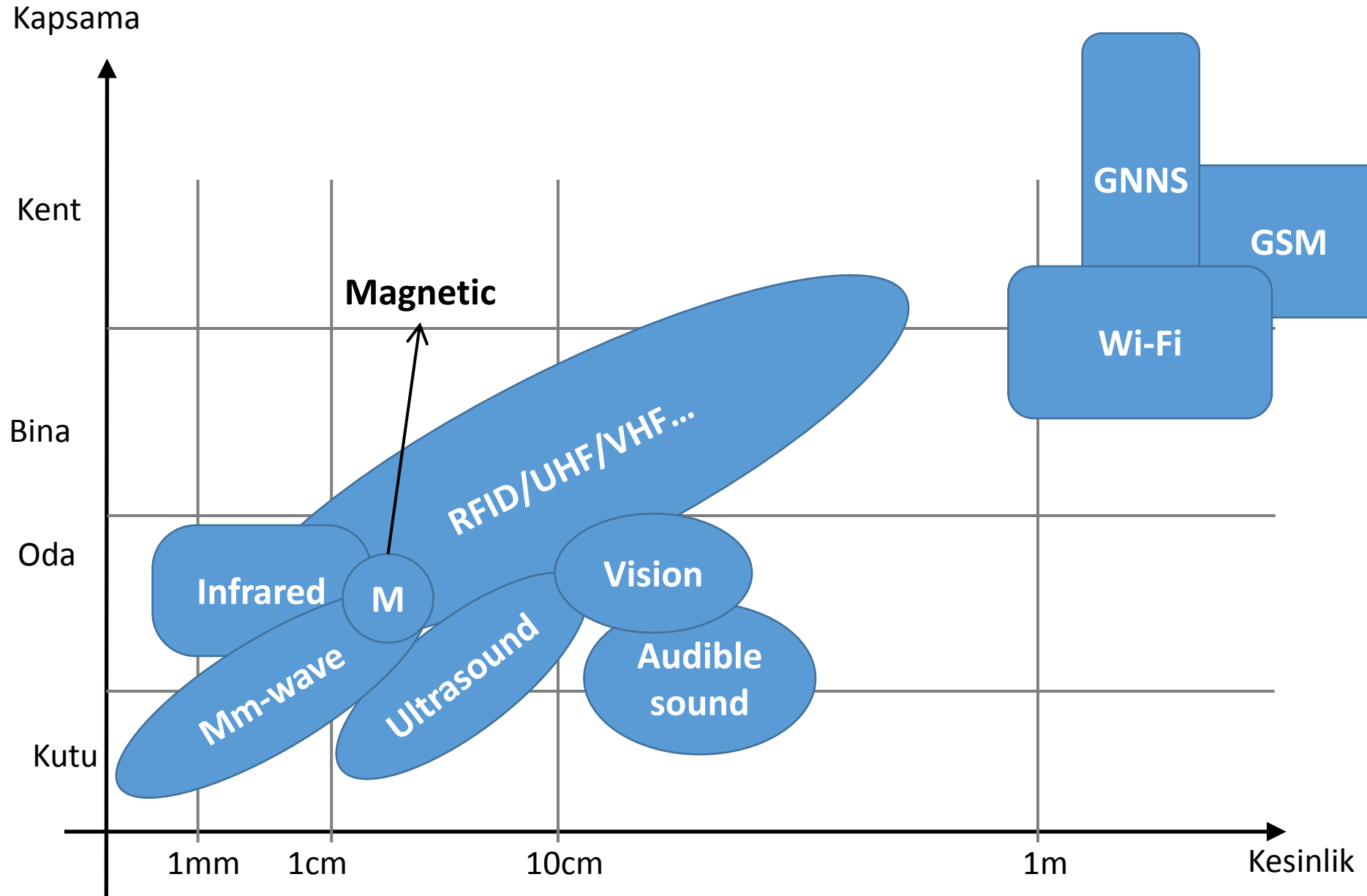
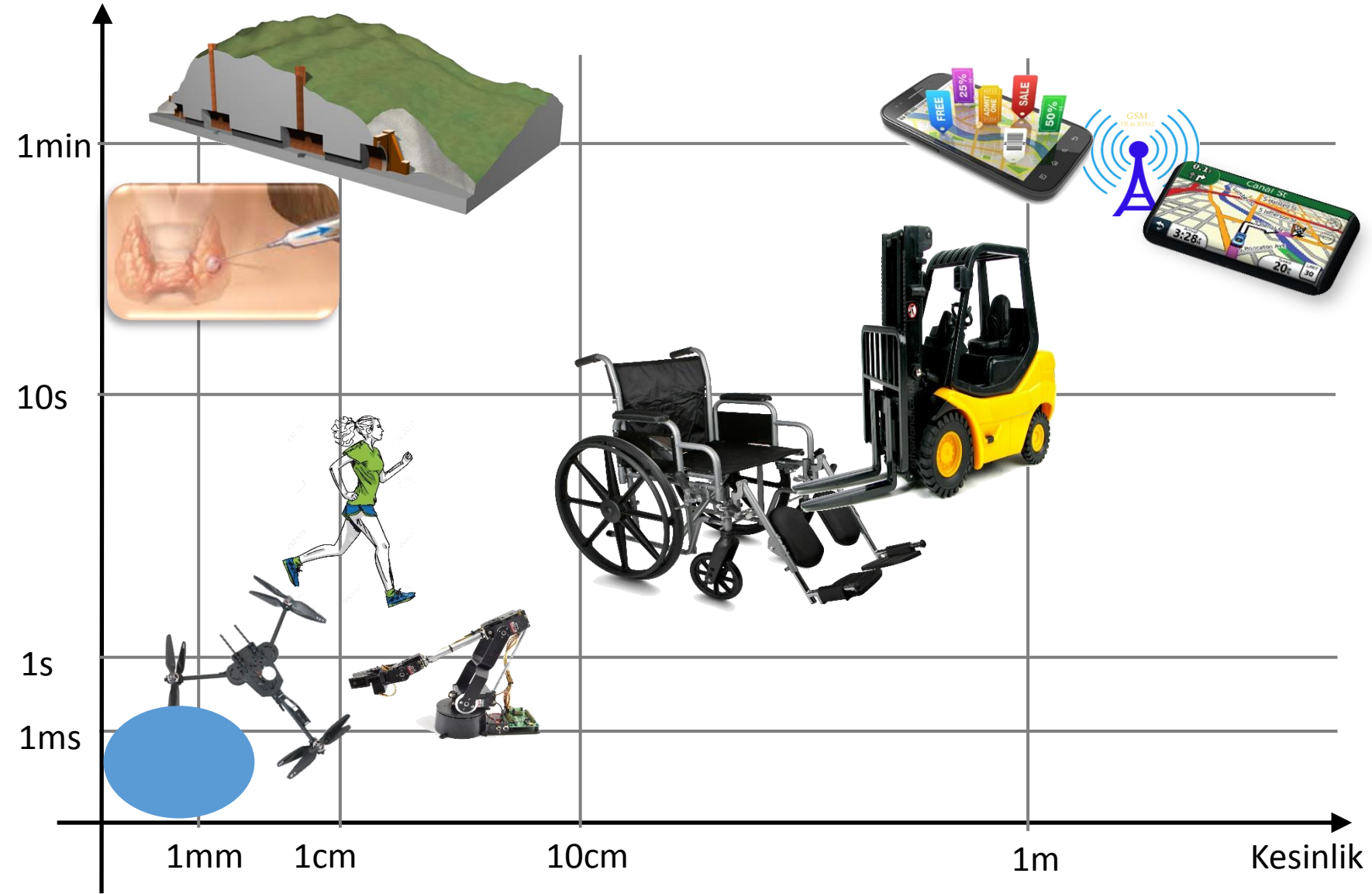


Fig. NASA



Güncelleme hızı



# İsterler

## Temel isterler

- Kesinlik, doğruluk, hassasiyet
- Kapsama (coverage, range)
- Güncelleme hızı (update rate)
- Enerji ve güç tüketimi
- Büyüklük (etiket ve referans noktaları)

## Kurulumu bağlı isterler

- Kurulum süresi, şekli ve kalibrasyon
- Başka sistemlerle etkileşim

# Sınıflandırma

## Konum bilgisi

### Mutlak konum

- Fazla etiket olan ortamlar
- GPS ile etkileşim

### Bağıl konum

- Hedefin hareketi

### Komşuluk

- Az sayıda etiketi sürekli izlemek

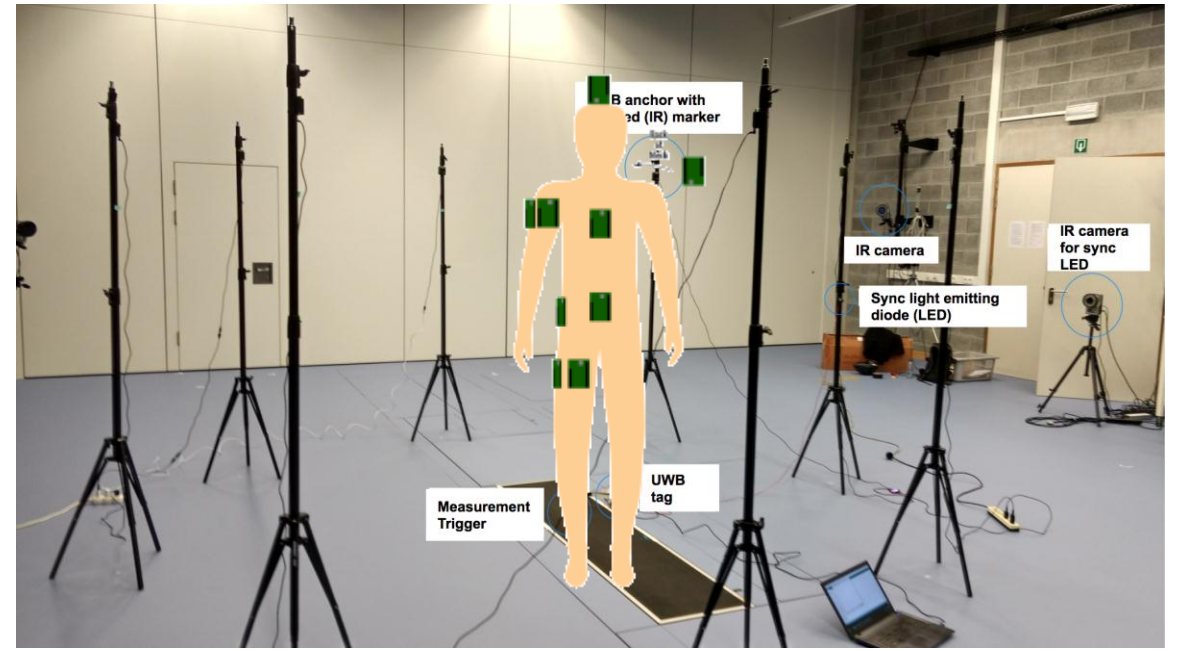
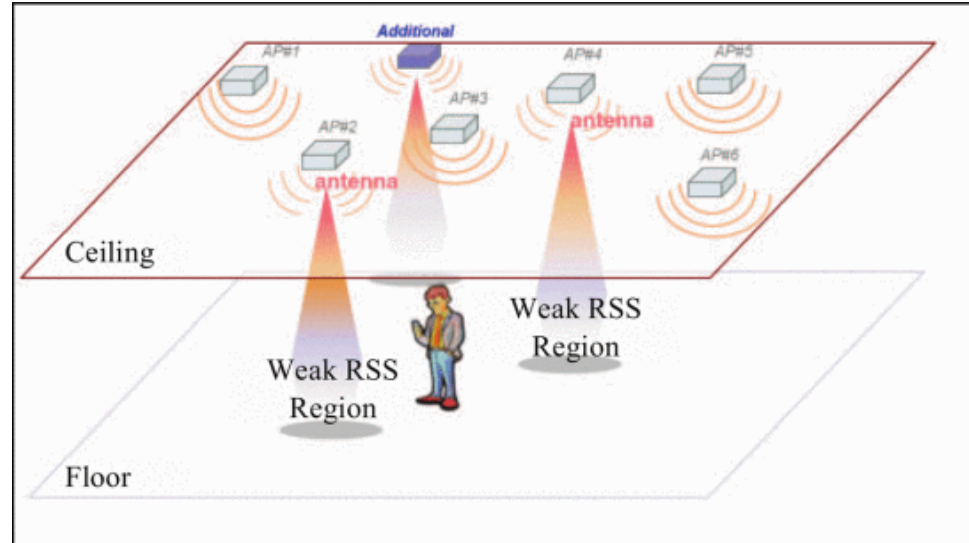


Fig. Matteo Ridolf



|     | P11 | P12 | P21  | P22 | P... | Pmn |
|-----|-----|-----|------|-----|------|-----|
| AP1 | RSS | RSS | RSS  | RSS | RSS  | RSS |
| AP2 | RSS | RSS | Weak | RSS | RSS  | RSS |
| AP3 | RSS | RSS | RSS  | RSS | RSS  | RSS |
| AP4 | RSS | RSS | RSS  | RSS | Weak | RSS |

Fig. Cni-Lun Mak

## Mesafe ölçüm tekniği

### Mutlak

- Mesafe ölçümü: TDoA, RSS, AoA

### Bağıl

- Etiket ve düğümler birbirine göre konumlarını buluyor.

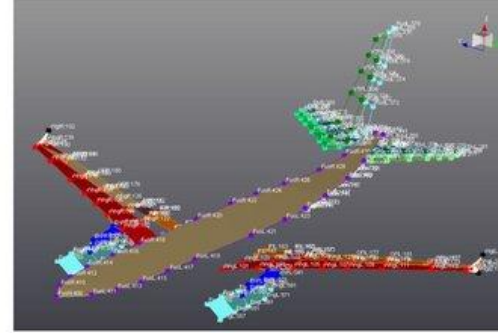
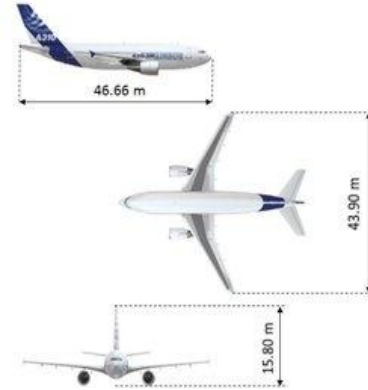


Fig. B. Cornelis

## Mimari

### Merkezi hesaplama

- D ğ mlerden gelen veri bir merkezde toplanır.

### Dağınık hesaplama

- Her d ğ m bir konum hesaplar.

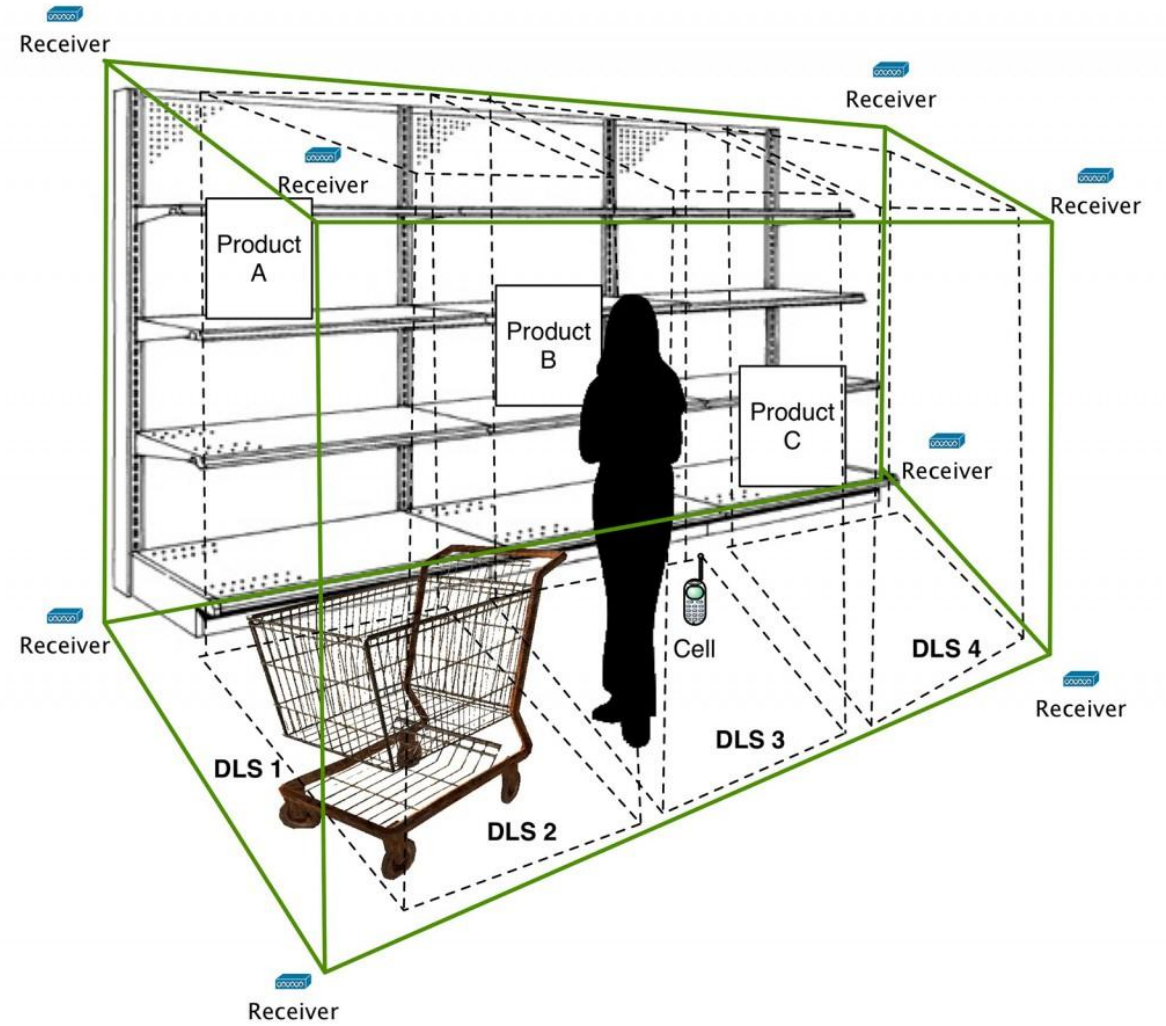


Fig. Michael Perrault

## Güvenlik

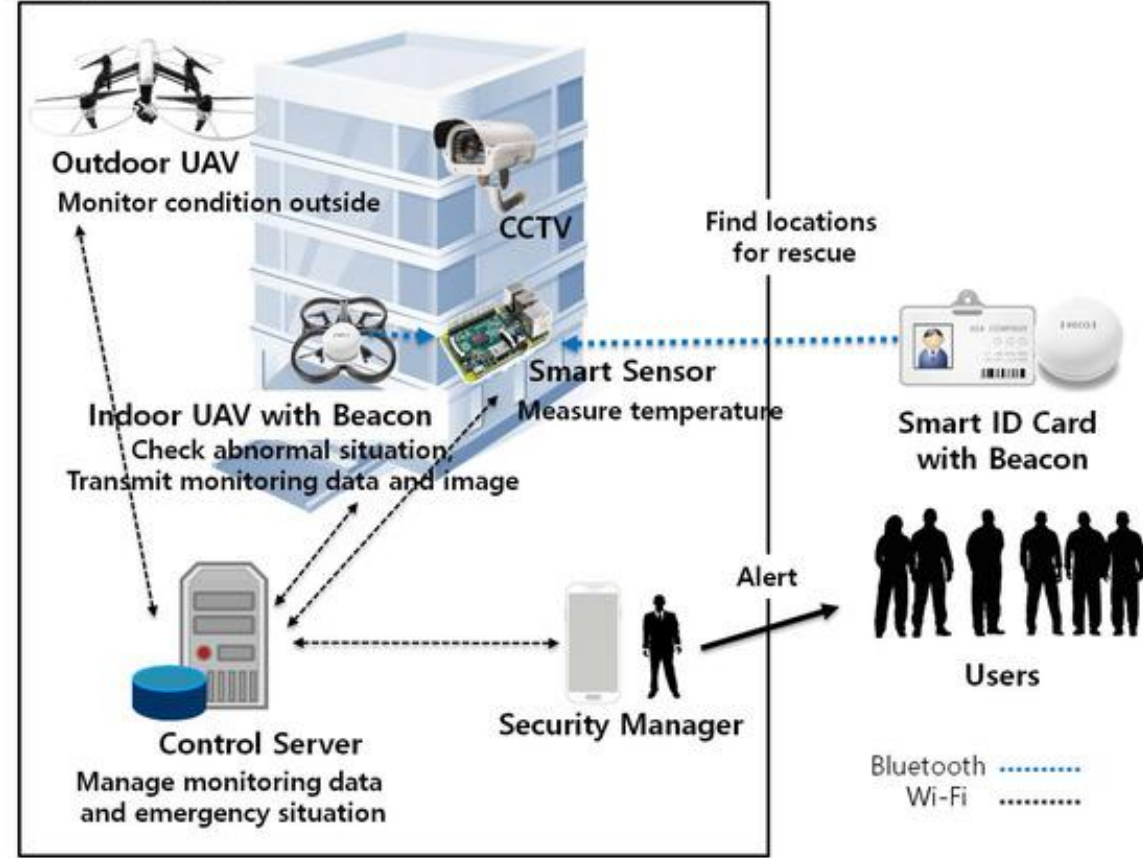
### Şifreli

- Ham veri ve/veya mesafe bilgisi şifrelenmiştir.
- Farklı güvenlik seviyeleri

### Açık

- Her düğüm bir konum hesaplar.

AllJoyn Security Platform



## Güvenlik

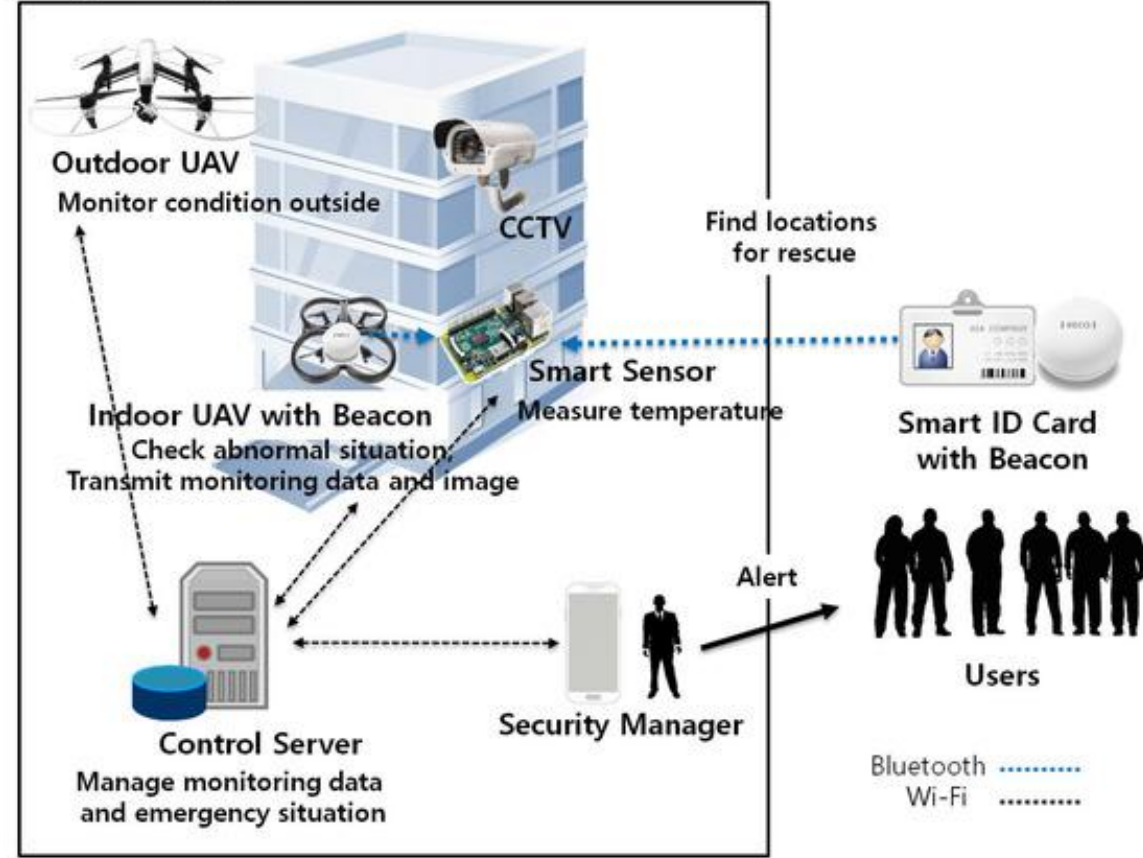
### Şifreli

- Ham veri ve/veya mesafe bilgisi şifrelenmiştir.
- Farklı güvenlik seviyeleri

### Açık

- Her düğüm bir konum hesaplar.

AllJoyn Security Platform



# Etiket gerekliliği

## Aktif

- Belirlenecek/takip edilecek olan kişi elektronik bir etikete sahip olmalıdır.

## Pasif

- 1. Device free Passive (DfP)
- 2. Device based

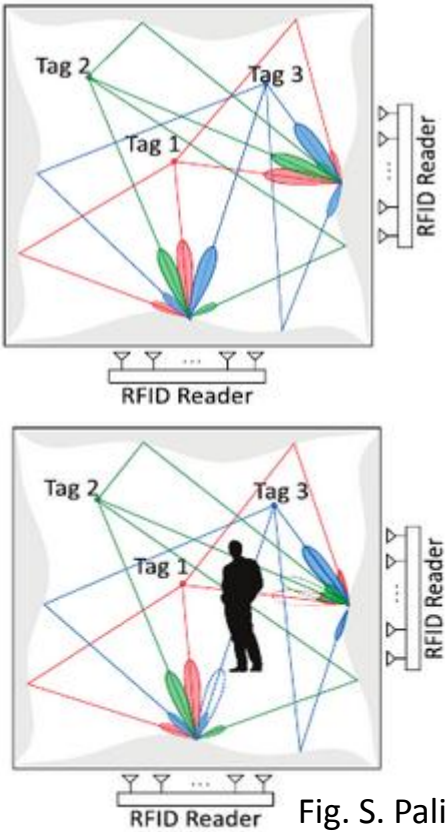


Fig. S. Palipana

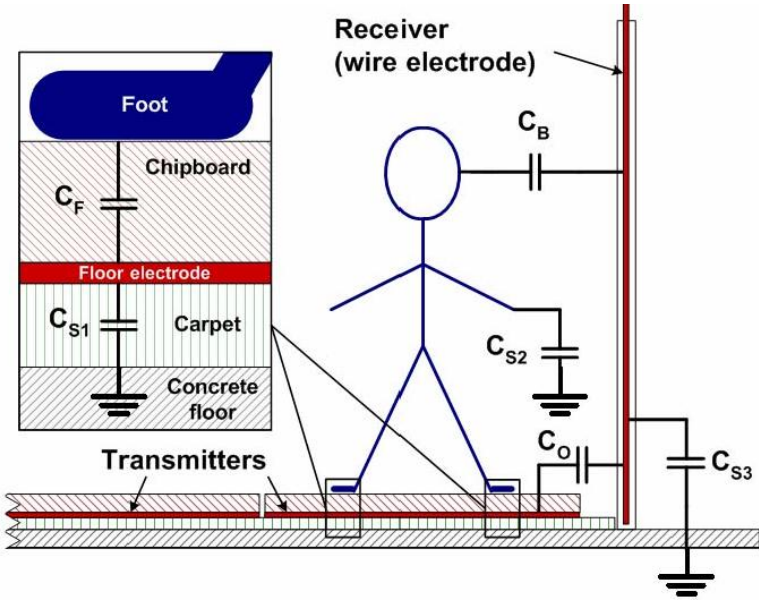
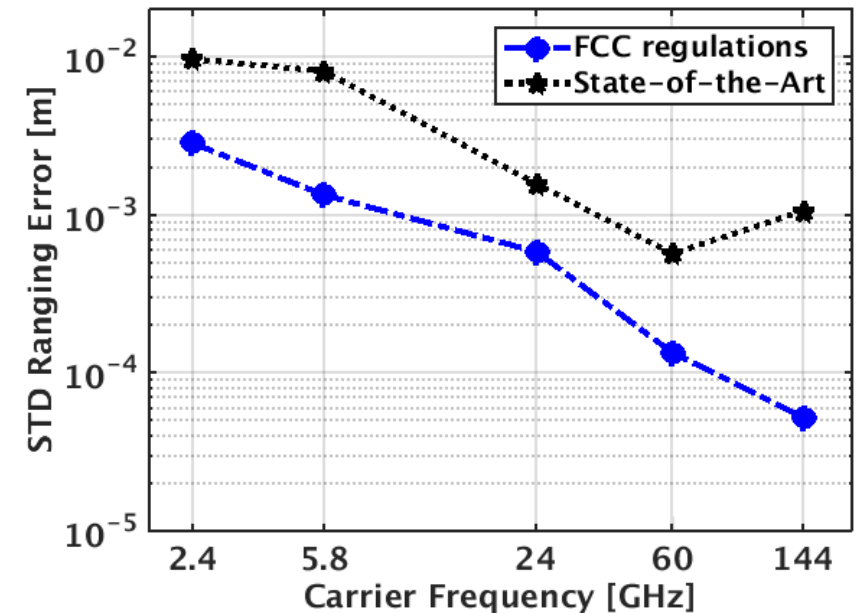
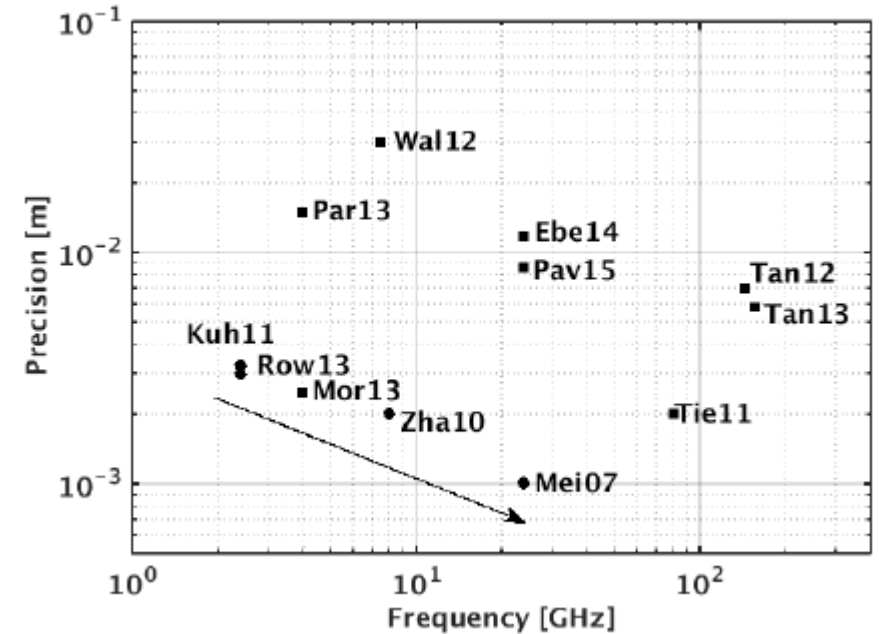


Fig. Miika Valtonen

| System                                             | Location Technologies                                             | Positioning Algorithm         | Accuracy/ Precision                                         | Complexity  | Scalability/ Space dimension | Cost |
|----------------------------------------------------|-------------------------------------------------------------------|-------------------------------|-------------------------------------------------------------|-------------|------------------------------|------|
| Through-Wall Motion Tracking (VRTI) (2006) [51,52] | Passive RSSI, IEEE 802.15.4                                       | Kalman Filter                 | 0.45 m/ NA                                                  | Medium-High | Good/ 2D                     | Low  |
| EasyLiving: Multi-camera Multi-person (2000) [18]  | Video Images                                                      | Video Processing Algorithms   | approx. 10 cm/ NA                                           | Medium-High | Good/ 2D                     | High |
| Device-free Passive Localisation (2007) [3-5]      | WLAN, Passive RSSI, IEEE 802.11 a/b/g/n                           | Bayesian Inversion            | approx. 18 cm/ NA                                           | Moderate    | Good/ 2D                     | Low  |
| TileTrack (2009) [17]                              | Capacitance between multiple floor tiles and receiving electrodes | Centroid of                   | 14.3 cm -Standing<br>40.7 cm - Walking/<br>80% within 10 cm | Moderate    | Poor/                        | Low  |
| AirBus (2008) [7]                                  | Differential air pressure                                         | Feature Extraction Algorithms | 68%-80%/ NA                                                 | Moderate    | NA/ NA                       | Low  |

# UWB, WLAN, RFID

- Diğer RF işaretlerden etkilenme
- Propagasyon
- Yansıma: multipath
- Yoğunluk



# UWB sistemler: Ubisense, BeSpoon, DecaWave



AoA ve TDoA'nın birlikte kullanımı hassasiyeti artırır, ya da kurulum maliyetini düşürür.

6-8GHz (haberleşme için 2.4 GHz kullanır.)

Senkronizasyon için kablo gerektirir.



Telefon ile kontrol edilebilir (WiFi / BLE).

<10cm hassasiyet

3.99GHz



IEEE 802.15.4-2011 UWB standardına uygun  
Geliştirmeye uygun  
3.99 GHz ve 6.48 GHz bantlarını kullanır.  
~10cm hassasiyet

# Hibrid sistemler: RFID + WSN

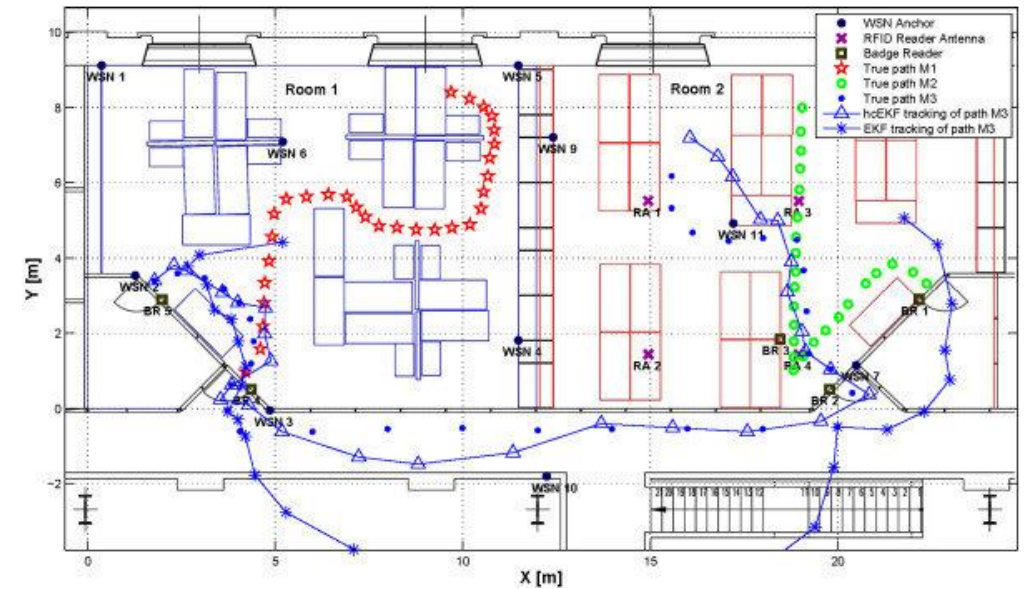
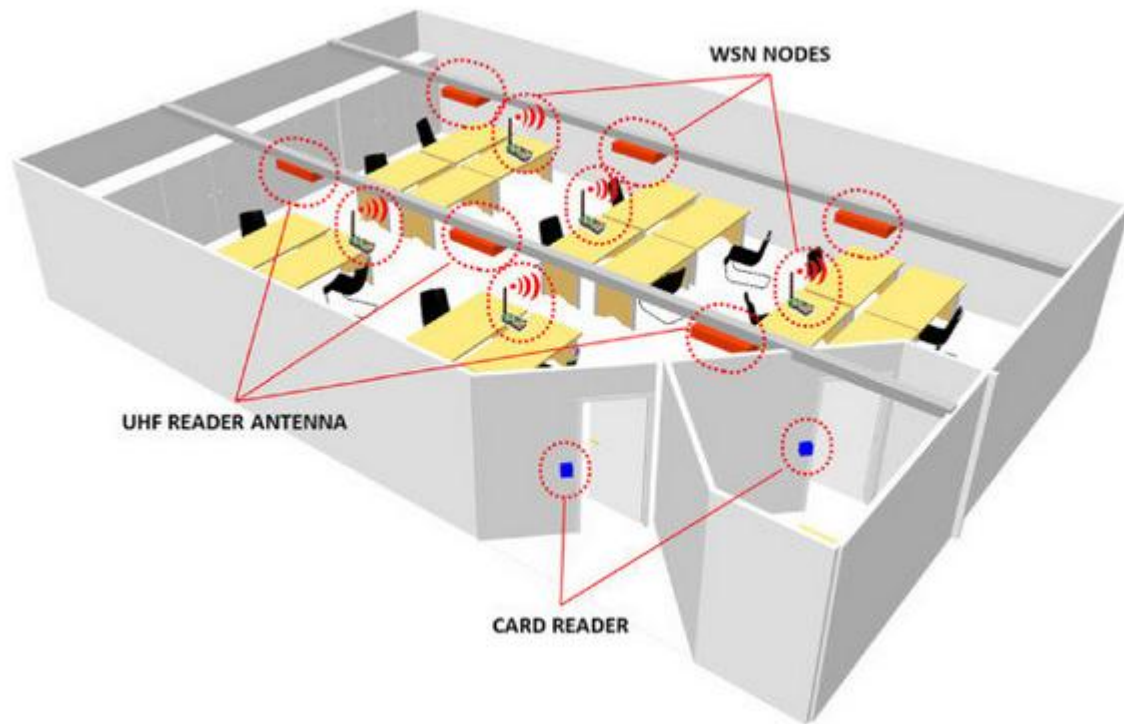
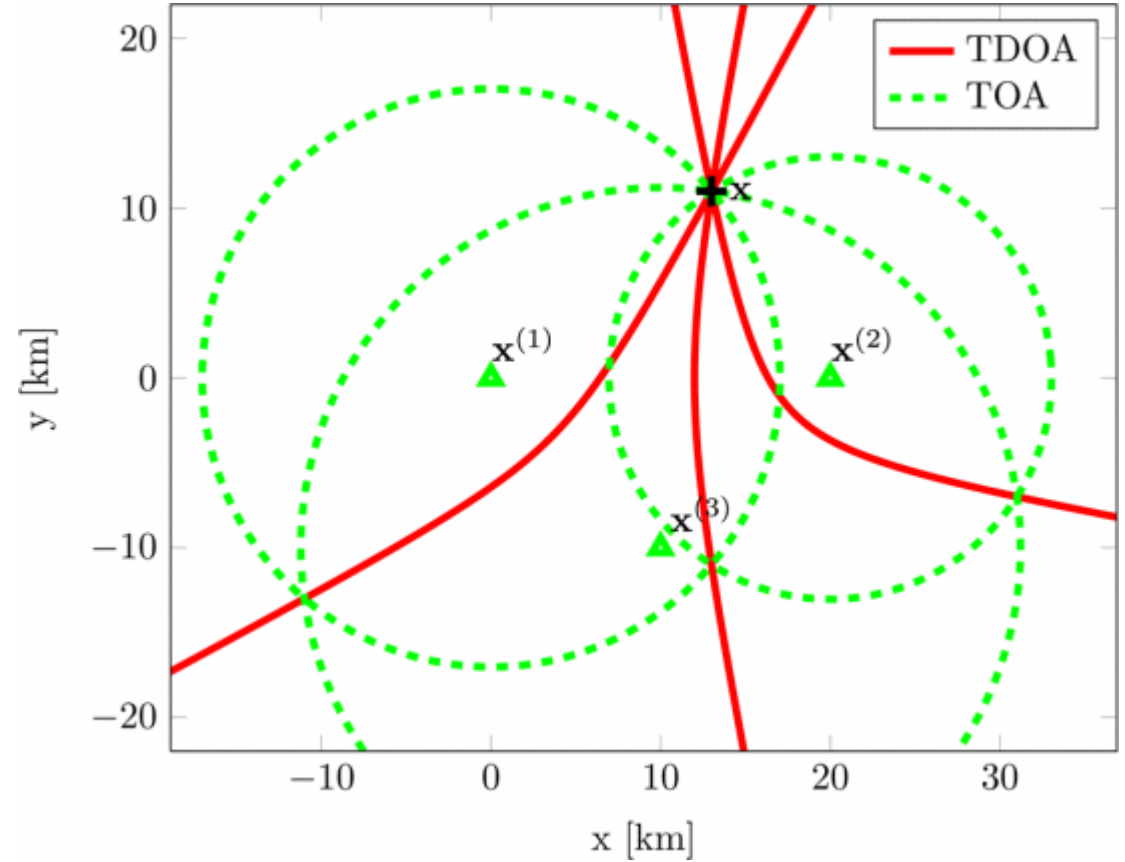


Fig. Zhoubing Xiong

# Diğer problemler

- Algoritma seçimi  
TDoA, ToA, AoA, RSS
- Kurulum ve süreklilik
- Kalibrasyon
- Senkronizasyon

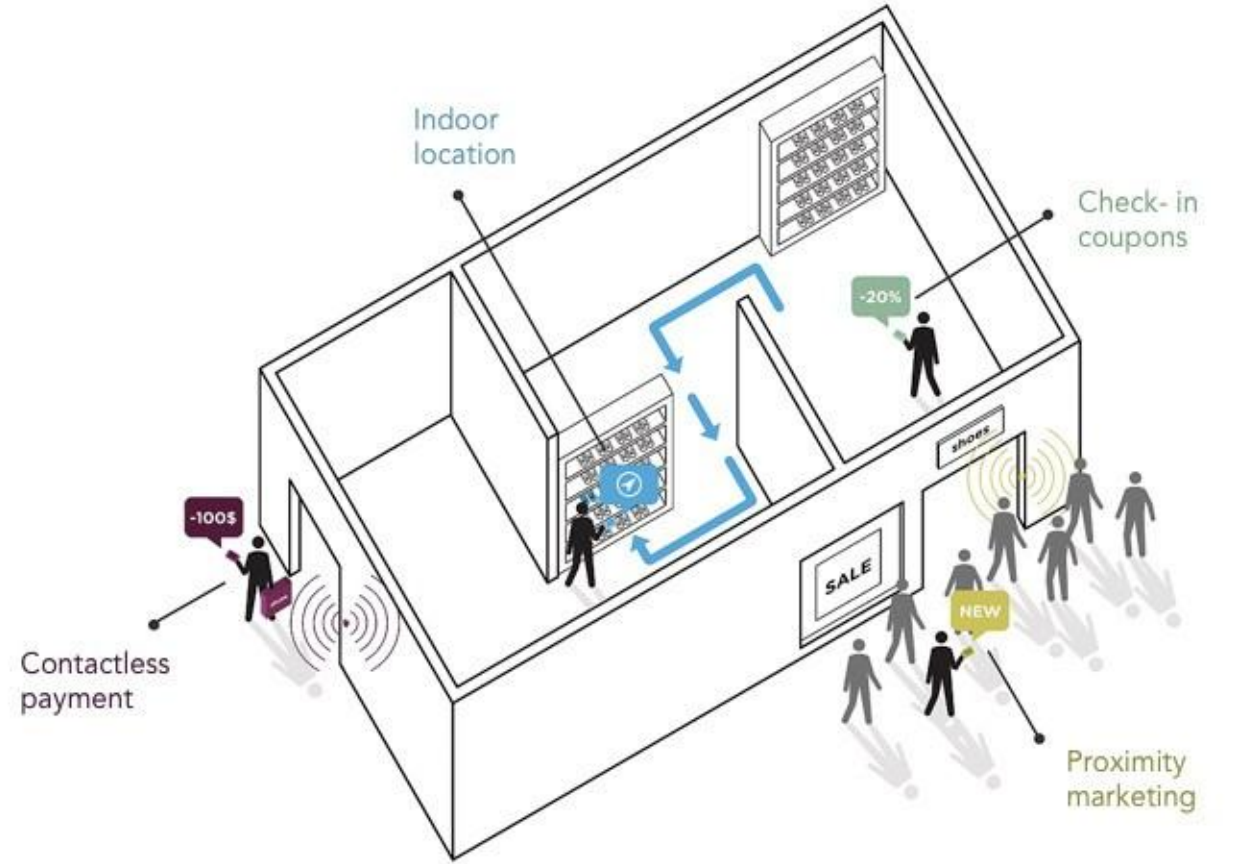


# Diğer problemler

- Algoritma seçimi
- Kurulum ve süreklilik:

Ortamdaki Apleri kullanmak donanım kurulum süresini azaltır, ancak sistemin ortam değişikliklerine uyumu güçleşebilir.

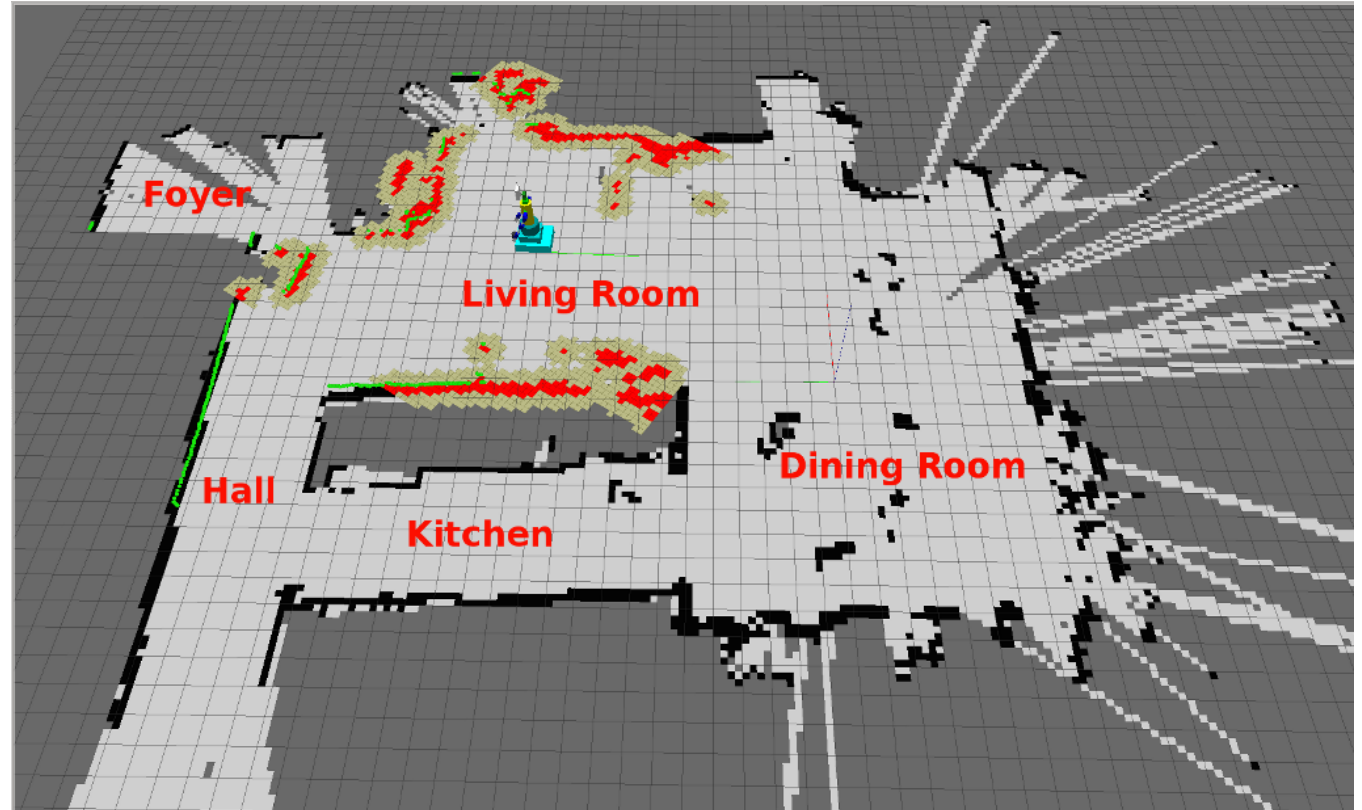
- Kalibrasyon
- Senkronizasyon



# Diğer problemler

- Algoritma seçimi
- Kurulum ve süreklilik:
- Kalibrasyon
- Senkronizasyon

SLAM: Simultaneous Localization and Mapping



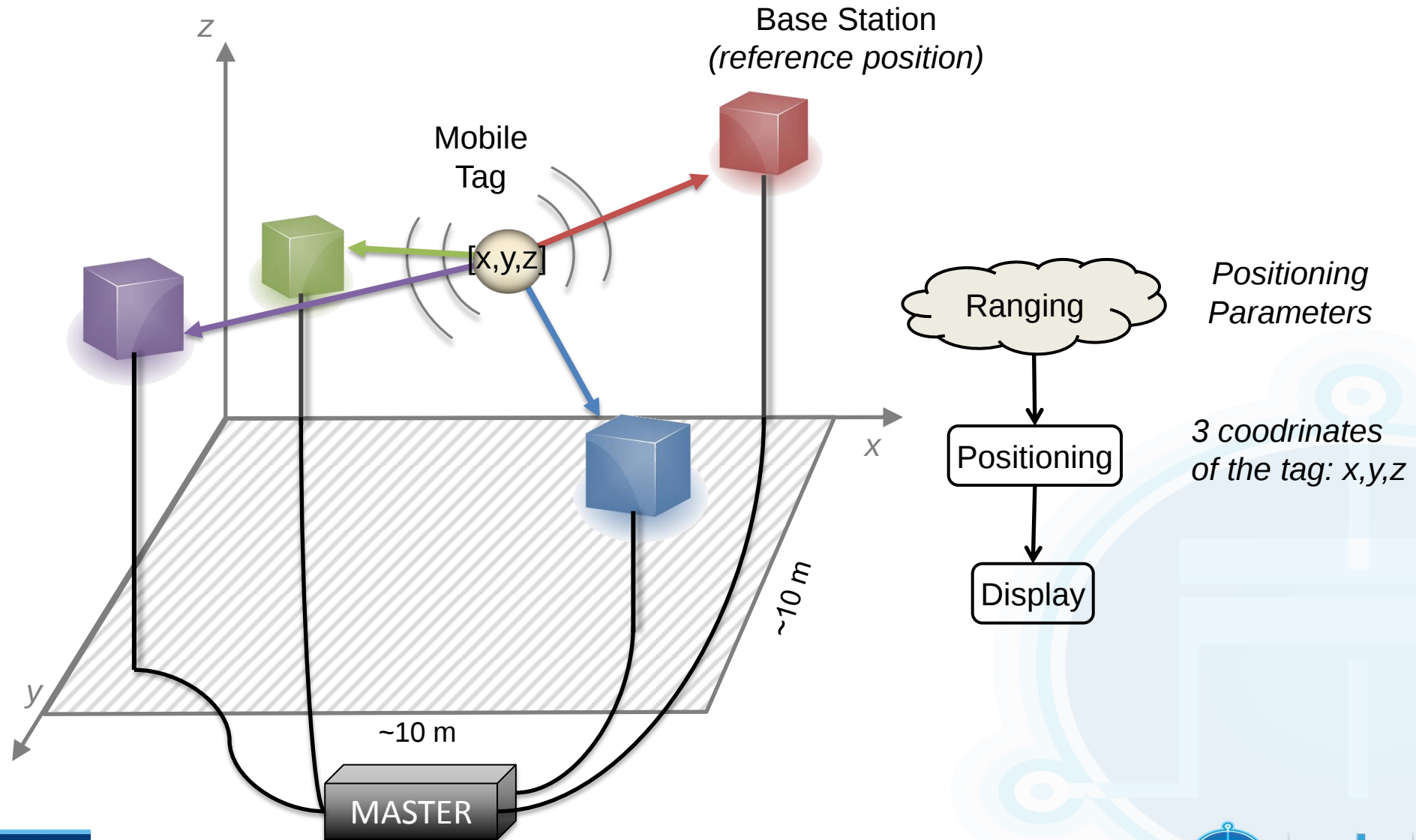
# Diğer problemler

- Algoritma seçimi
- Kurulum ve süreklilik:
- Kalibrasyon
- Senkronizasyon

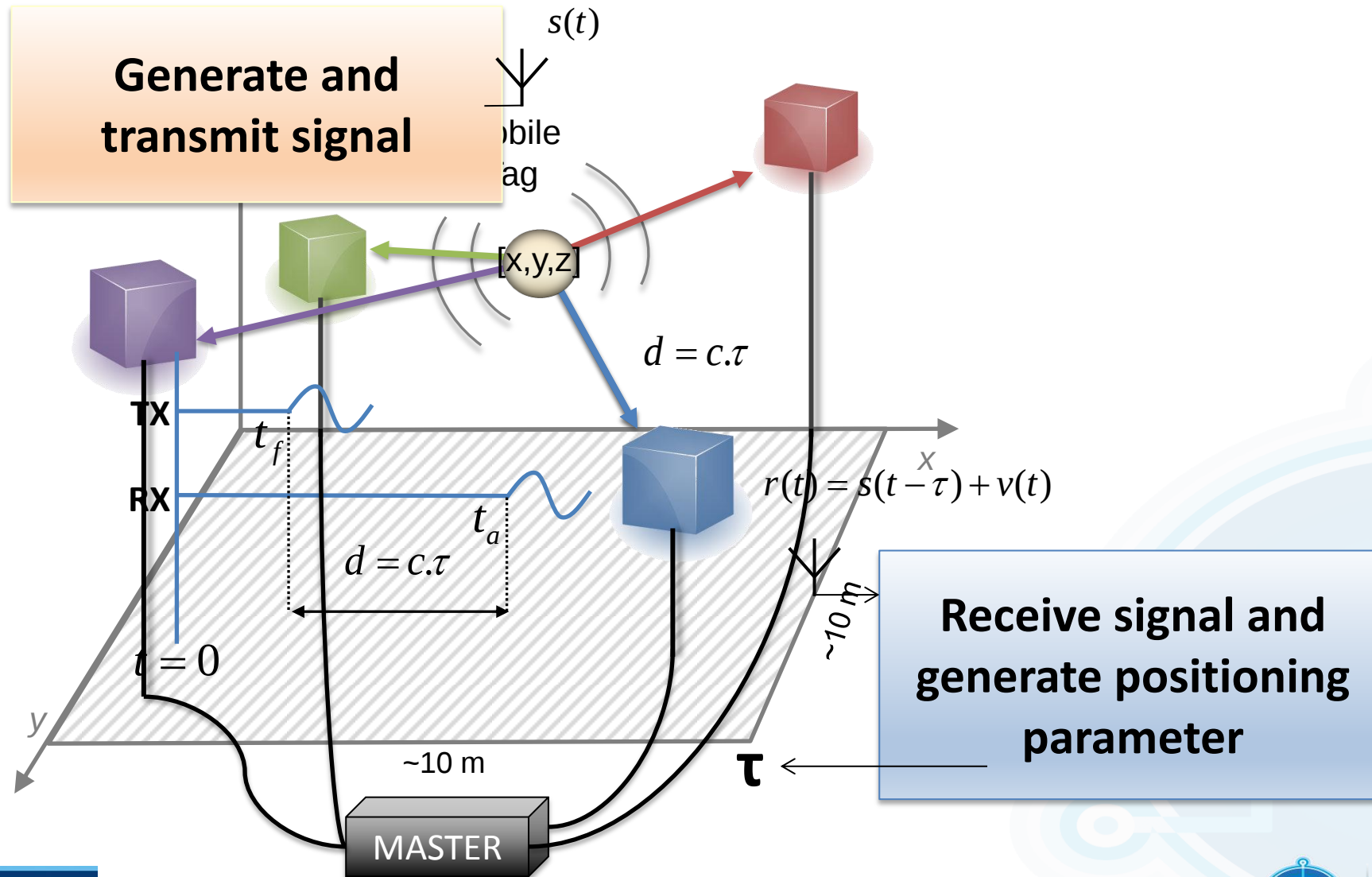
# Örnek bir sistem

Yüksek kesinlikli iç ortam konumlama sistemi

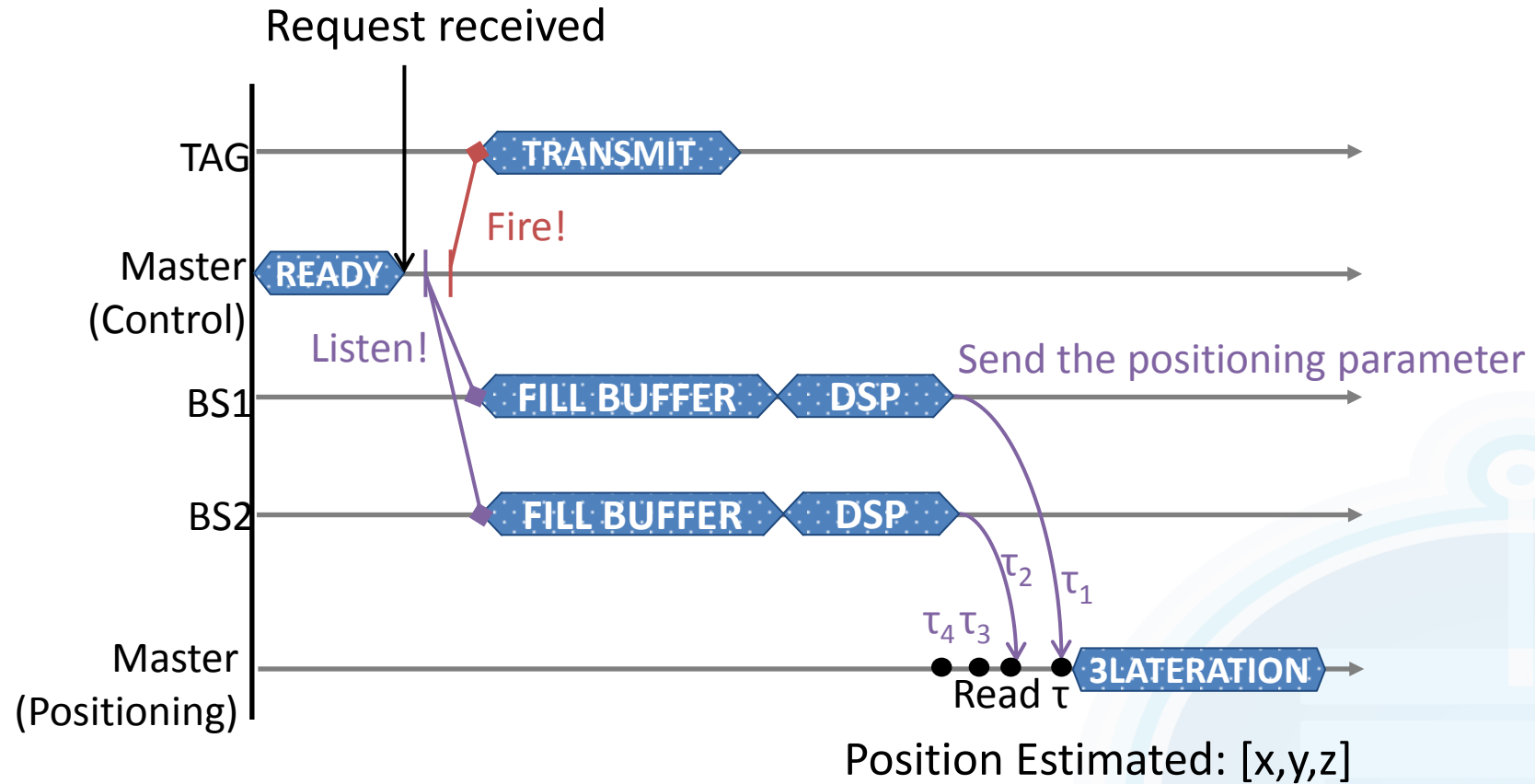
# 3D Positioning System - Architecture



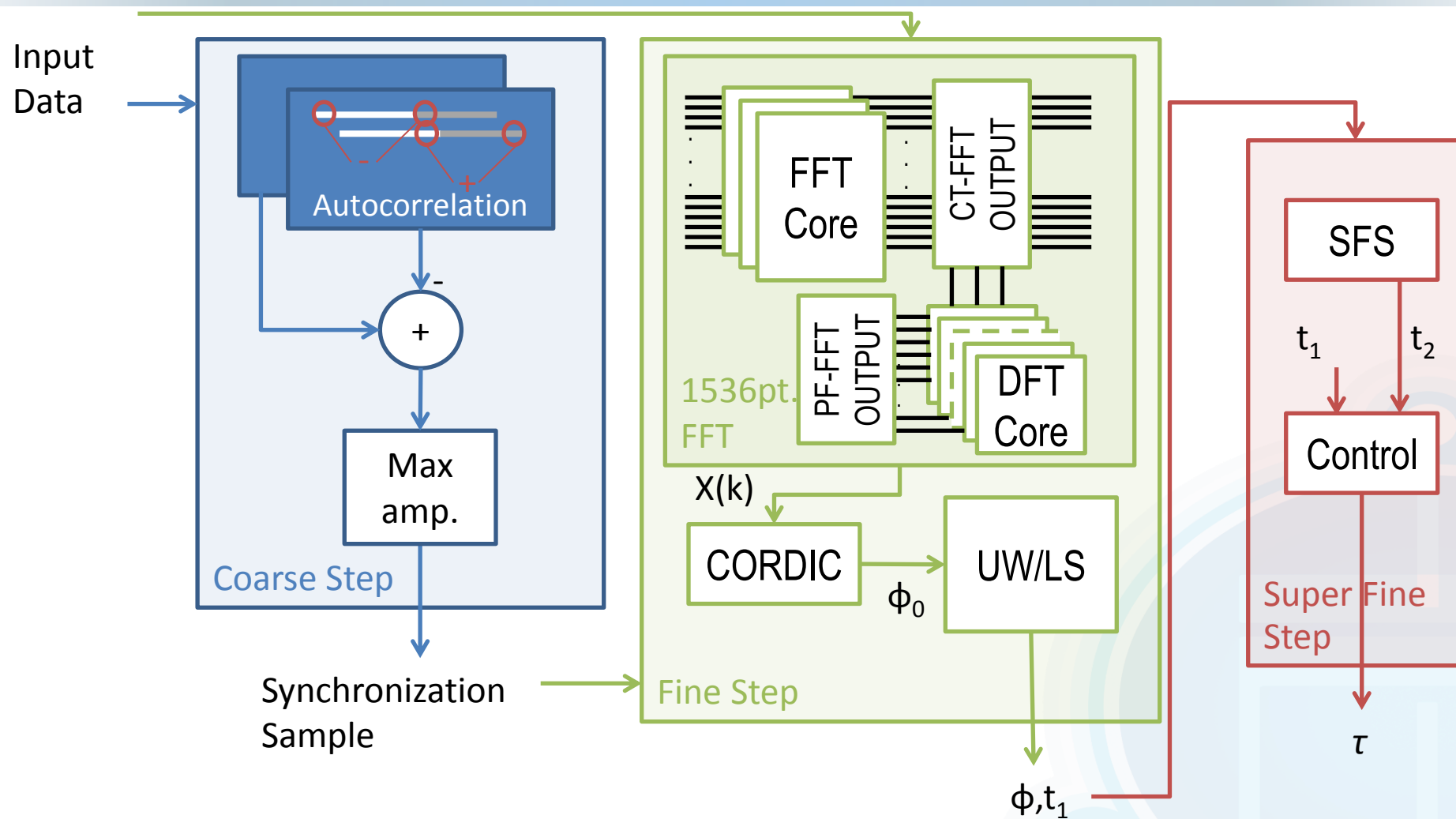
## 3D Positioning System – Ranging



# 3D Positioning System – Positioning and display

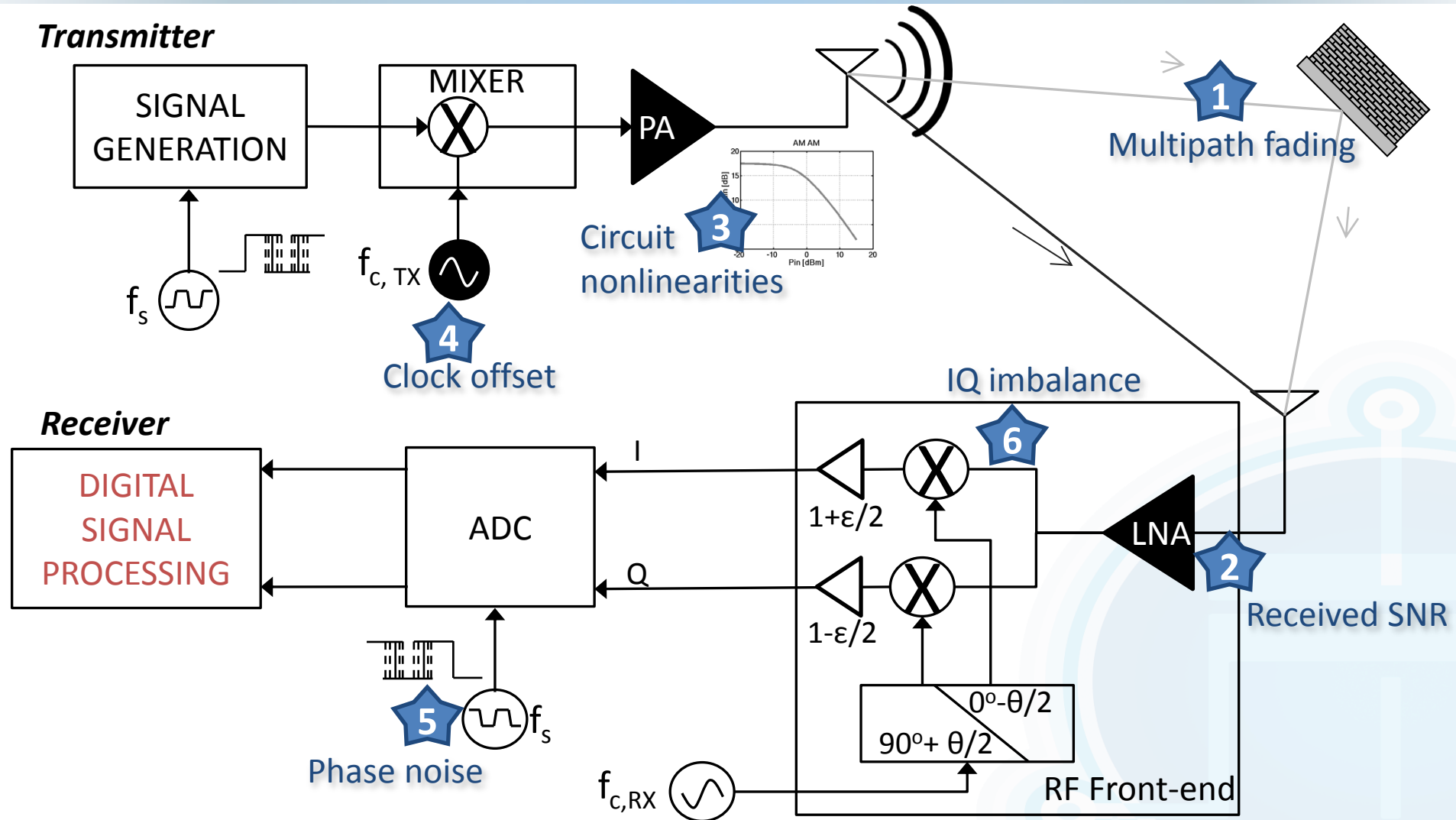


# Ranging system - FPGA implementation

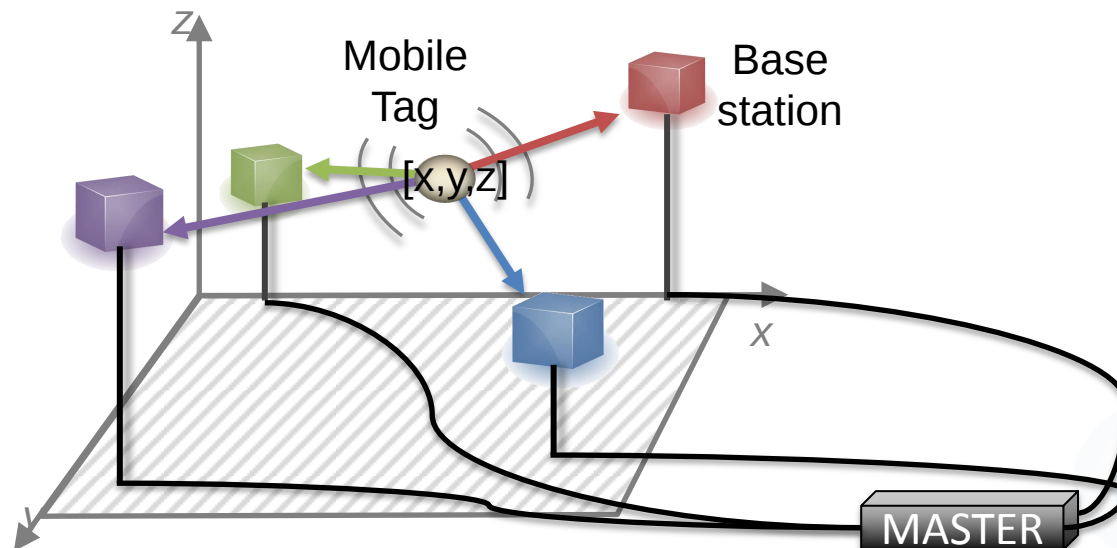
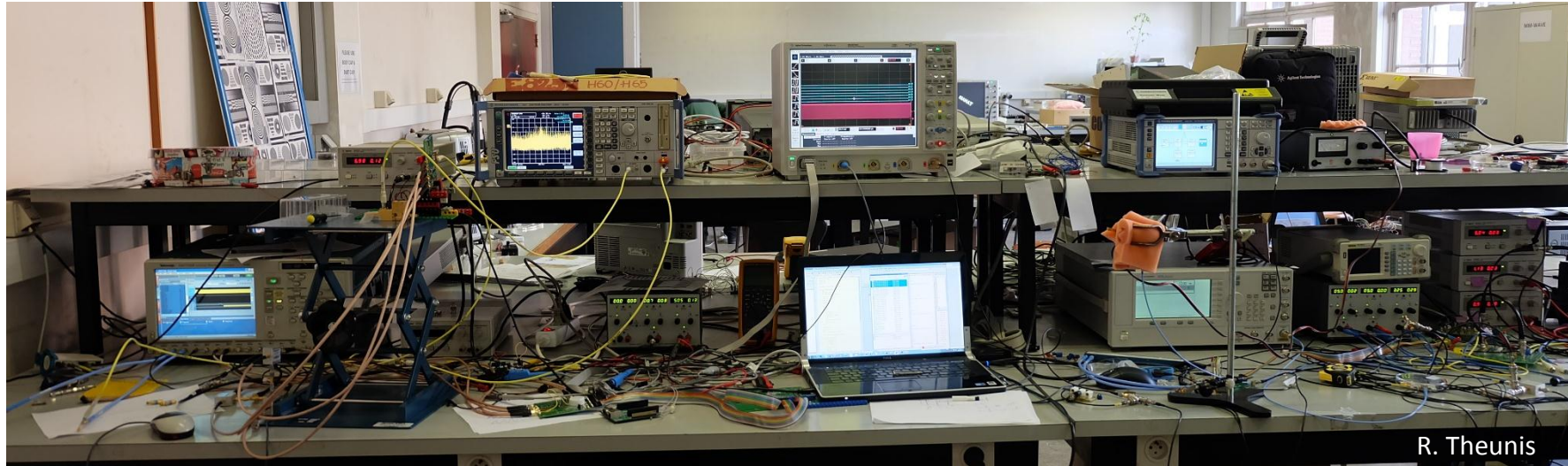


Running on Atrix 7 FPGA

# Ranging System – HW and environmental impairments



# Positioning system - Integration



# Kaynakça

- Sana, A Survey of Indoor Localization Techniques, IOSR Journal of Electrical and Electronics Engineering, 2013.
- Bram Cornelis, Bart Peeters, Stefan Gogaert, Automatic sensor localization methods for efficient physical prototype testing, September 2016, ISMA2016-USD2016
- Seung-Hyun Seo , Jung-In Choi, Jinseok Song, Secure Utilization of Beacons and UAVs in Emergency Response Systems for Building Fire Hazard, *Sensors* 2017.
- Zhoubing Xiong, vd. Hybrid WSN and RFID indoor positioning and tracking system, EURASIP Journal on Embedded Systems 2013
- Michael Perrault, **Location Tracking Using RFID**, Features, LBx Journal, Spring 2014
- Matteo Ridolf, vd., **Experimental Evaluation of UWB Indoor Positioning for Sport Postures**, *Sensors* 2018
- Gabriel Deak vd., «A survey of active and passive indoor localisation systems», Computer Communications, 2012
- S. Palipana, vd., «**Recent advances in RF-based passive device-free localisation for indoor applications**», 2013
- Miika Valtonen, vd., «**TileTrack: Capacitive human tracking using floor tiles**», 2009.
- Cni-Lun Mak, vd., «**Refined Wi-Fi fingerprinting with tag-less proximity-based positioning technique**», 2014 International Conference on Indoor Positioning and Indoor Navigation (IPIN)