
# Indoor Guidance Application

Supervised By: **Prof. Michael R. Lyu**

**Choi Mei Shan (1155045904)**

**Wong Tsz Kin (1155038146)**

# Outline

- Introduction
- Design Overview
- Feasibility Study
- Implementation
- Limitations & Future Goals
- System Demonstration

# Introduction to Guidance System

*“SWIM ACROSS THE ATLANTIC OCEAN (ONLY 3,464 MILES)”*
**RECOMMENDED BY GOOGLE MAP**

# Introduction to Guidance System

## What is Guidance / Navigation System?

- **Google Map** can be consider as a guidance system since it *giving advice on how to get to somewhere from a given location*.

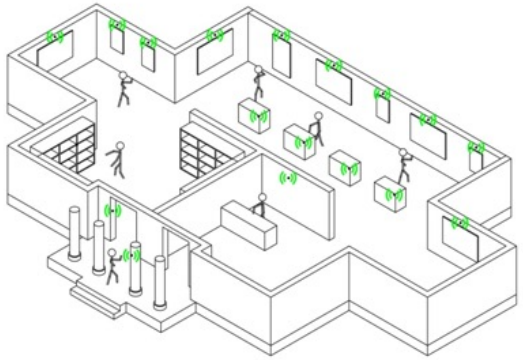
## Types of Navigation System?

- **Outdoor Navigation System**
  - Requires Outdoor positioning
- **Indoor Navigation System**
  - Requires Indoor positioning

# Introduction to Guidance System

## Indoor Navigation System (INS)

- GPS cannot provide indoor position service.
- INS can locate people or object inside the building by using beacons, Wi-Fi, NFC etc.
- Beacon technologies showed up in recent year which make a new trend of INS.



# Motivation

# Motivation

- In this semester, we have made a completed carpark indoor guidance service.
  - But why we choose carpark?

# Motivation

- Why we choose carpark?
  - Lots of INS focus on the behaviors of walking

    E.g. exhibition indoor guidance
  - There are some limitations in driving scenario

    E.g. traffic congestion, barricades.

**Challenge!**

# Motivation

- What problems are drivers facing to through parking?
  - May take time to search available parking spaces
  - Forgot where they have parked the car
  - Hard to find the entrance and exit

**Our app can benefit to drivers!!**

# Design Overview

*“IF YOU GIVE ME SIX HOURS TO CUT DOWN A TREE,*
*I WILL SPEND FOUR HOUR SHARPENING MY AXE.”*
*BY ABE LINCOLN*

# Design Overview

## Car-park Guidance System

- How to archive guidance in car park?

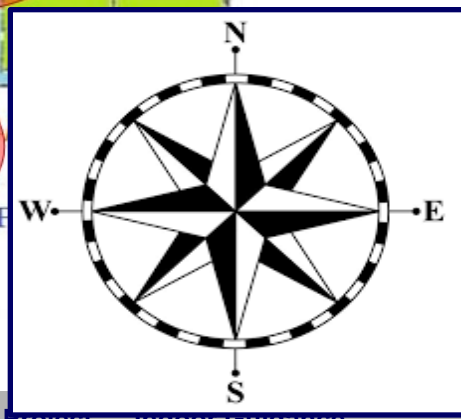
# Design Overview

- **Car-park Guidance System**
  - How to archive guidance in car park?

- **2 things**
  - Current Location  (Where am I?)
  - Target Location  (Where am I going?)

# Design Overview

## Car-park Guidance System

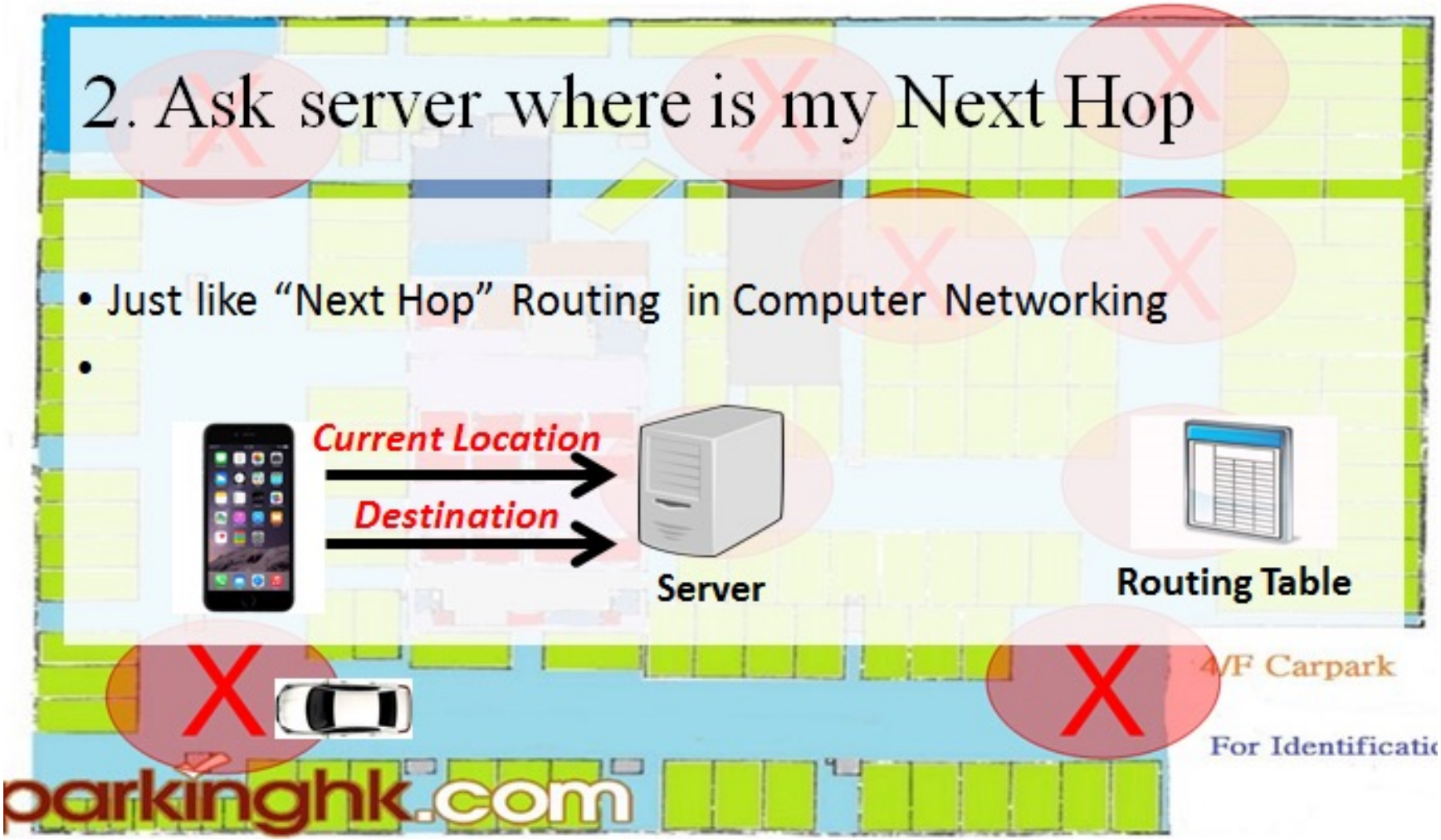



# Design Overview

## Car-park Guidance System

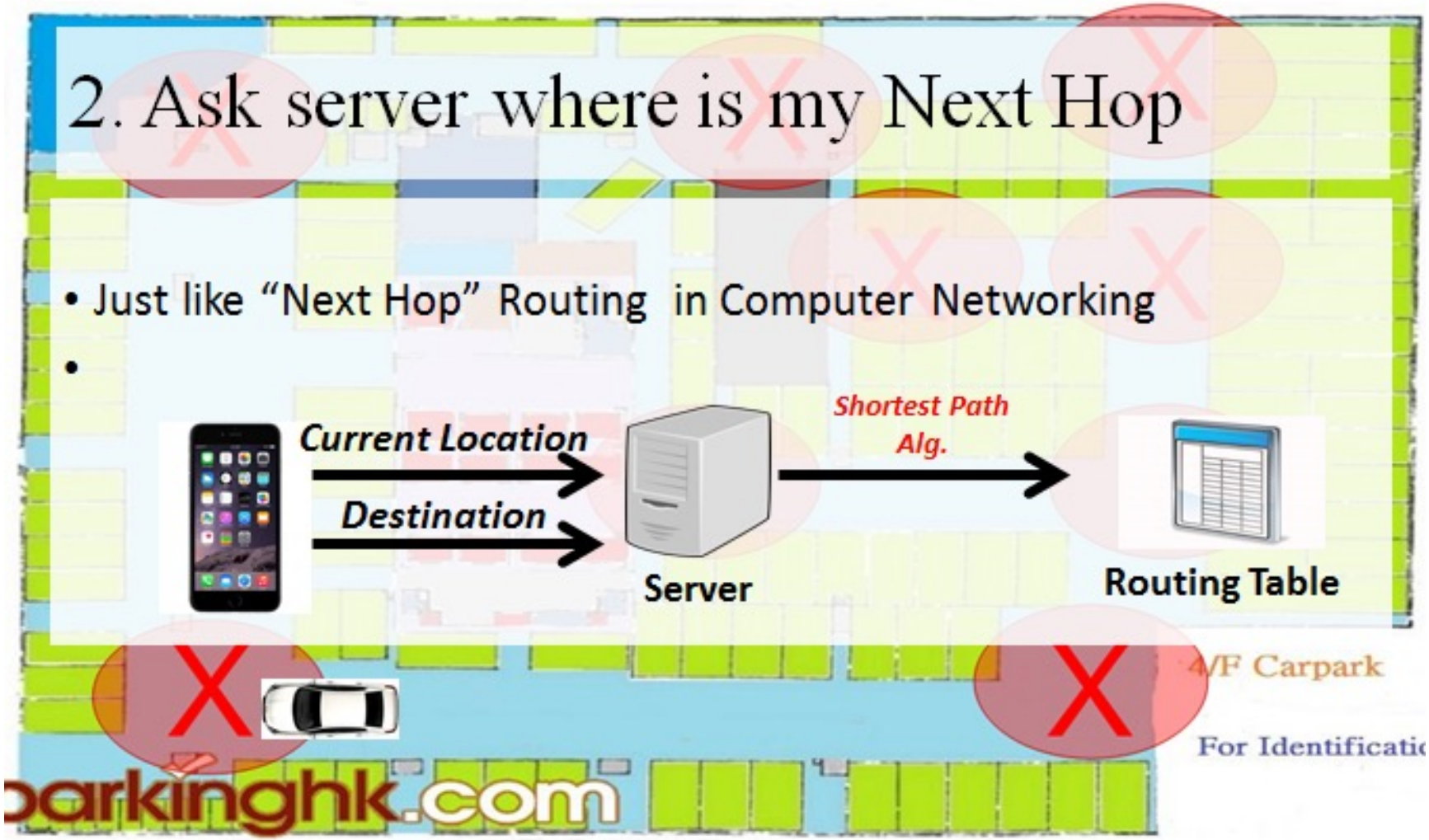
# Design Overview

## Car-park Guidance System



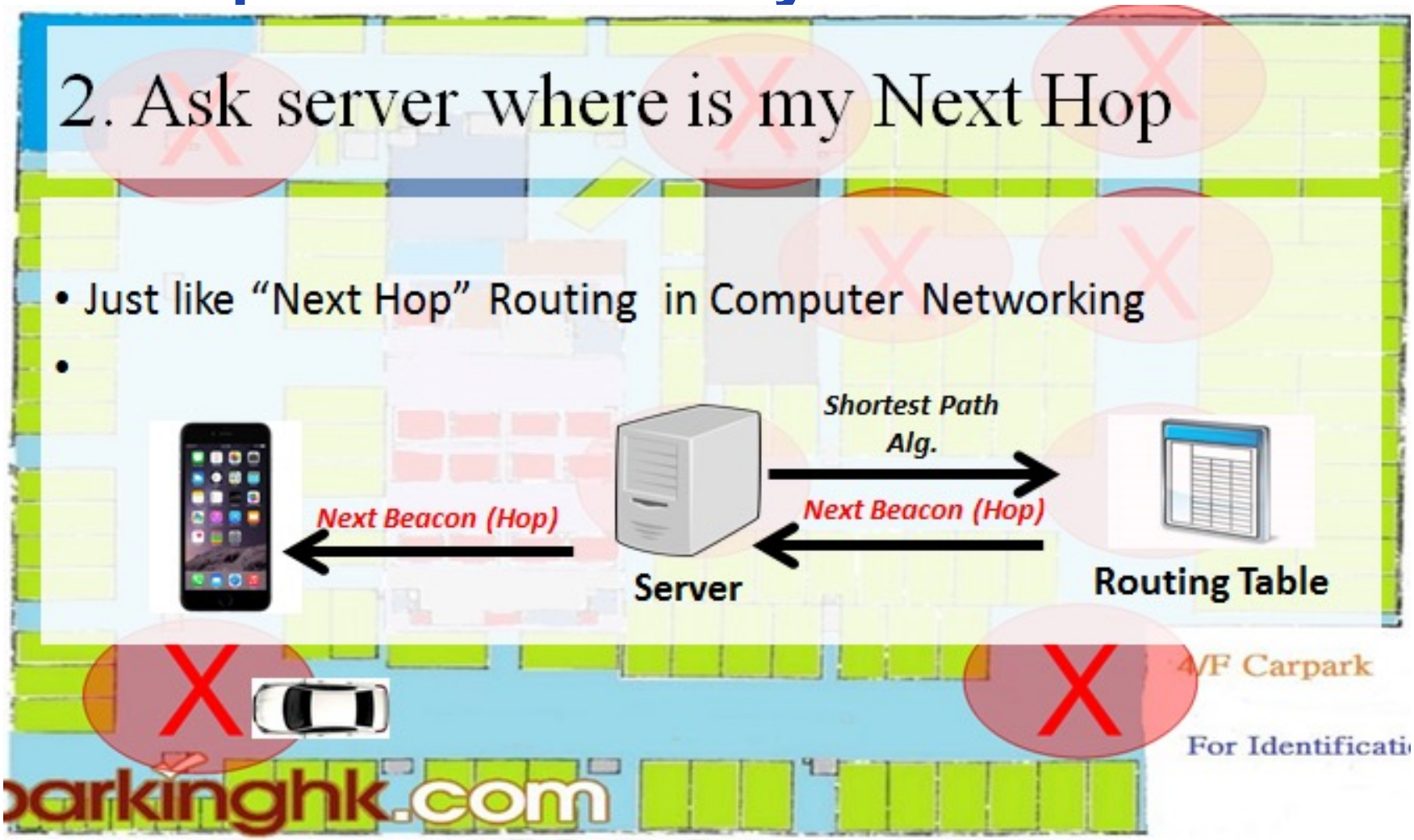
# Design Overview

## Car-park Guidance System



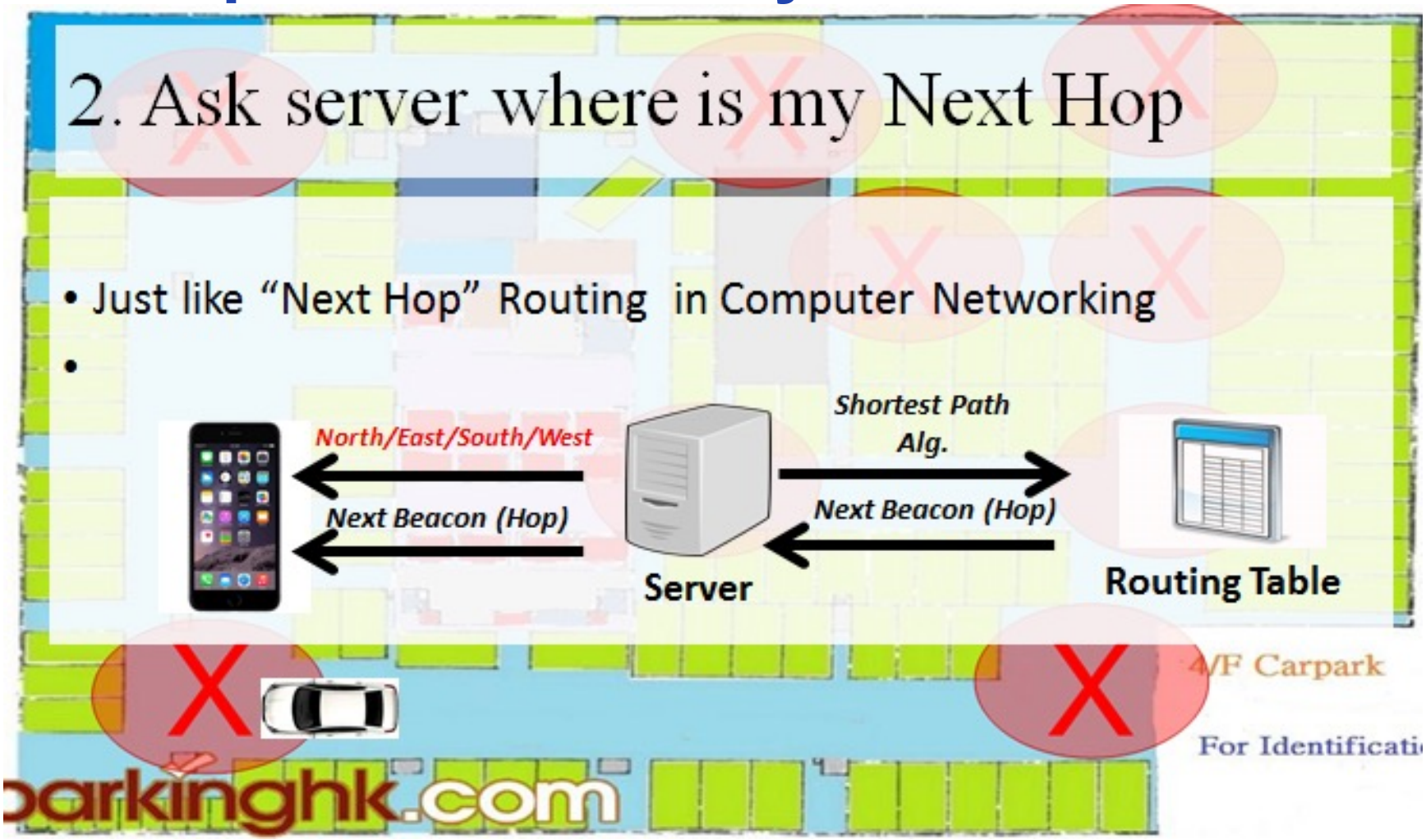
# Design Overview

## ❖Car-park Guidance System



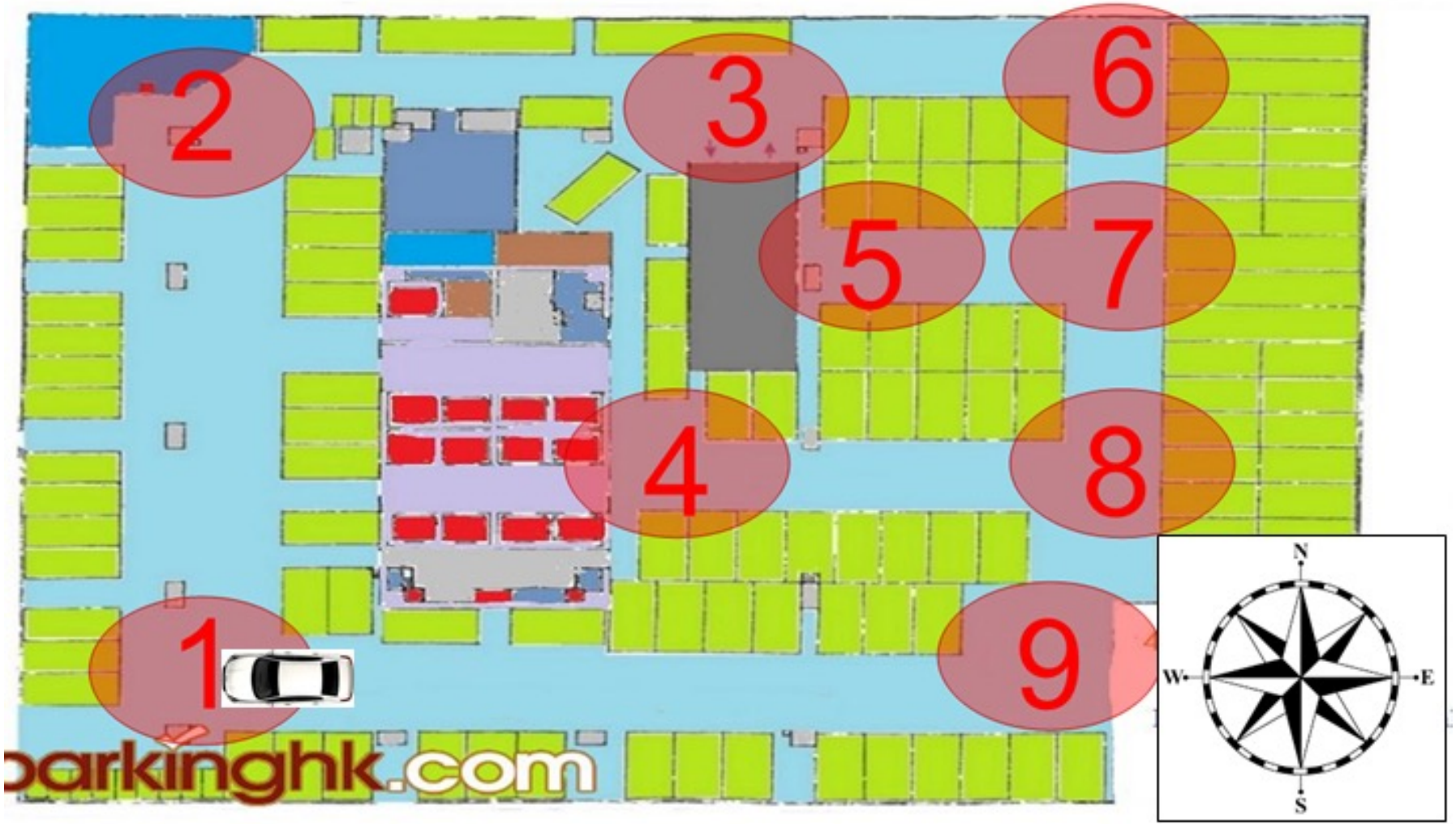
# Design Overview

## Car-park Guidance System



# Design Overview

- **Example** (From ***Beacon 1*** to ***Beacon 3***)



# Design Overview

## Example (From *Beacon 1* to *Beacon 3*)

# Design Overview

## Example (From *Beacon 1* to *Beacon 3*)

# Design Overview

## ❖ Example (From *Beacon 1* to *Beacon 3*)

# Design Overview

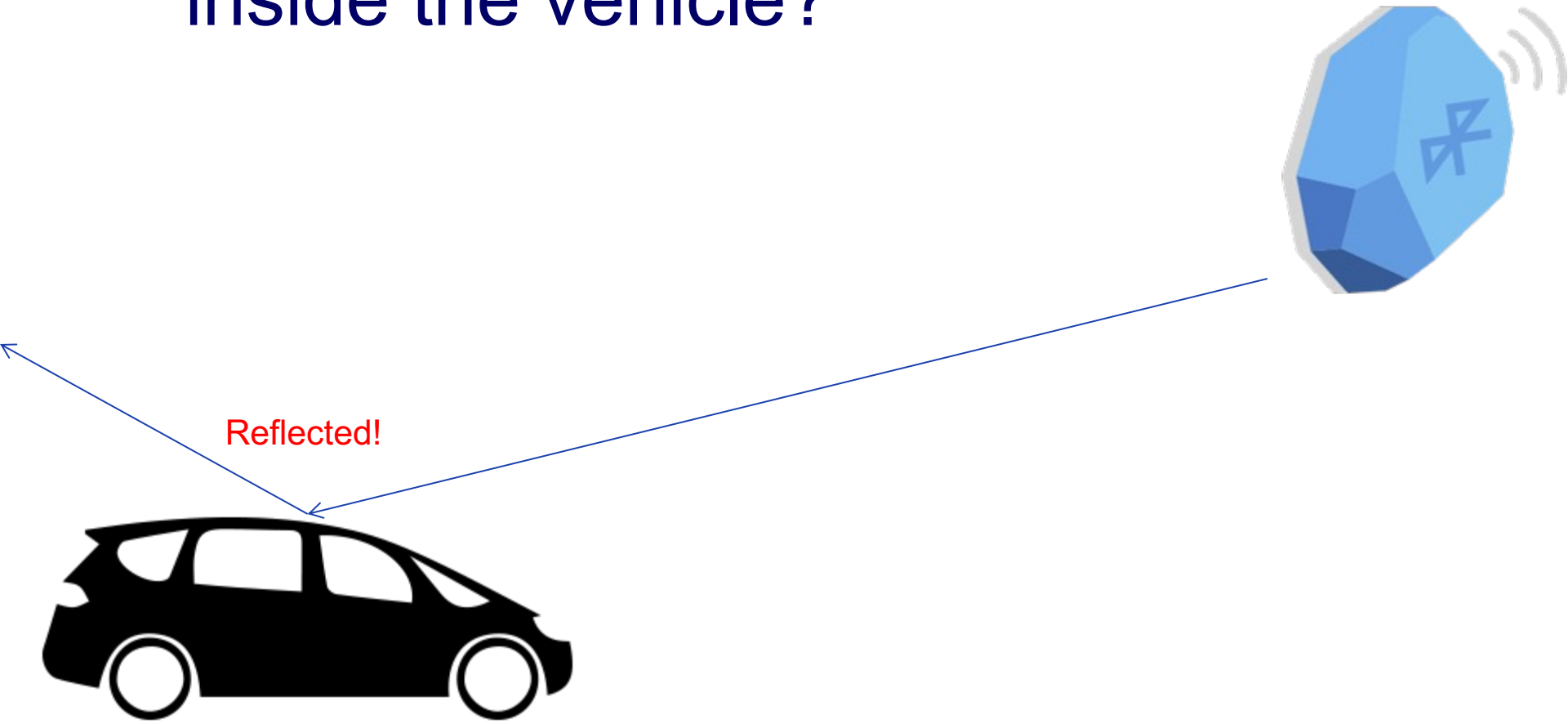
- **Example** (From ***Beacon 1*** to ***Beacon 3***)

# Feasibility Study

*“NOTHING IS IMPOSSIBLE.”*
BY *MY BOSS*

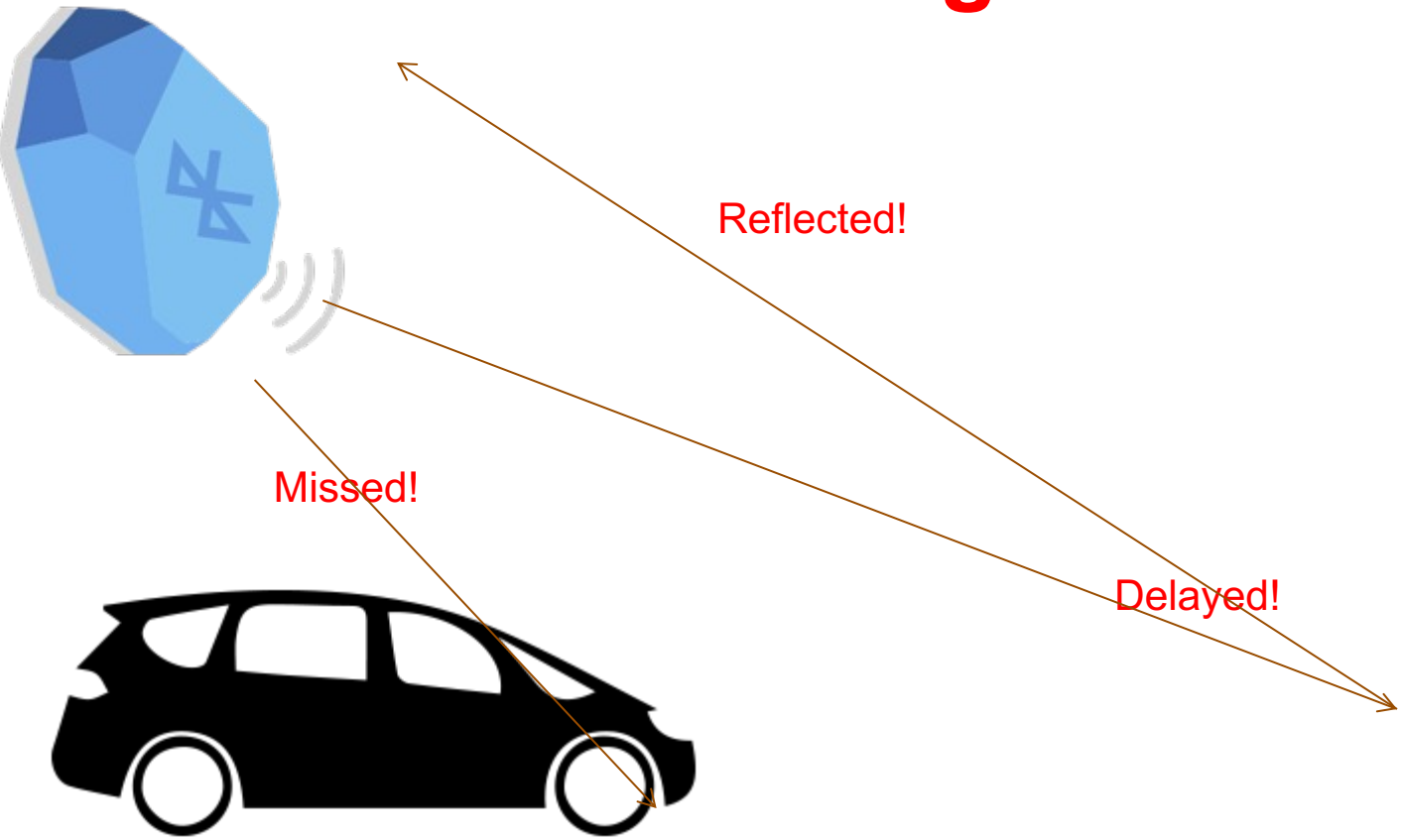
# Feasibility Study

- Beacons are detectable when I'm inside the vehicle?



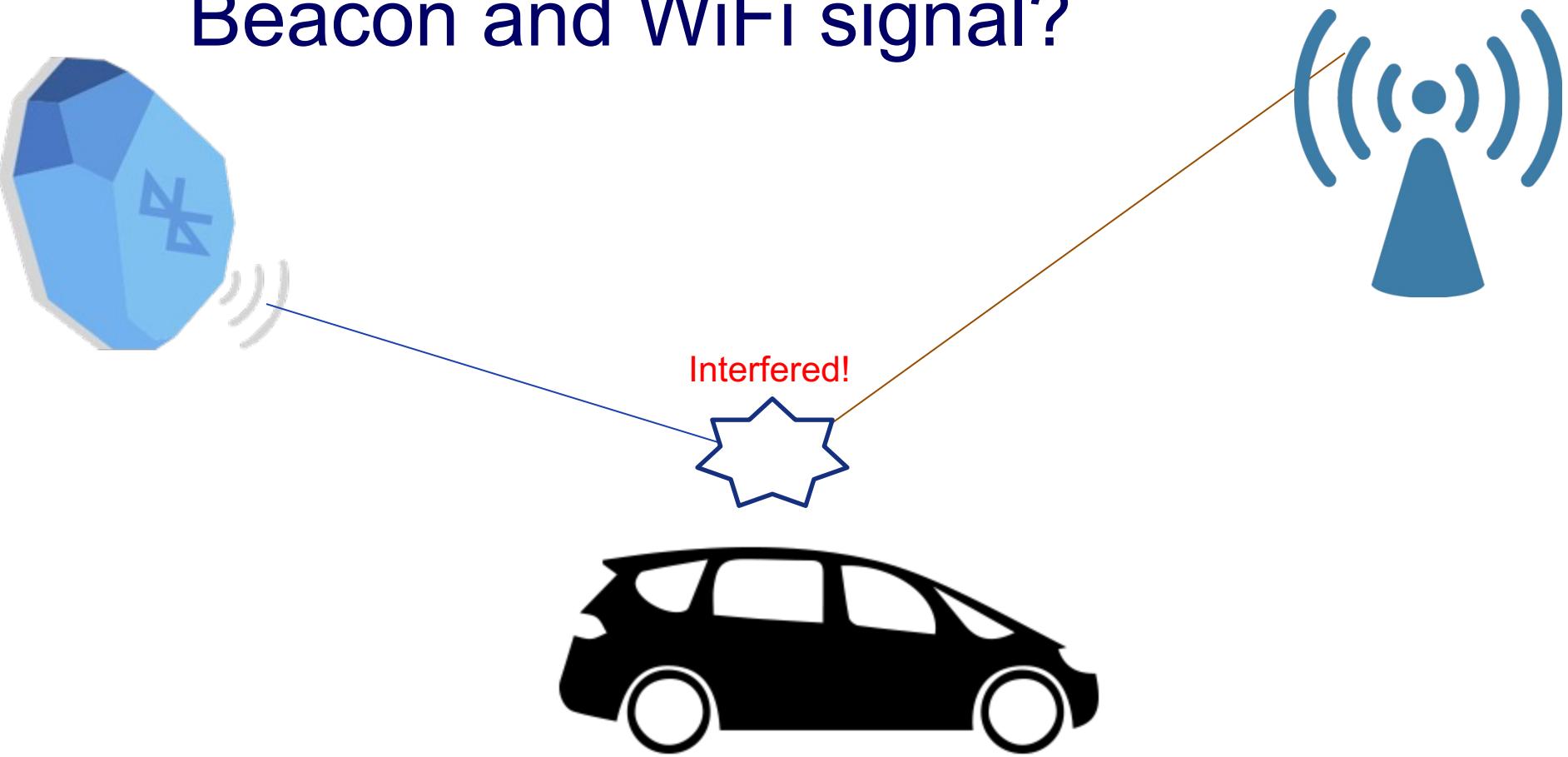
# Feasibility Study

- Beacons are detectable when I'm inside the **moving** vehicle?



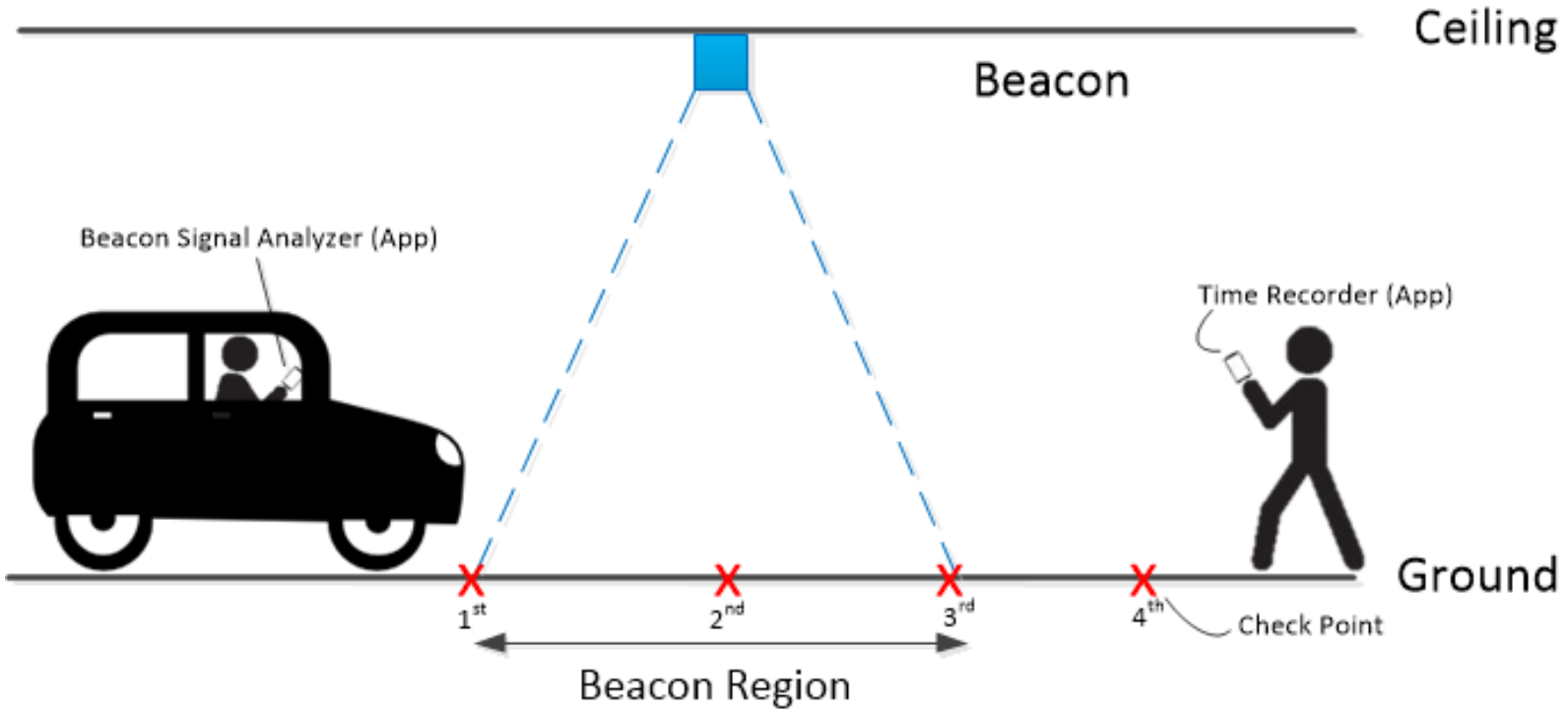
# Feasibility Study

- Inter-Symbol Interference between Beacon and WiFi signal?



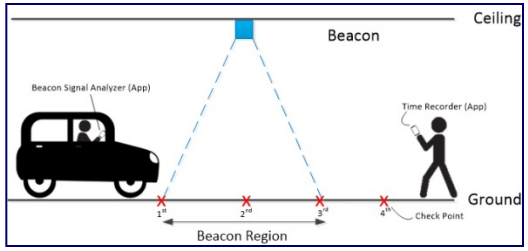
# Feasibility Study

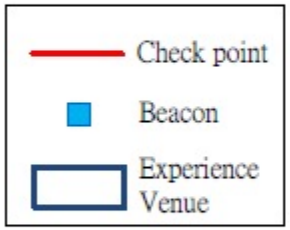
## Experiment

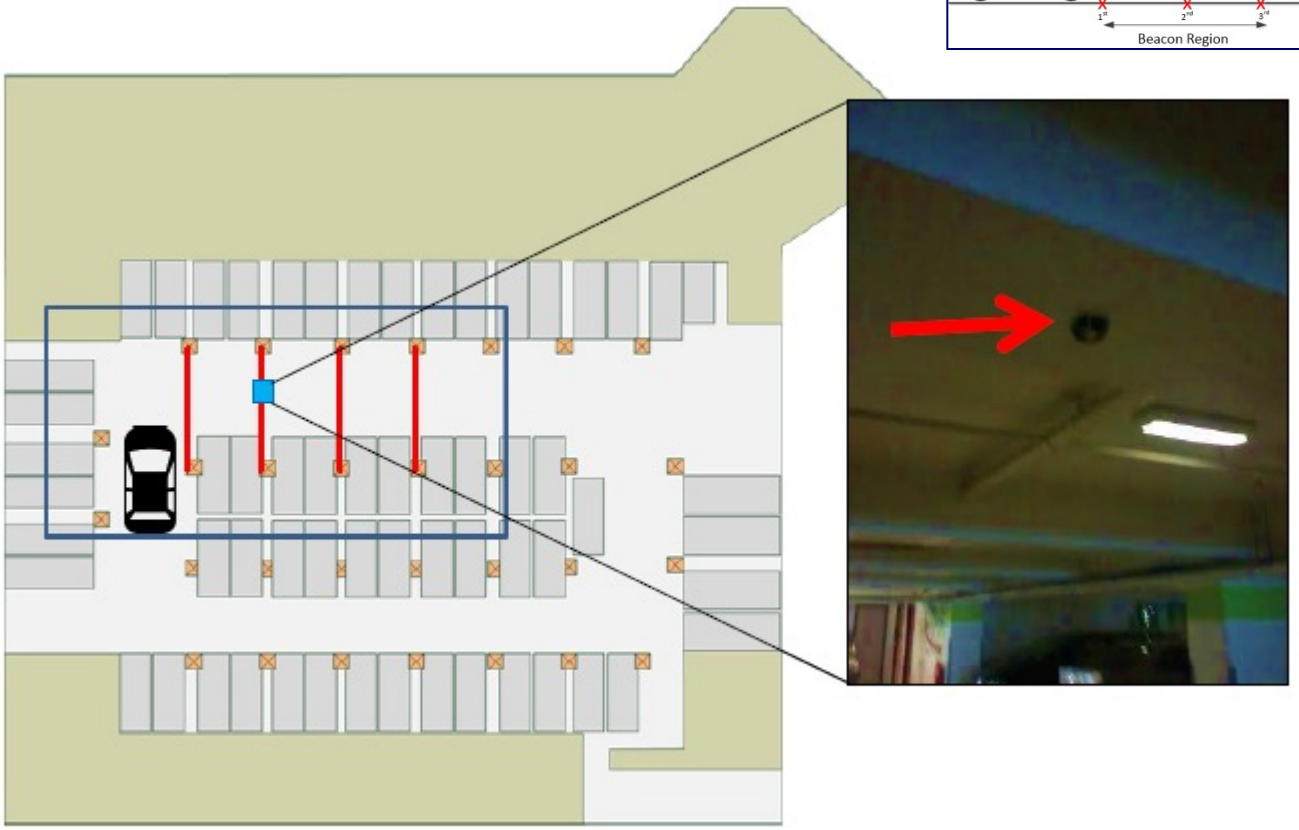


# Feasibility Study

## Experiment Venue



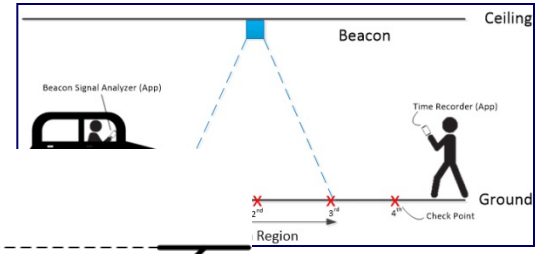



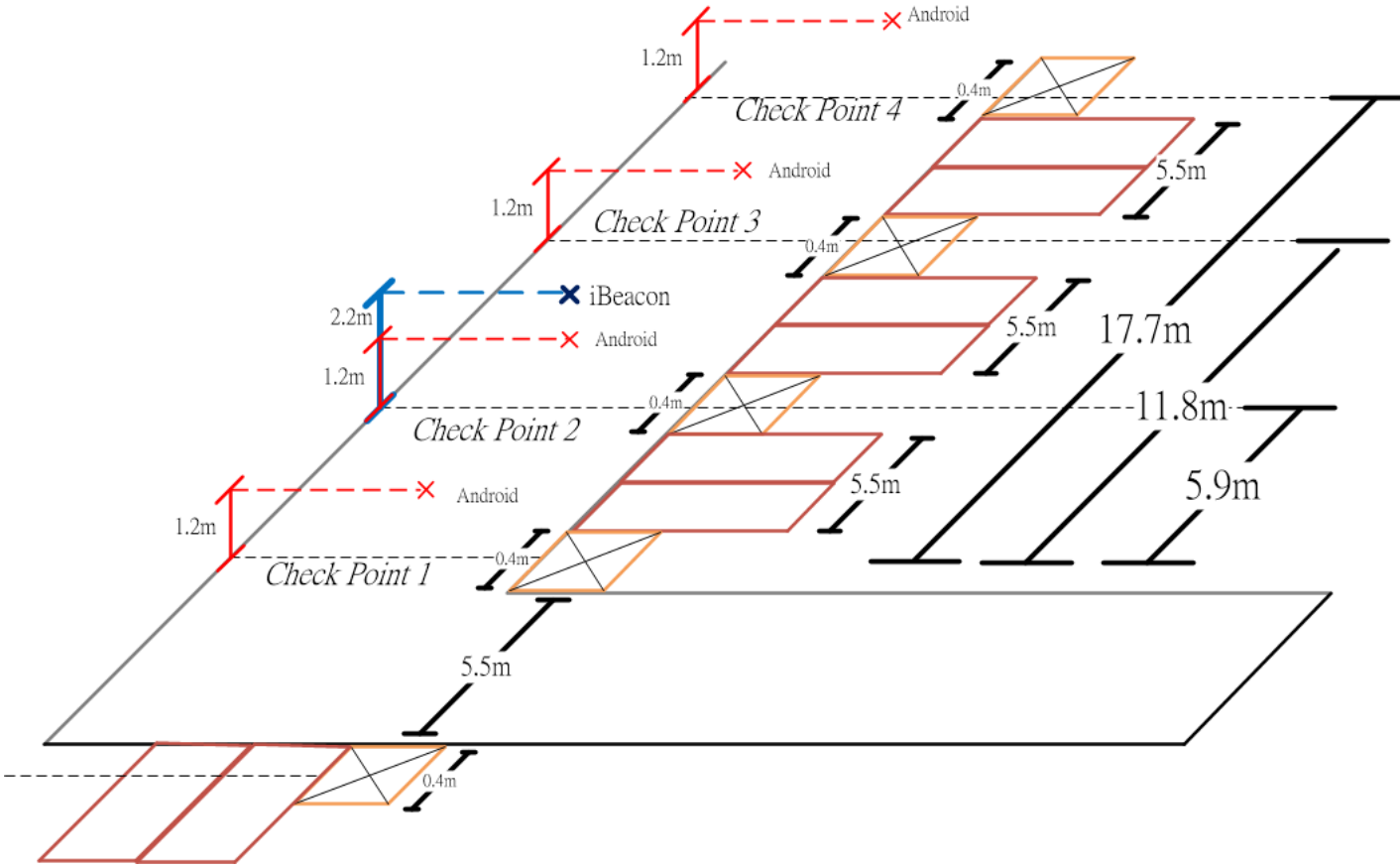



CUHK Lady Shaw Building
Car-park 2nd Floor

# Feasibility Study

## Experiment Venue



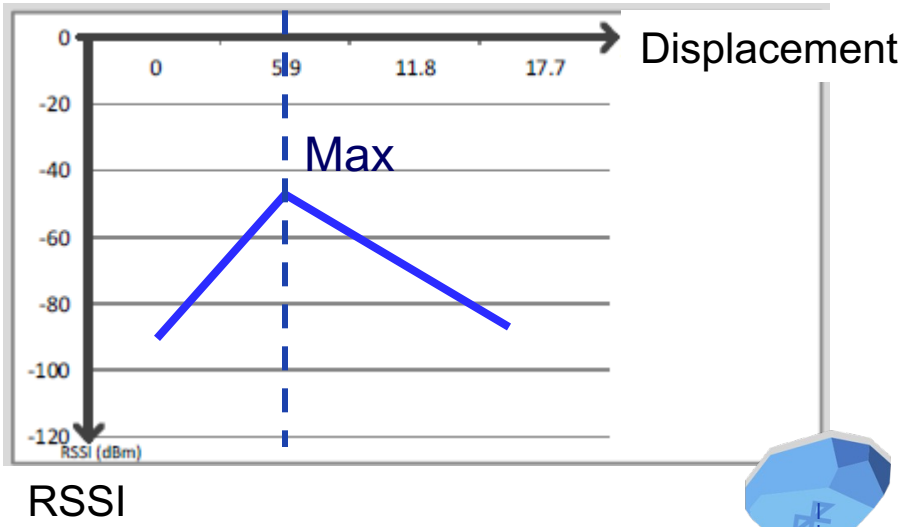

CUHK Lady Shaw Building
Car-park 2nd Floor

# Feasibility Study

- Experiment Objective
  - Measure the **RSSI** of Beacon's signal **against displacement** of a moving vehicle
  - Analyze the **Delay Error**, and **Signal Dissipation**.

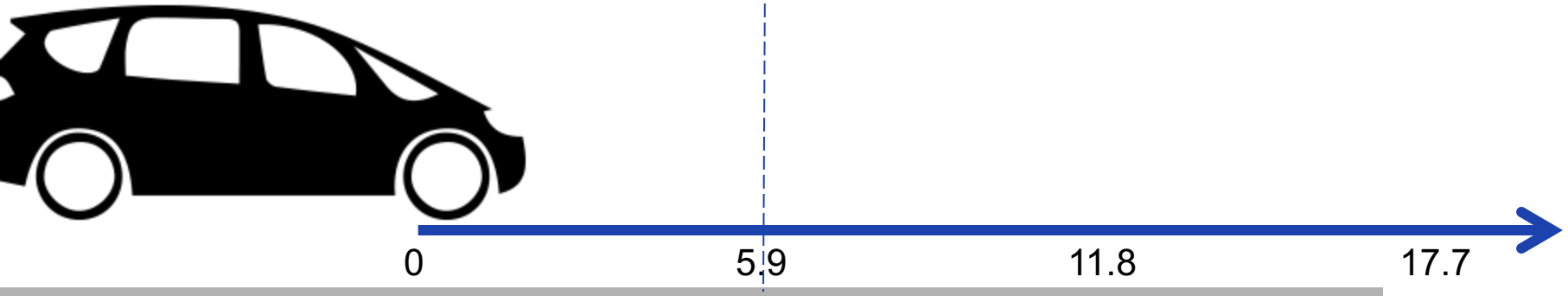
# Feasibility Study

## RSSI against Displacement graph:




## Expected Result:

- Increasing RSSI = entering Beacon's coverage
- Max. RSSI = just under Beacon
- Decreasing RSSI = leaving Beacon's coverage



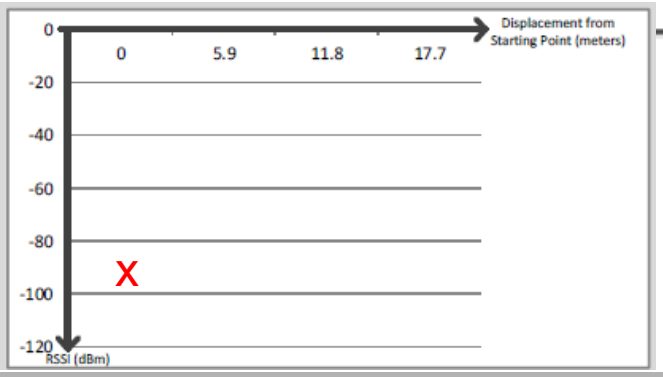
# Feasibility Study

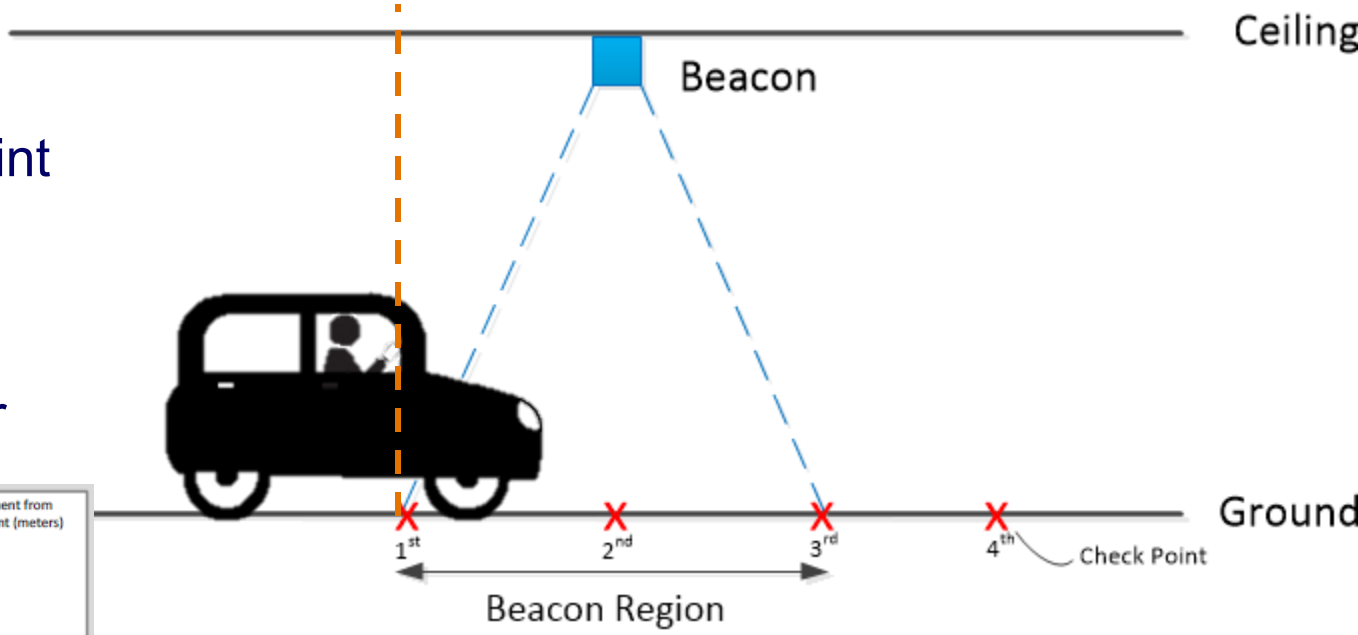
## Experiment Result:

Position: **1st** Check point

RSSI : **-96** dBm

Displacement: **0** meter



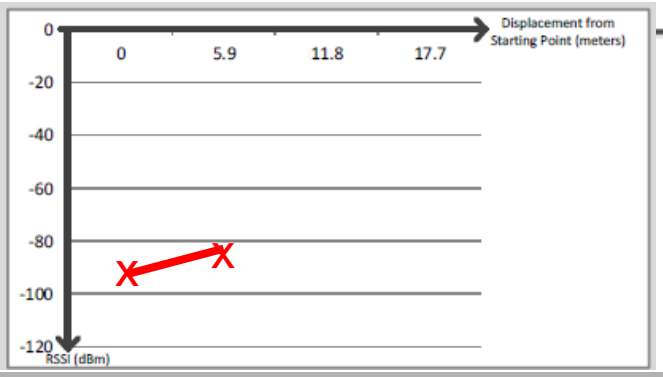
# Feasibility Study

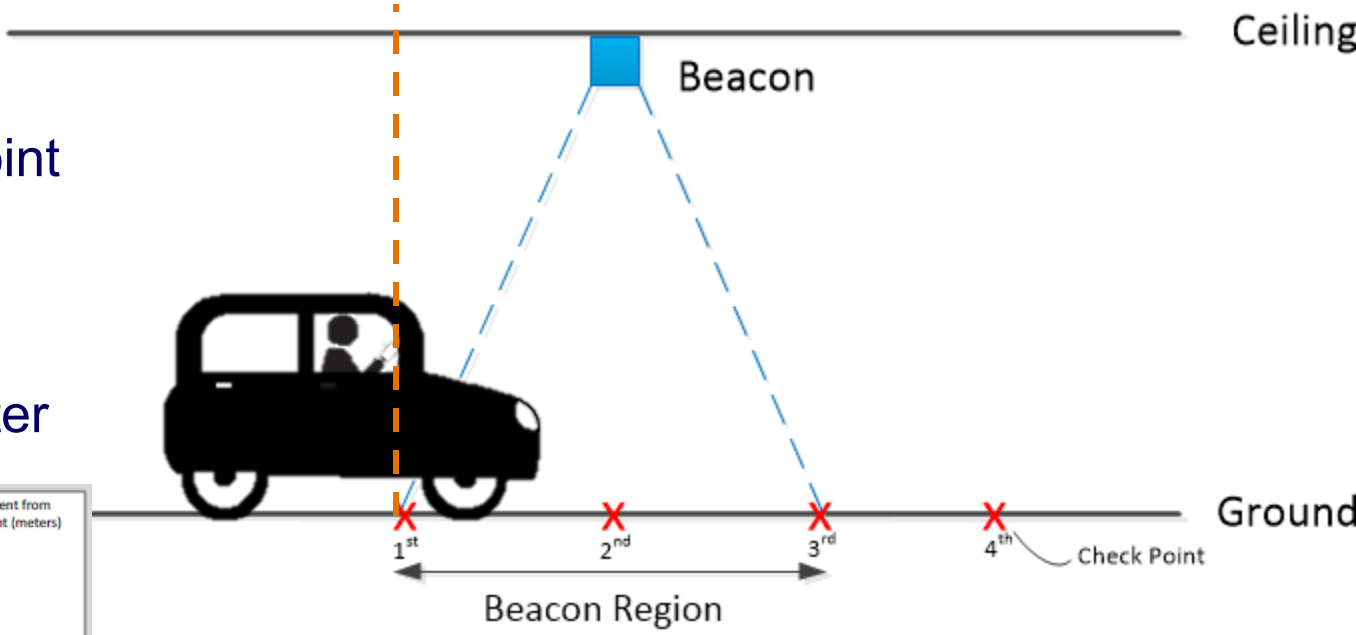
## Experiment Result:

Position: **2nd** Check point

RSSI : **-84** dBm

Displacement: **5.9** meter



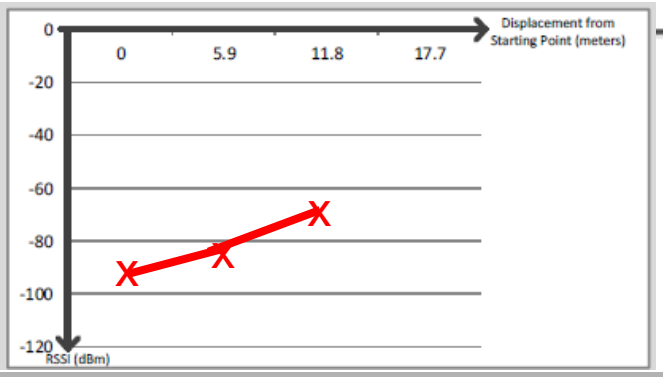
# Feasibility Study

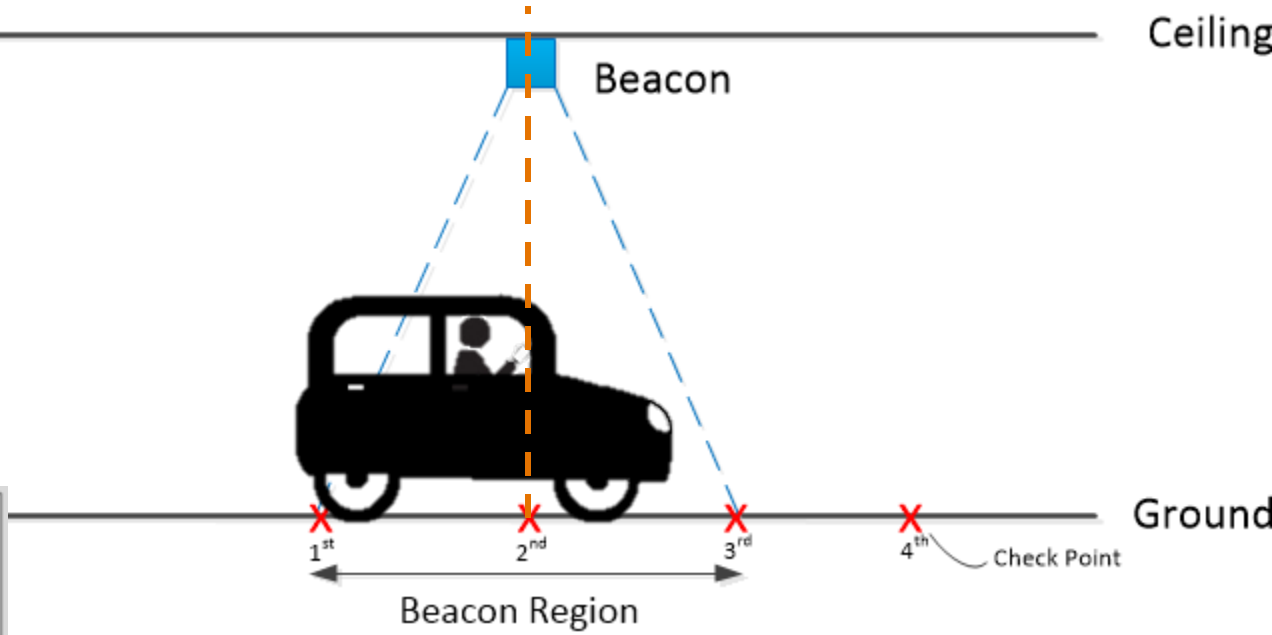
## Experiment Result:

Position: **3rd** Check point

RSSI : **-71** dBm

Displacement: **11.8** meter



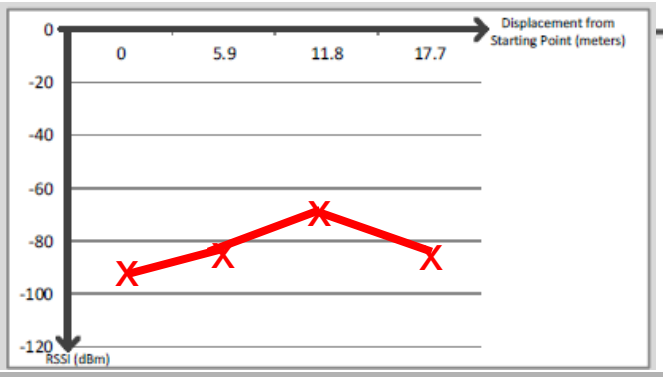
# Feasibility Study

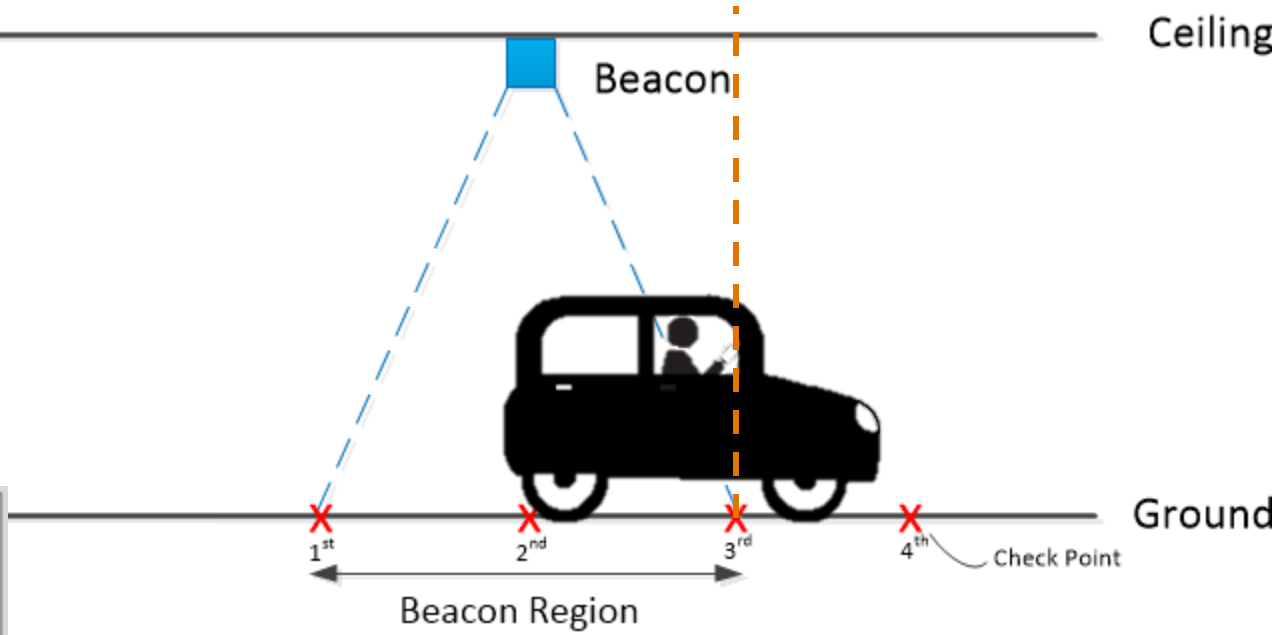
## Experiment Result:

Position: **4th** Check point

RSSI : **-84** dBm

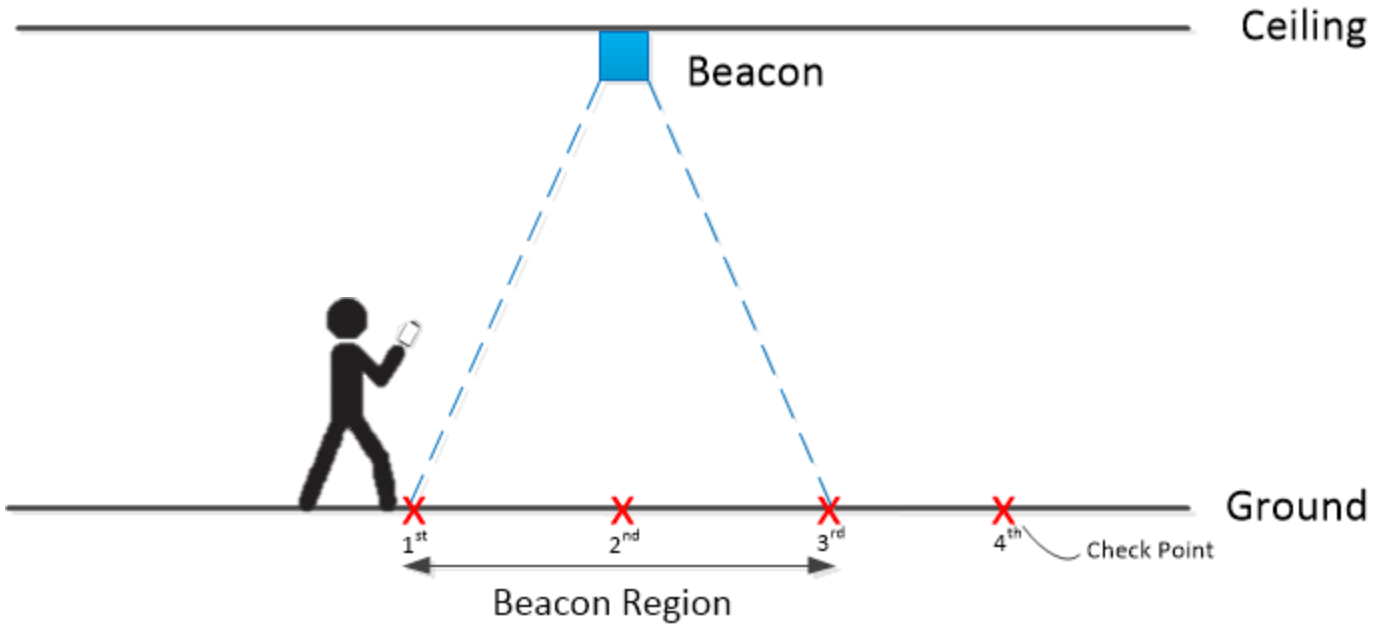
Displacement: **17.7** meter



# Feasibility Study

- Controlled Experiment
  - Measure the **RSSI** of Beacon's signal **for each check point**



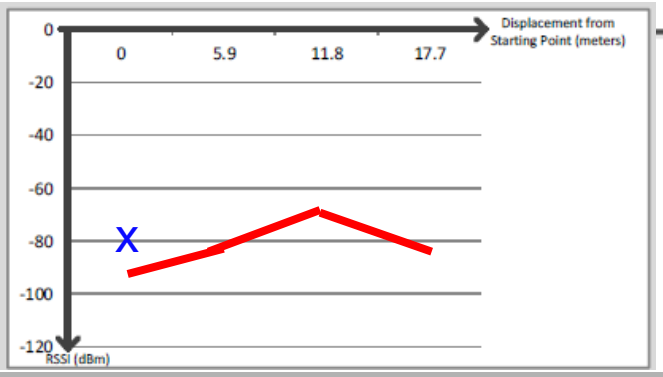
# Feasibility Study

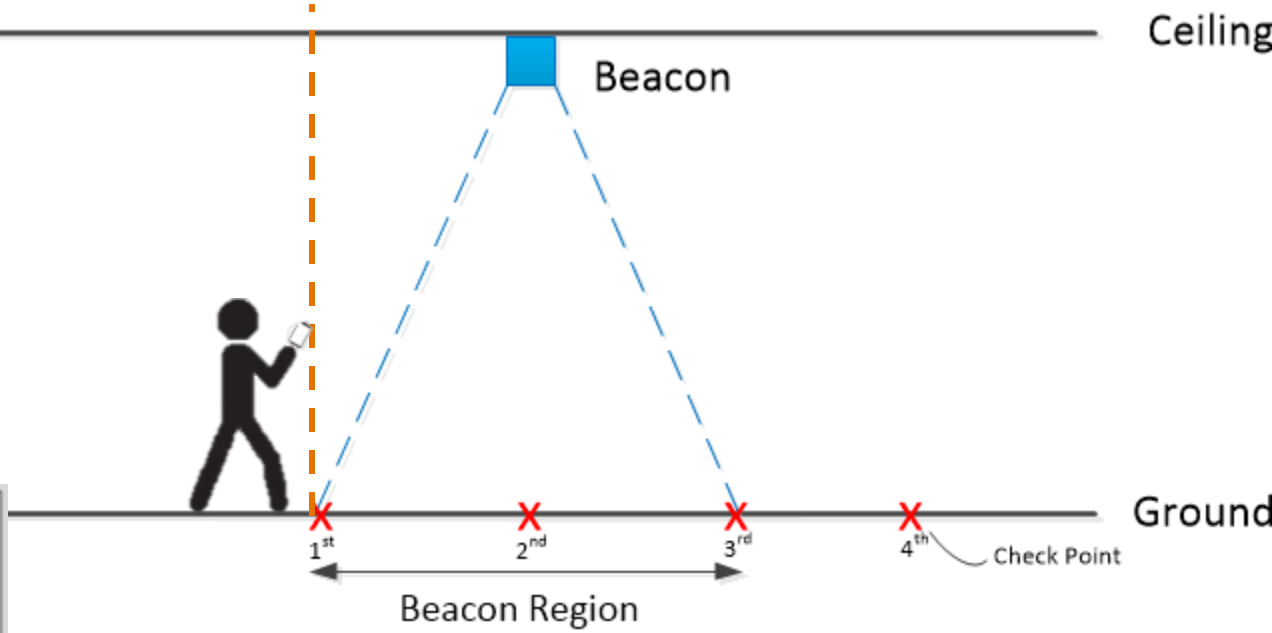
## Controlled Experiment Result:

Position: **1st** Check point

RSSI : **-80** dBm

Displacement: **0** meter



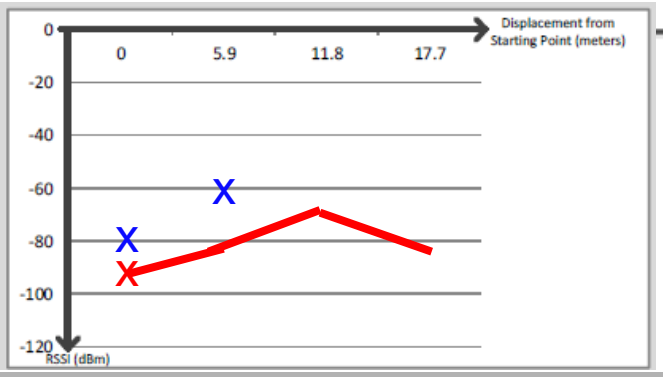
# Feasibility Study

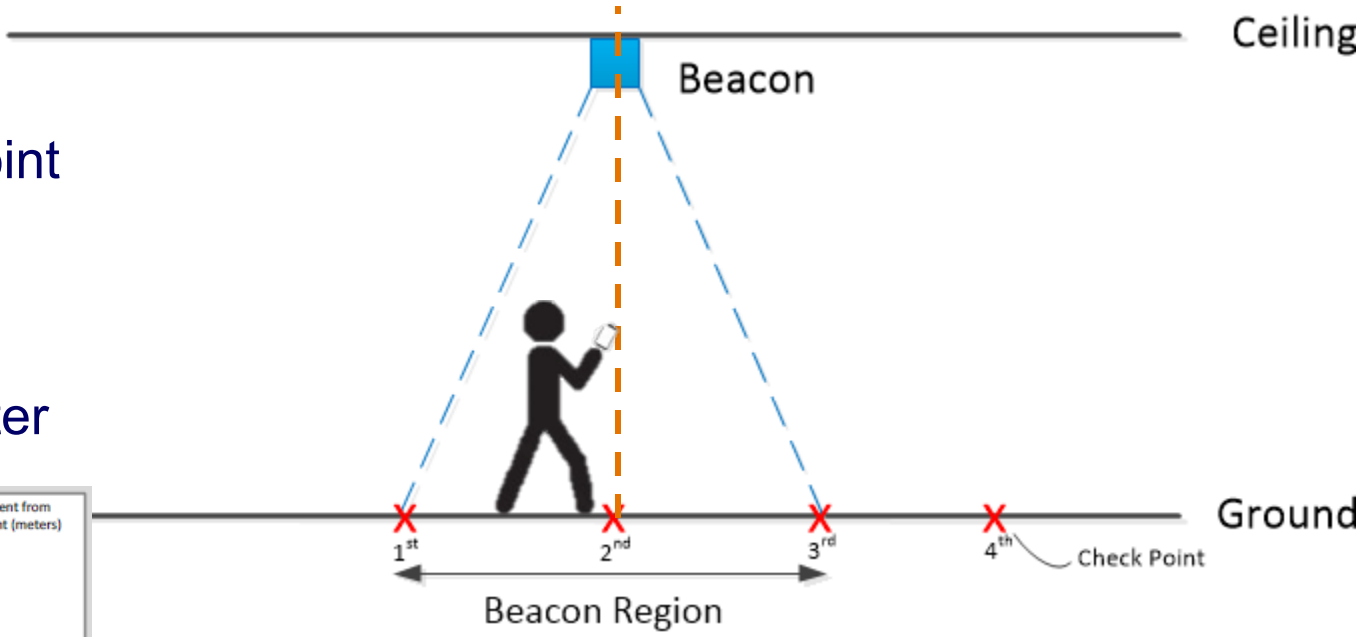
## Controlled Experiment Result:

Position: **2nd** Check point

RSSI : **-61** dBm

Displacement: **5.9** meter



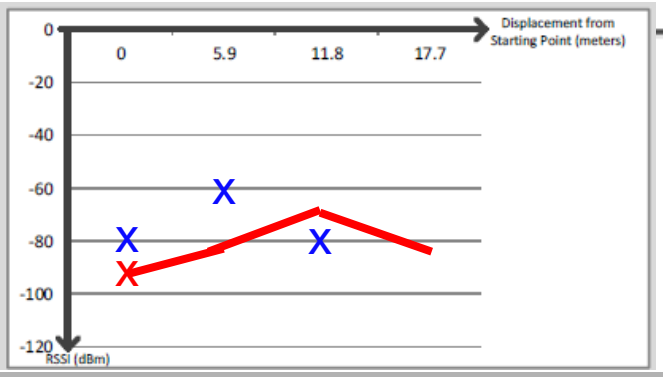
# Feasibility Study

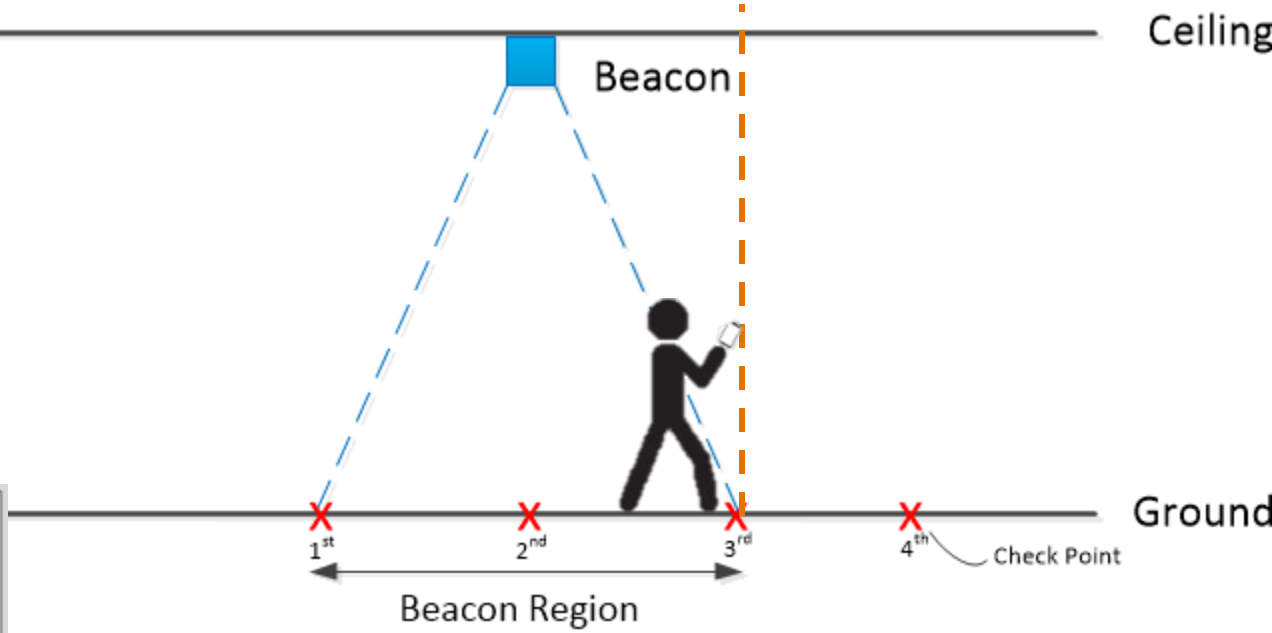
## Controlled Experiment Result:

Position: **3rd** Check point

RSSI : **-81** dBm

Displacement: **11.8** meter



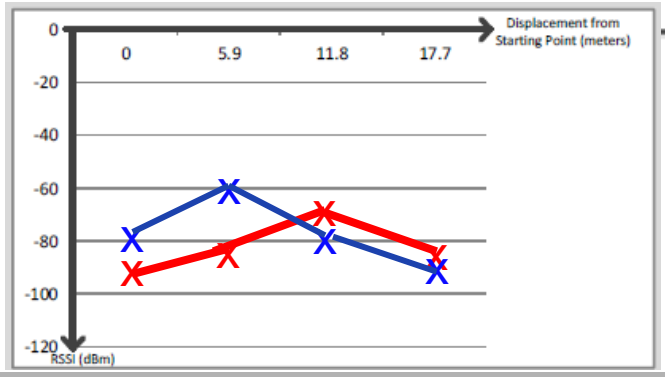
# Feasibility Study

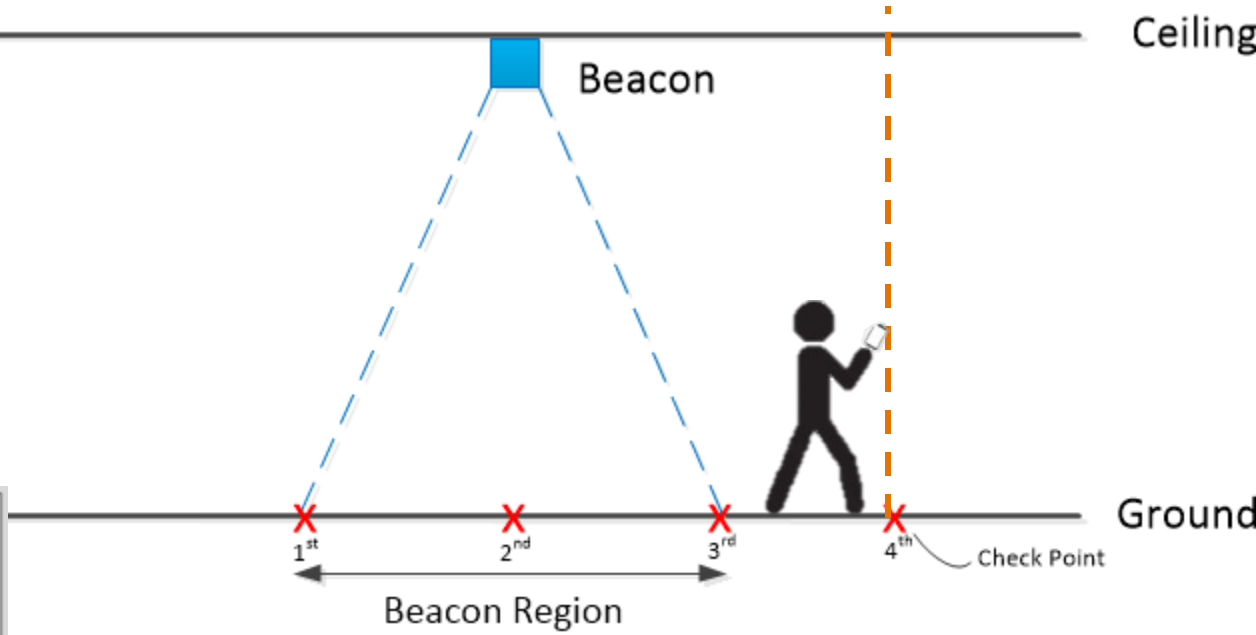
## Comparing Results:

Position: **4th** Check point

RSSI : **-88** dBm

Displacement: **17.7** meter



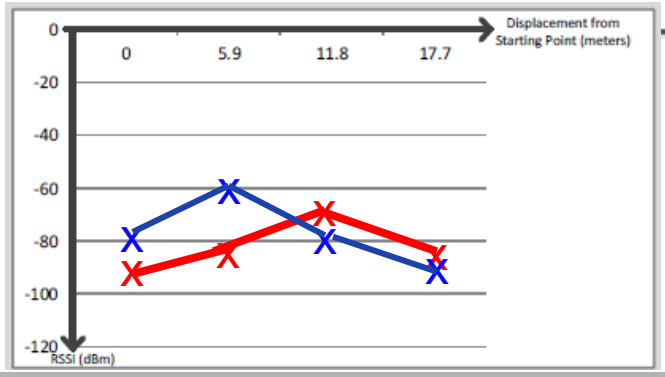
# Feasibility Study

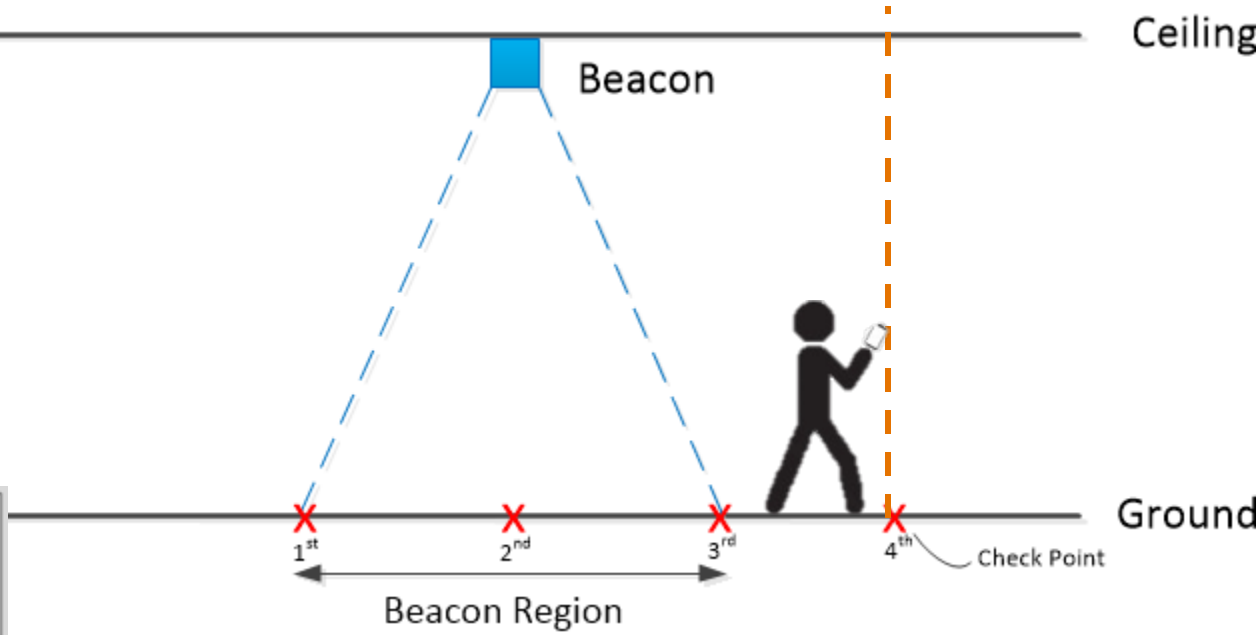
## Comparing Results:

Position: **4th** Check point

RSSI : **-88** dBm

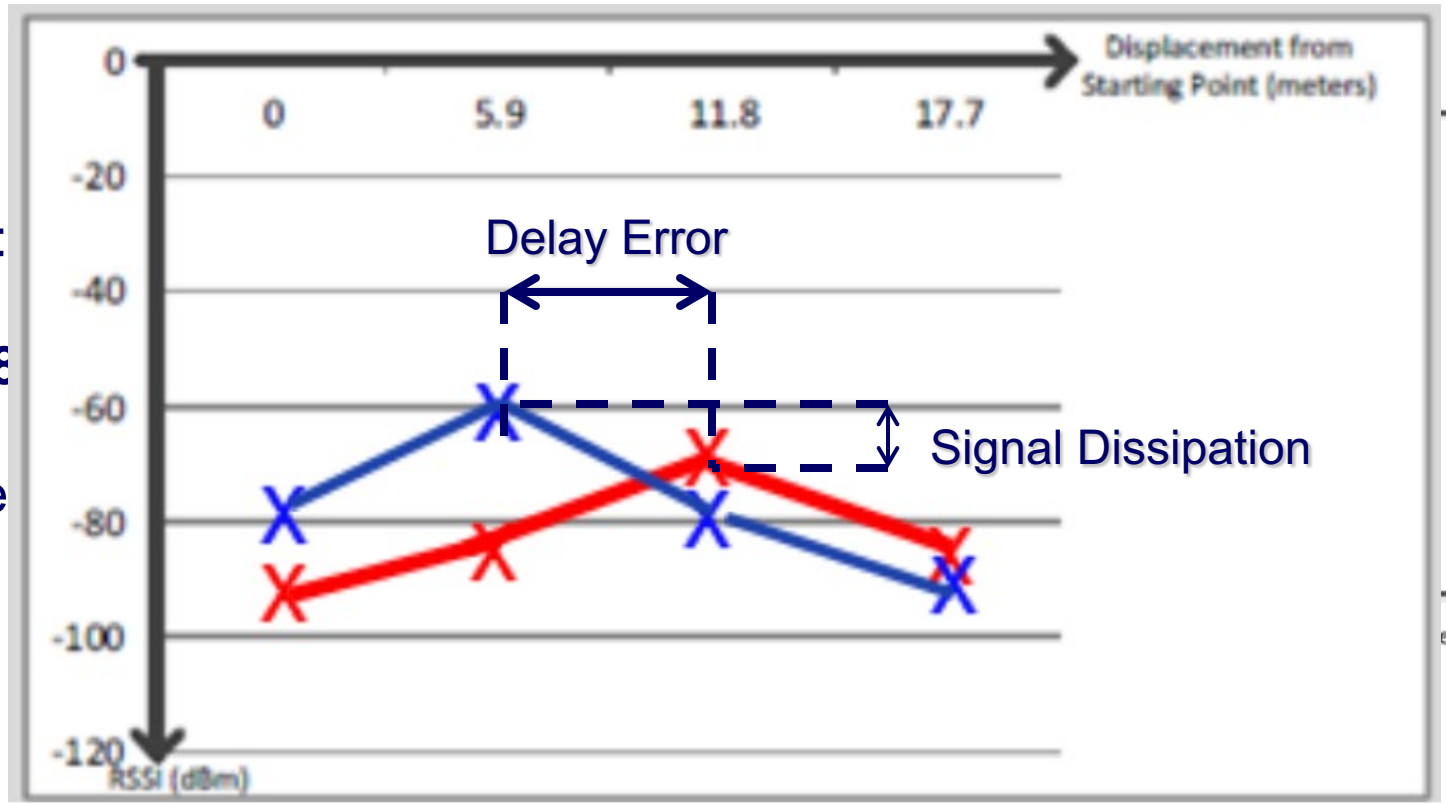
Displacement: **17.7** meter



# Feasibility Study

## Comparing Results:



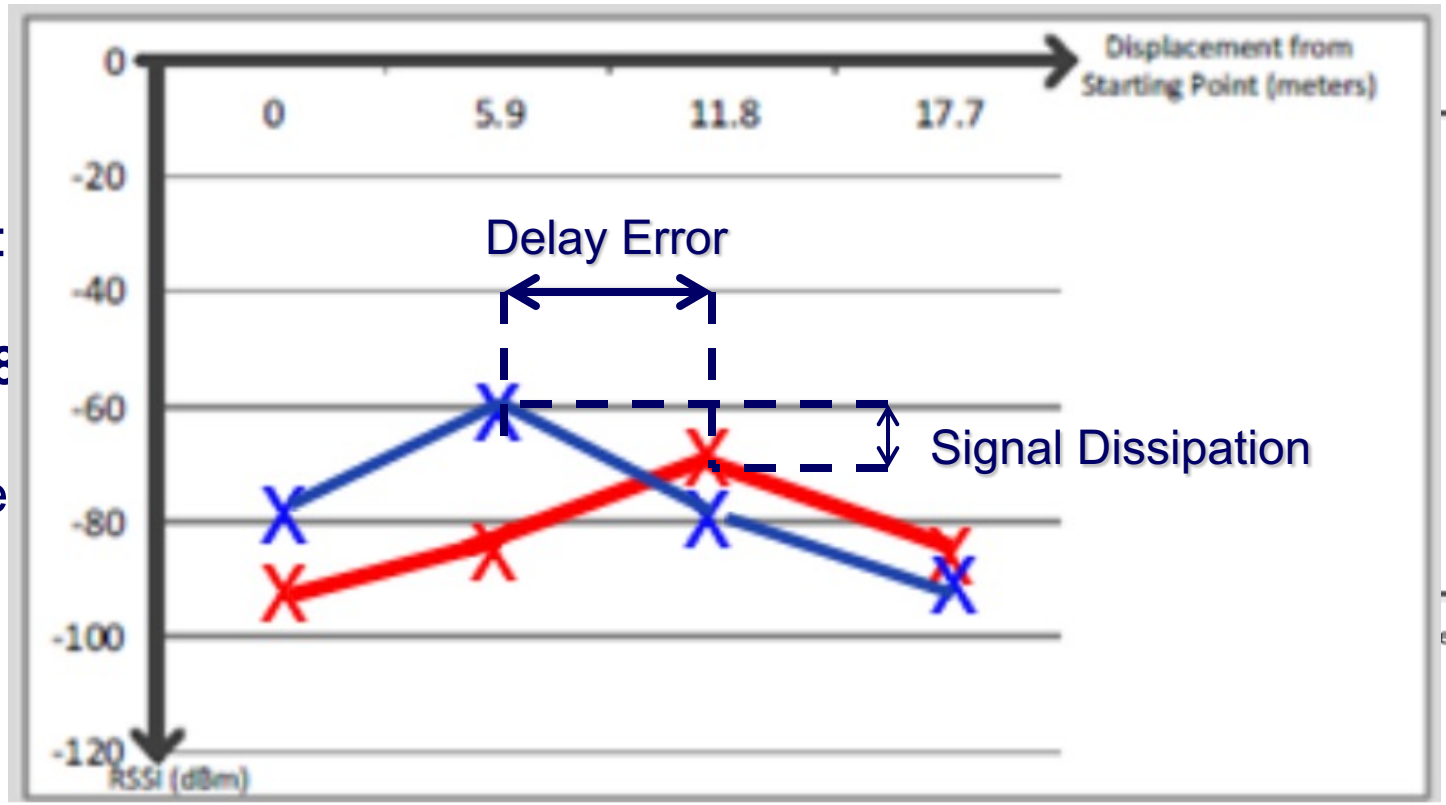

Position:

RSSI : -8

Displace

# Feasibility Study

## Comparing Results:




Position:

RSSI : -8

Displace

# Feasibility Study

## Experiment Conclusion:

1. Beacons' signal is detectable within moving vehicle
2. Beacons' signal is dissipated by ~10dBm due to car's metal shell
3. Beacons' signal is delayed by ~5.9m due to vehicle motion

# Feasibility Study

## Experiment Conclusion:

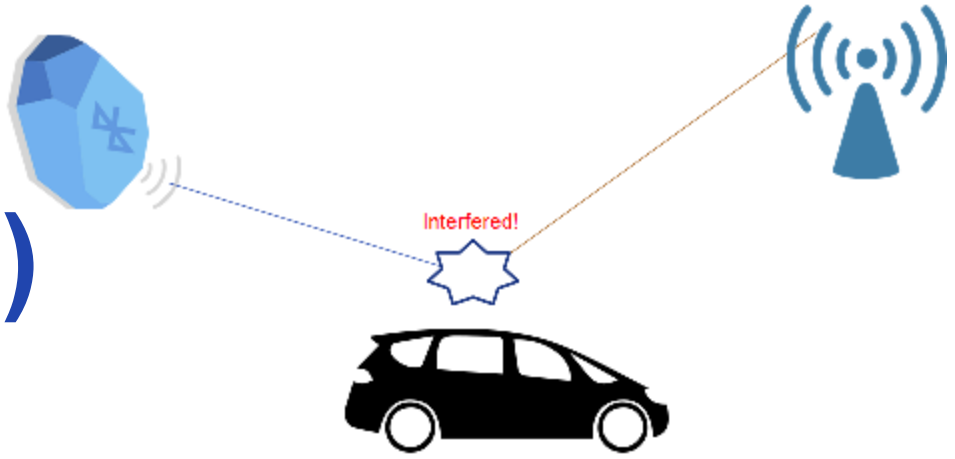
1. Beacons' signal is detectable within moving vehicle
2. Beacons' signal is dissipated by ~10dBm due to car's metal shell
3. Beacons' signal is delayed by ~5.9m due to vehicle motion

So, to migrate the problem:

1. Place Beacon 5.9 meters earlier than the original place
2. Reduce the RSSI threshold value by 10dBm than normal

# Feasibility Study

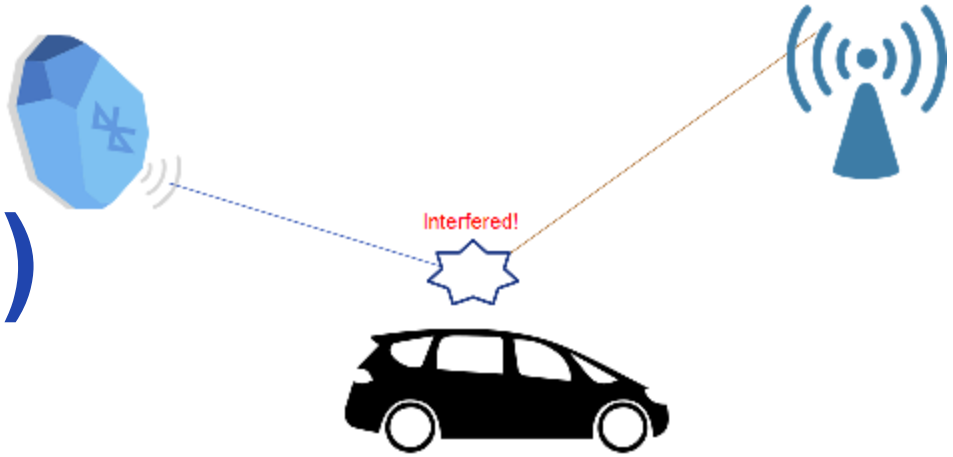
## Inter-Symbol Interference (ISI)




- 2.4GHz Free License Band
- Bandwidth for Beacon (1MHz)
  for WiFi (20MHz)
- If both channels overlapped, ISI occurs.

# Feasibility Study

## ❖Inter-Symbol Interference (ISI)



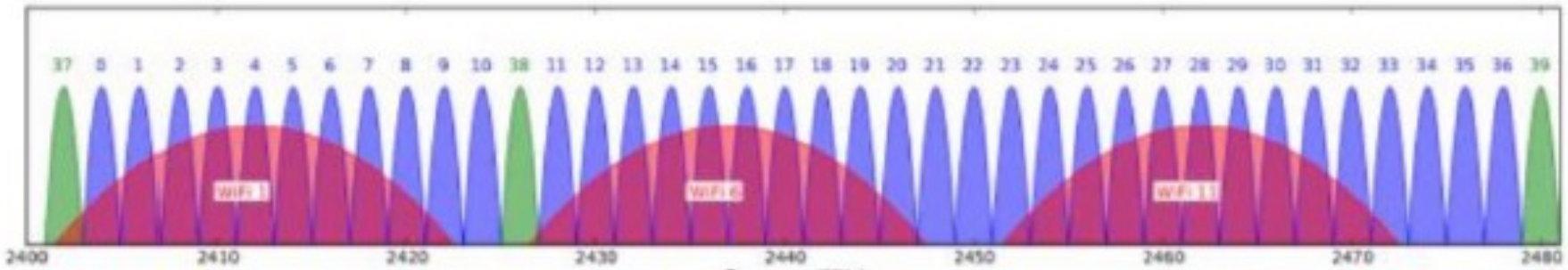
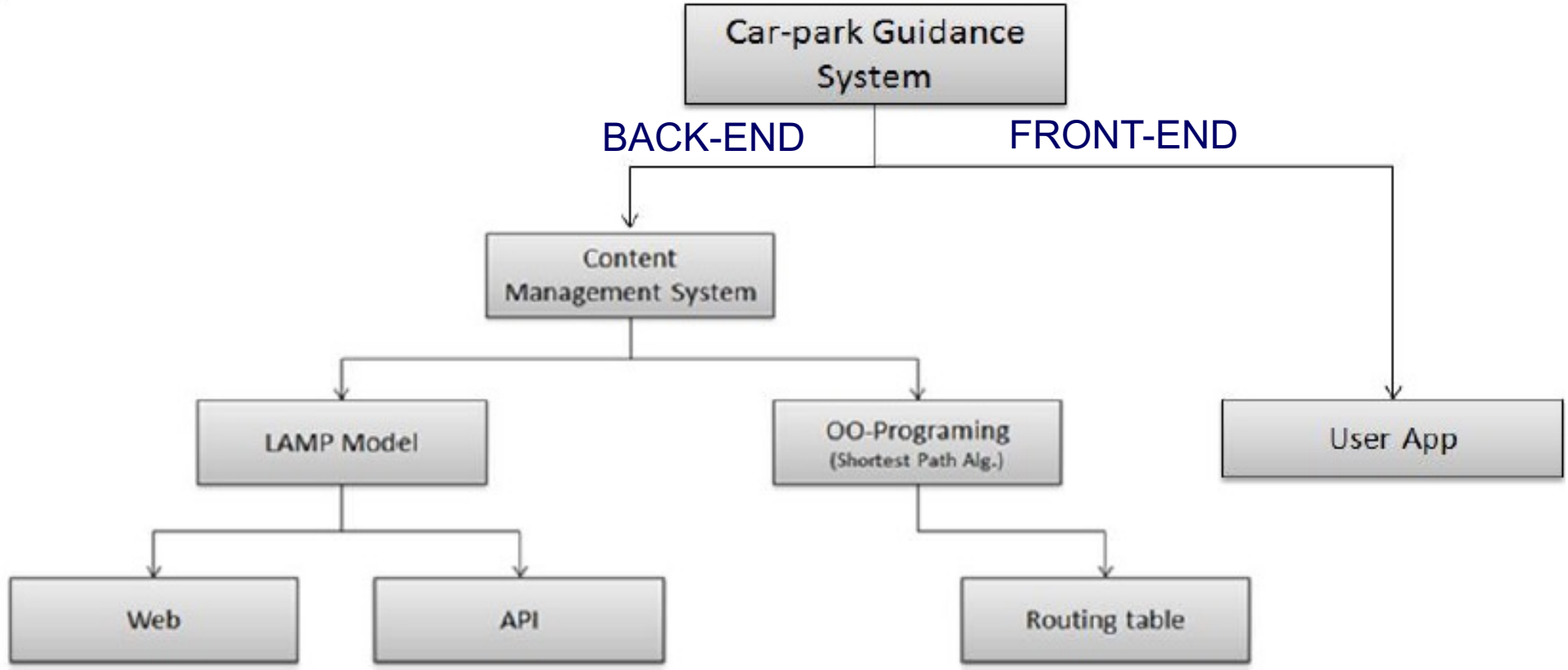




*Figure 2 shows the 40 BLE channels within the 2.4 GHz band. The green channels are the advertising channels used by BLE beacons. Three WiFi channels are shown for comparison (red).*

# Implementation

*“IDEAS ARE EASY. IMPLEMENTATION IS HARD”*
*BY GUY KAWASAKI*

# Implementation



# Implementation

## Back-end of System

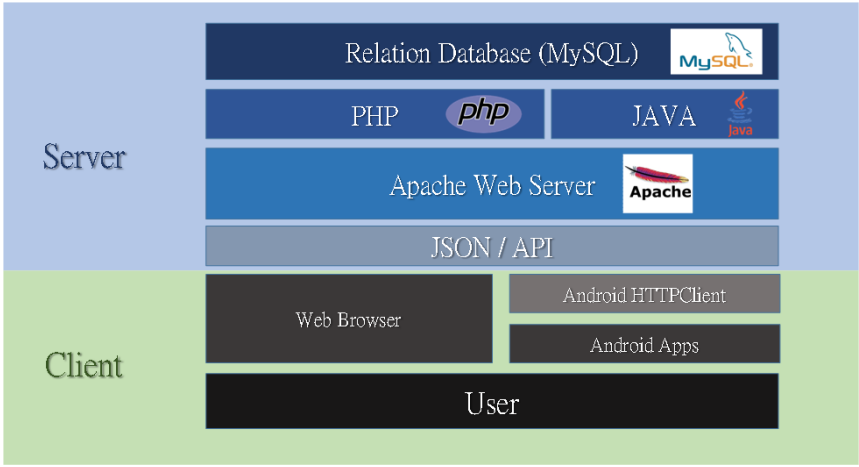
- Content Management System (CMS)
- Target User:  Car-parks' Administrator
- Functions:
  - Manages the information of **Car-park**, **Users**, **Beacons**, **Routes between Beacons**

# Implementation

## Content Management System (CMS)

- Can further divided into **WEB**, **API**, **ROUTING TABLE**.

- WEB and API are Based on LAMP Model

# Implementation

## Content Management System (CMS)

- Can further divided into **WEB**, **API**, **ROUTING TABLE**.

- ROUTING TABLE is Based on JAVA (OO-Program) to calculate shortest path by using existing *graph data structure* library (JgraphT).


+

# Implementation

## Content Management System (CMS)

- The functions of CMS will be demonstrated in the last section.
- So, now let's focus on the front-end of system.

# Implementation (APP)

## Support Beacon Types

- iBeacon
  - Simple and easy to implement
- Eddystone
  - Flexible but more complicated to code



| | iBeacon | Eddystone |
|---|---|---|
| Protocol | Close source | Open source |
| Packet | Broadcast 1 packet | Broadcast 3 packets |
| (Unique ID number) | UUID, Major, Minor | Eddystone – UID |
| (URL address) | | Eddystone – URL |
| (Telemetrics based on sensor) | | Eddystone – TLM |

# Implementation (APP)

## iBeacon

- UUID
  - Same for all iBeacons working with a specific app.
- Major, Minor
  - “Major” and “Minor” IDs are used to identify each beacon uniquely.

| Company Name | SAY_HI_TO_FYP | | | | | |
|---|---|---|---|---|---|---|
| UUID | A8C5DB1E-6785-1A25-778B-5E25DA57BC82 | | | | | |
| Store Location | Tai Po | | | ShaTin | | |
| Major | 1 | | | 2 | | |
| Products | Books | CDs | Pens | Books | CDs | Pens |
| Minor | 20 | 30 | 40 | 20 | 30 | 40 |

# Implementation (APP)

## Eddystone

- UID
  - Similar as UUID
  - Divided into “Namespace” and “Instance” ID
- URL
  - Beacon format for the “Physical Web
  - NOT require a custom app but require a beacon browser
- TLM

  Includes

  1) Beacon’s battery state
  2) Temperature
  3) The time since power-on
  4) A count of the advertising packets

# Implementation (APP)

## Why we develop on Android but not iOS?

- iOS doesn't provide a mechanism to find unknown beacons
  - Application must know all UUID of Beacons for monitoring.

- The number of Beacons can be scanned at a time is limited to 20

# Implementation (APP)

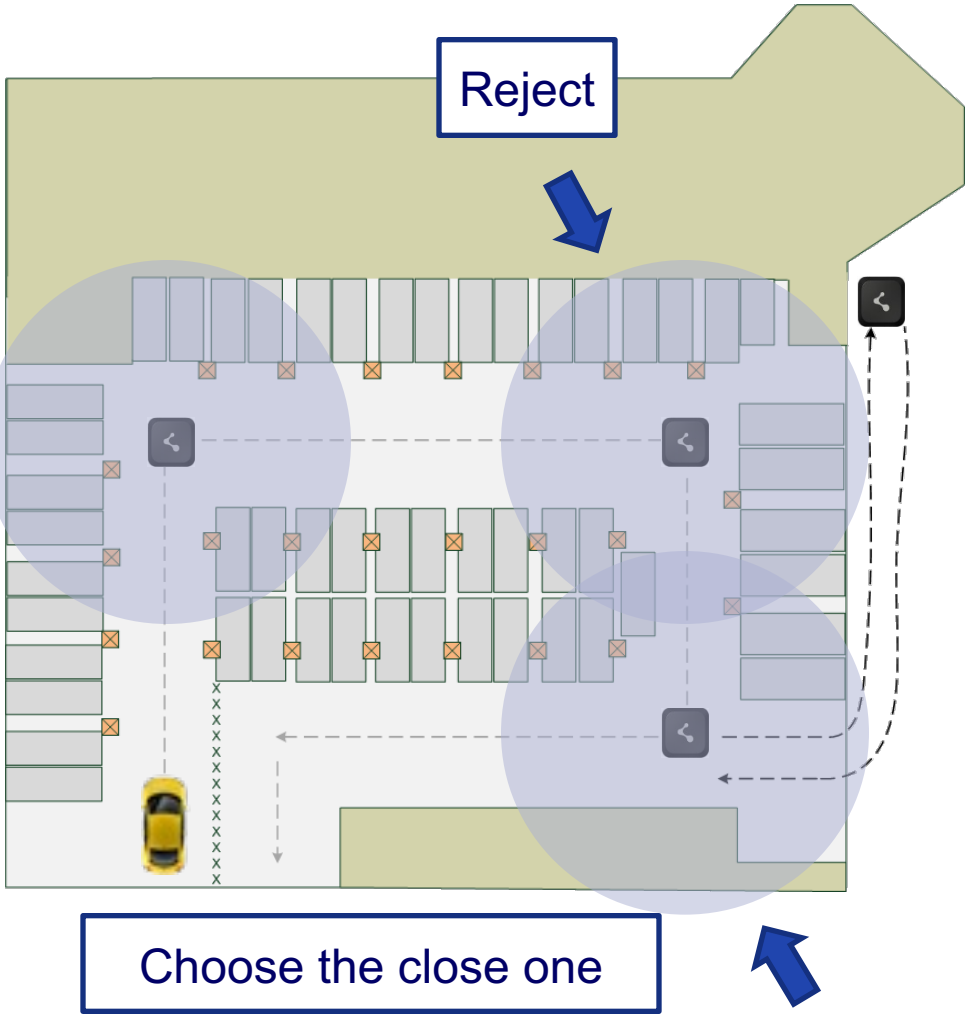
- **In our app,**
  - We have lots of functions.

- **Important functions**
  1) Scan a beacon
  2) Guidance pointer
  3) Notification…

# Implementation (APP)

## How can we guide?

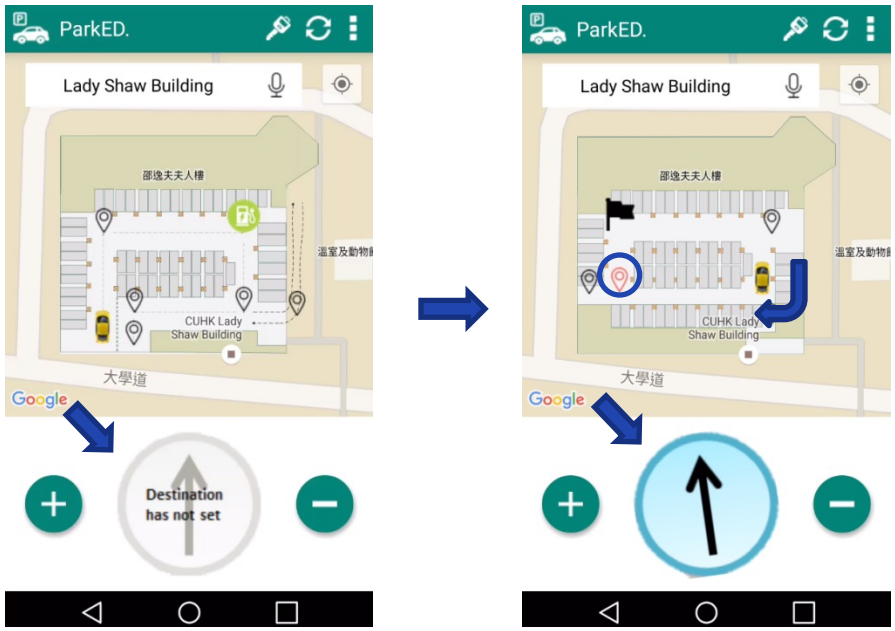
- By using Ranging to keep sensing beacons

# Implementation (APP)

## Guidance Pointer

- How its work?
- Always point to next beacon

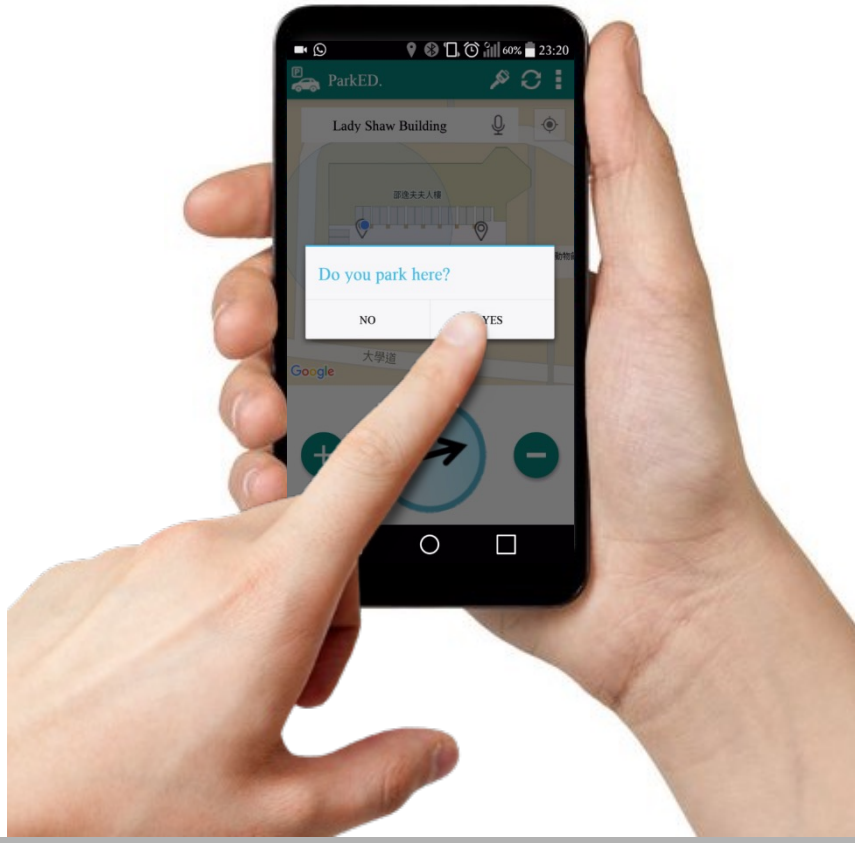


# Implementation (APP)

## Notification

- How its work?

1) Press “YES” Confirm parking



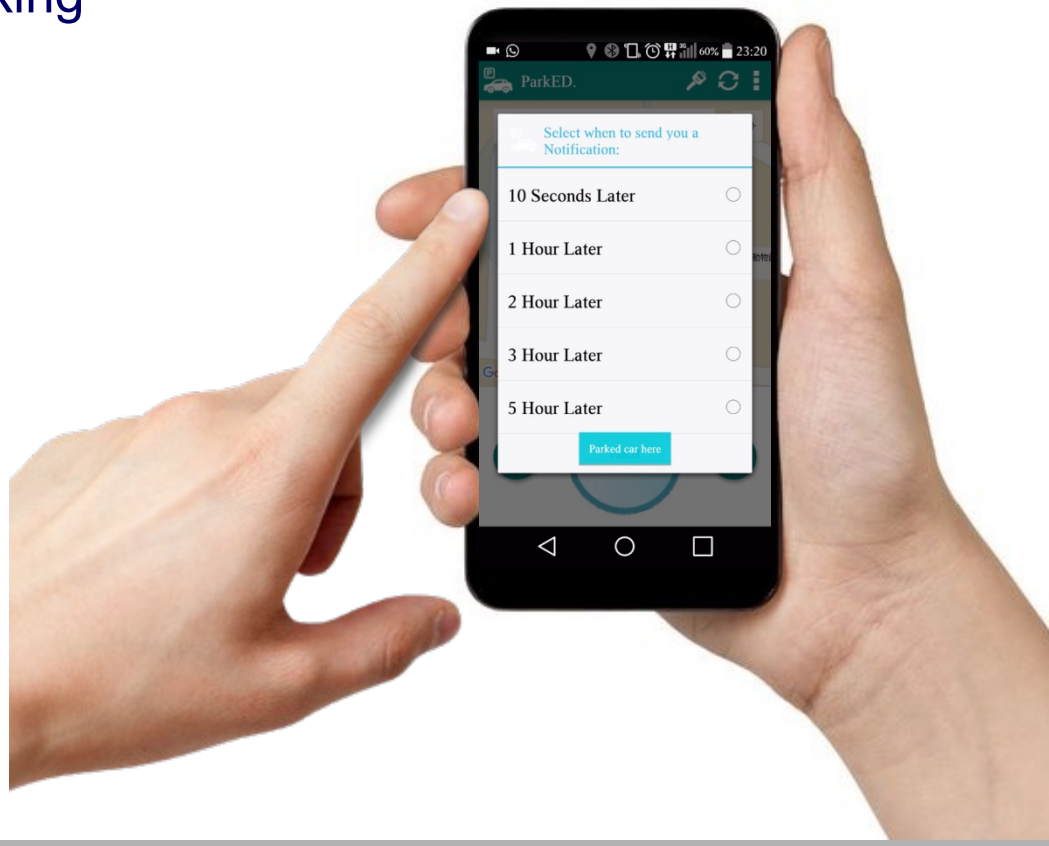
# Implementation (APP)

## Notification

- How its work?

1) Press “YES” Confirm parking

2) Choose the parking time
(E.G. 10 seconds)



# Implementation (APP)

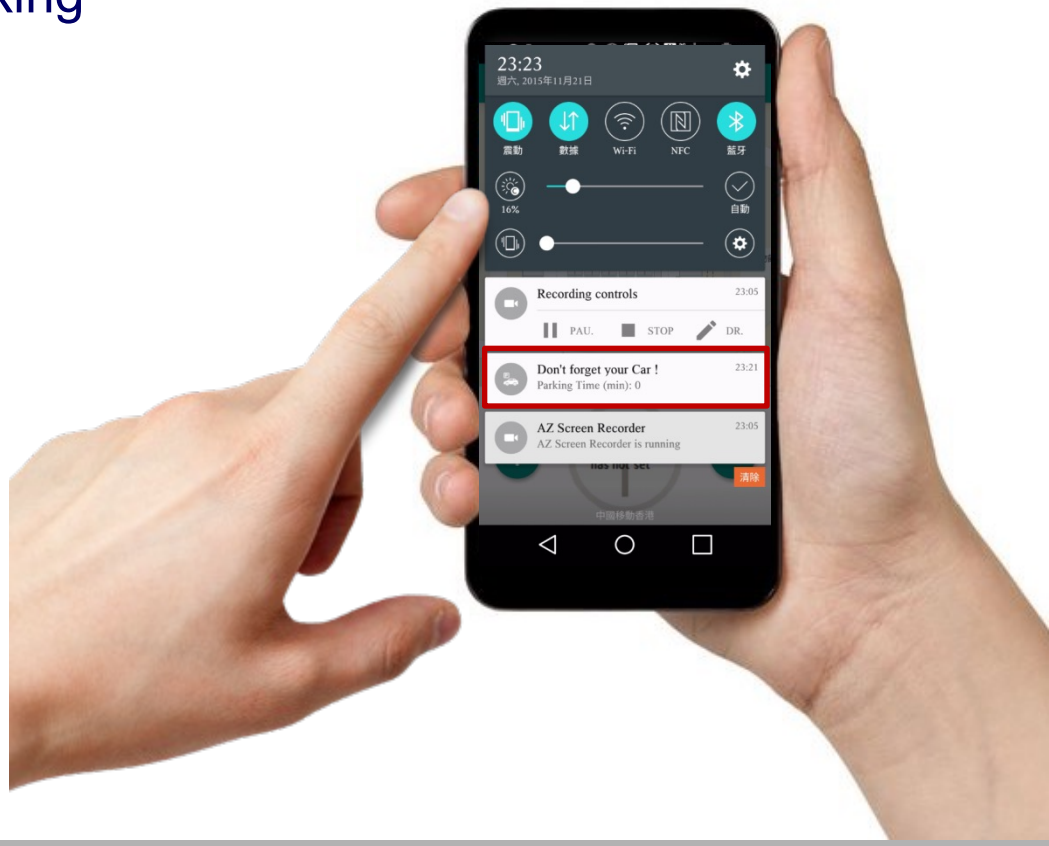
## Notification

- How its work?

1) Press “YES” Confirm parking

2) Choose the parking time (E.G. 10 seconds)

3) Notification will show up (After 10 seconds)



# Implementation (APP)

## Notification

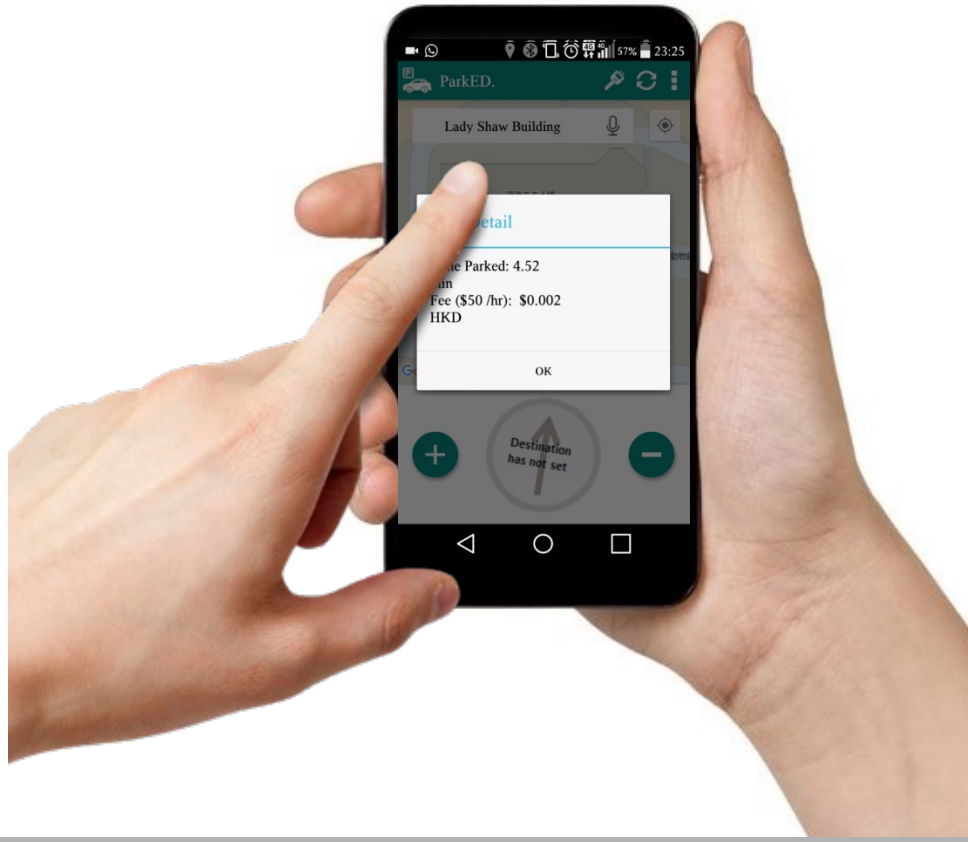
- How its work?

1) Press “YES” Confirm parking

2) Choose the parking time (E.G. 10 seconds)

3) Notification will show up (After 10 seconds)

4) After that you can get the car



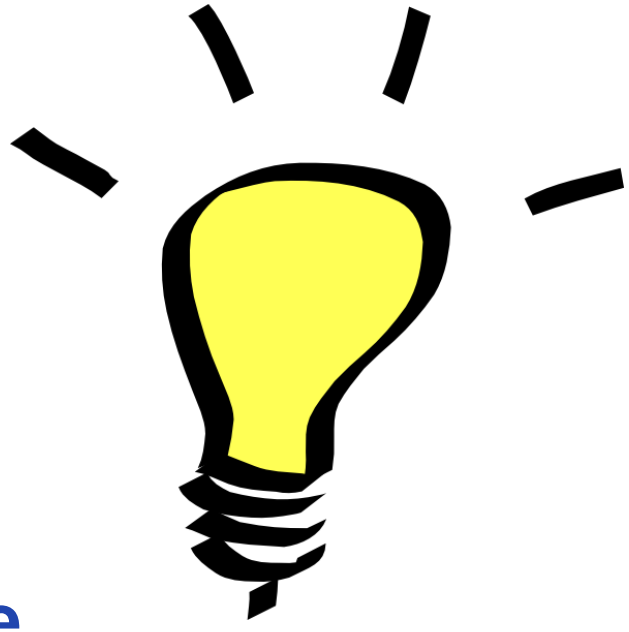
# Limitation & Future Goals

# Limitation

- Network
- Not enough beacons
- Don’t have permission to install beacon.
- Hard to test in real case
  (We cannot drive.)

# Next semester

- Dynamic Routing
  (dynamic route cost based on different situation)
- Data Analytic
- Graph Database Engine
- Prediction on user preference

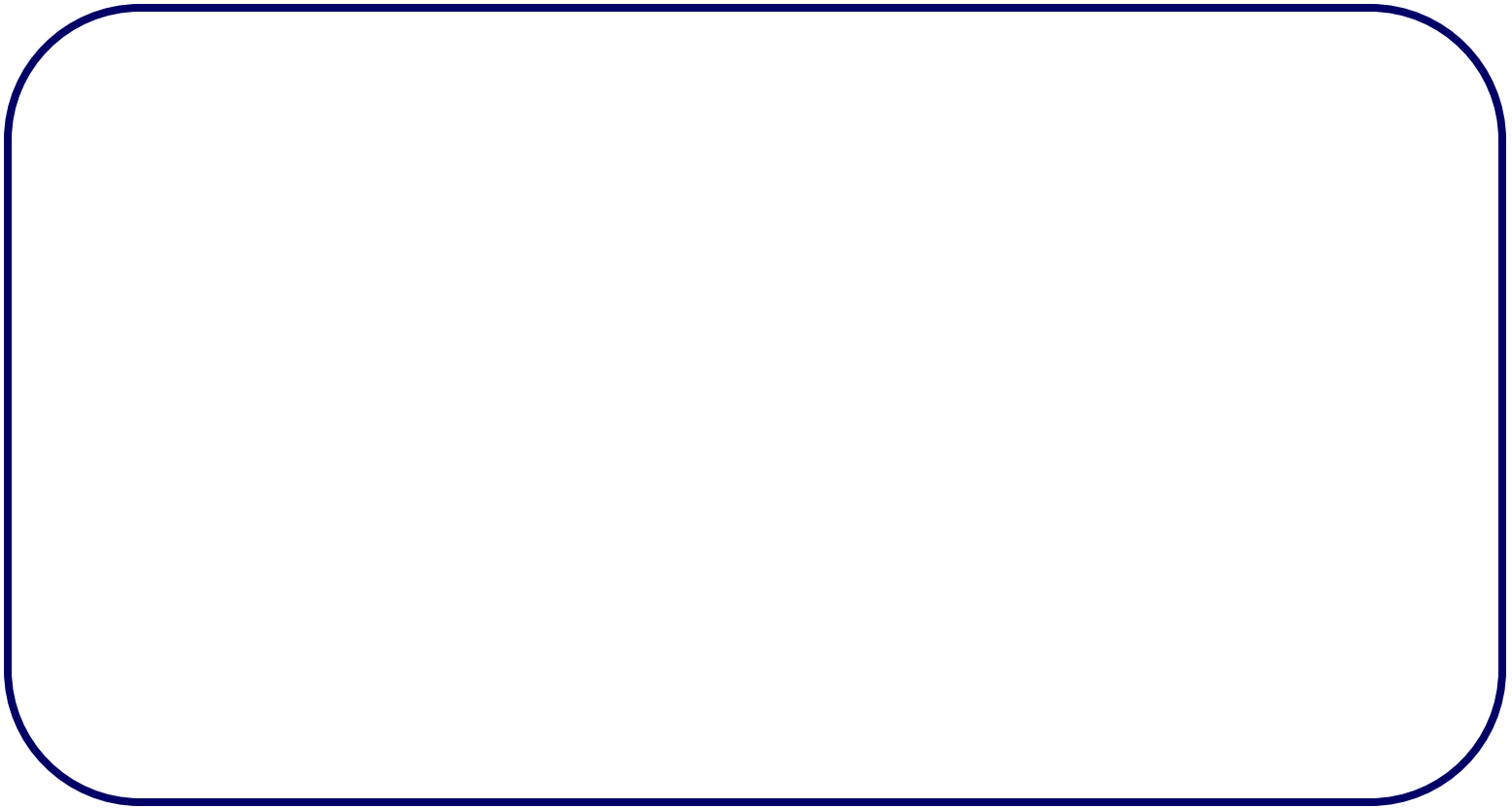


# System Demonstration

*“WHAT YOU DO, IS NOT WHAT YOU THINK”*
*EDWARD @ VIEWLAB, CUHK*

# Demo

- Video



# Q&A