


Development of a Wi-Fi-Fingerprinting for Position Determination by Mean of Probabilistic Methods

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### Overview

- Introduction
- Wi-Fi
- Occupancy Grid
- Results & Conclusion
- Outlook

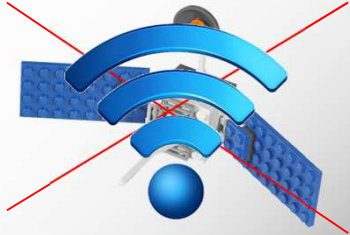



Sofia, Bulgaria

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## Introduction

- Today: easy & fast positioning
  - Use of LBS
  - Navigation
- Shielding inside buildings
- Alternatives to GNSS
  - Ultrasound
  - Infrared
  - Bluetooth
  - **Wi-Fi**





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## Wi-Fi

- Connection standard
- Range: 50 – 100 m
- Shielding inside buildings
  - Walls
  - Furniture
  - Human bodies



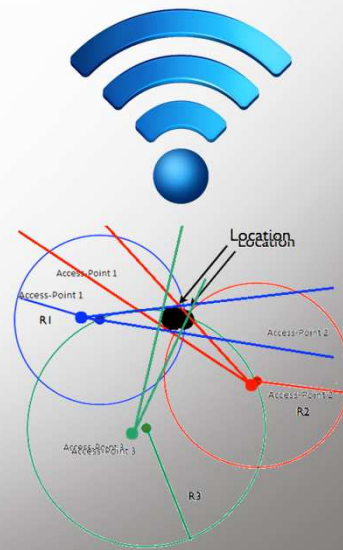
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## Wi-Fi

- Positioning methods

- 1) Angle Of Arrival (AOA)
- 2) Time Of Arrival (TOA)
- 3) Signal Strength
  - Received Signal Strength (RSS)
  - **Fingerprinting**

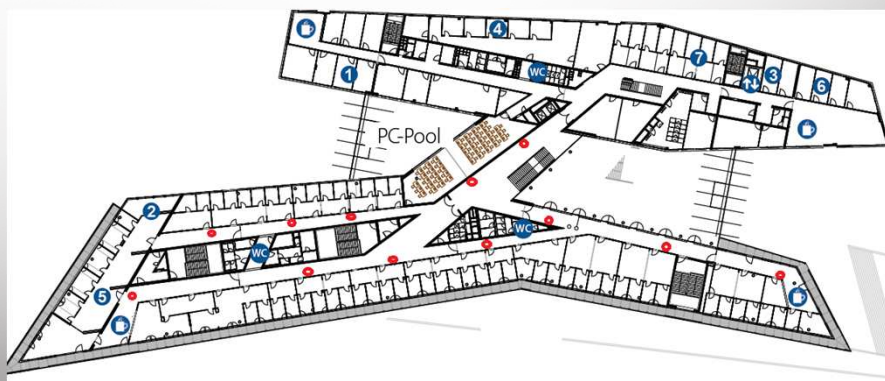


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## Wi-Fi



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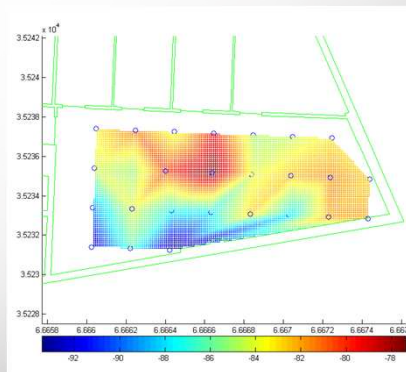
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# Wi-Fi

## Fingerprinting

- Phase I (Offline Phase)
  - Collection of RSS
  - Radio Map



Point	Easting [m]	Northing [m]	Mac1 [string]	RSS1 [dB]	Mac2 [string]	RSS2 [dB]
1	66673.37	35234.85	'00:1c:b3:af:39:cb'	-80.8	'0c:27:24:e0:fe:61'	-81.0
2	66674.29	35232.85	'00:1c:b3:af:39:cb'	-94.0	'0c:27:24:e1:00:70'	-99.0
3	66672.45	35236.92	'00:1c:b3:af:39:cb'	-79.8	'0c:27:24:e1:00:70'	-92.0

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# Wi-Fi



## Fingerprinting

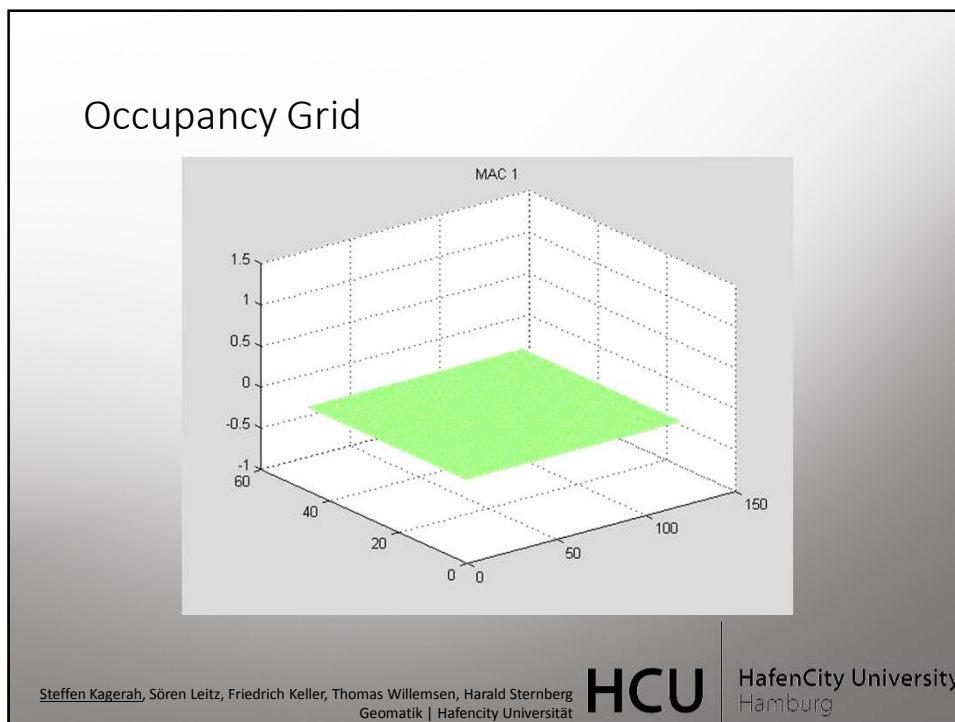
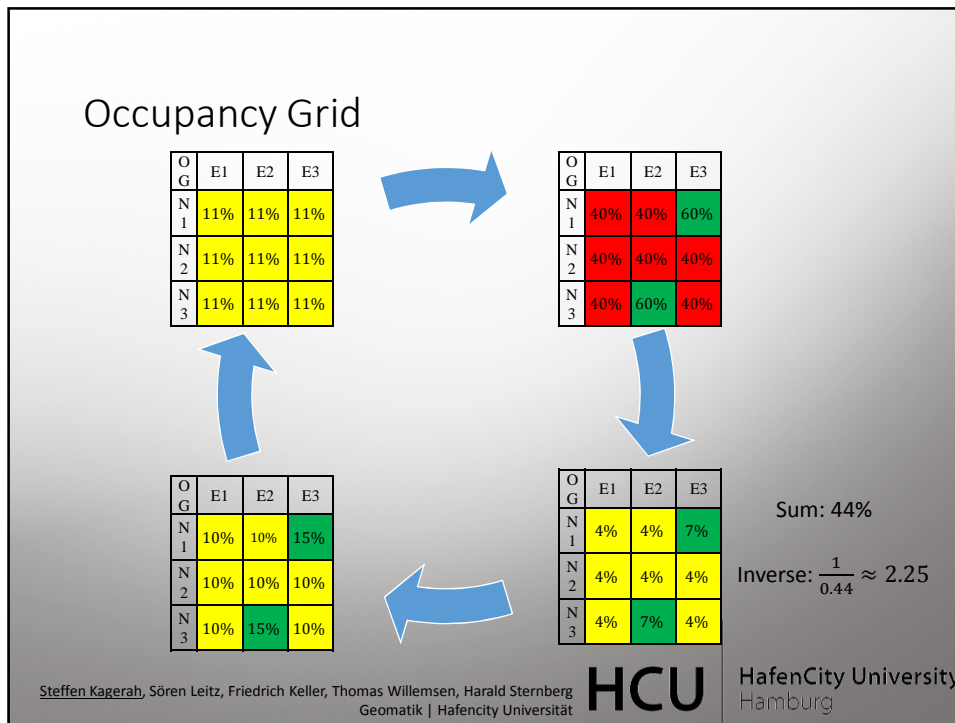
- Phase II (Online Phase)
  - Measuring the current RSS

Point	Easting [m]	Northing [m]	Mac1 [string]	RSS1 [dB]	Mac2 [string]	RSS2 [dB]
n	??????	??????	'00:1c:b3:af:39:cb'	-93.0	'0c:27:24:e1:00:70'	-97.0
1	66673.37	35234.85	'00:1c:b3:af:39:cb'	-80.8	'0c:27:24:e0:fe:61'	-81.0
2	66674.29	35232.85	'00:1c:b3:af:39:cb'	-94.0	'0c:27:24:e1:00:70'	-99.0
3	66672.45	35236.92	'00:1c:b3:af:39:cb'	-79.8	'0c:27:24:e1:00:70'	-92.0

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## Results & Conclusion

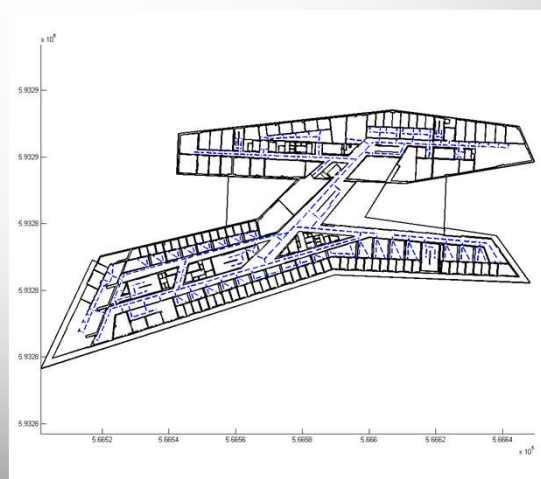
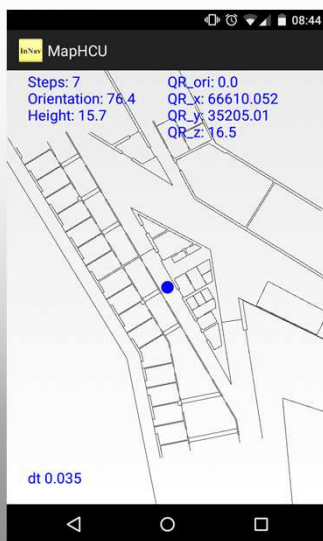
Point	Deviation to the target position with different positioning methods [m]			
	Nearest neighbor	Averaged	OG Cubic	OG Linear
1	5,9	5,9	1,8	1,6
2	5,8	4,5	5,8	1,5
3	8,2	8,7	6,0	3,0
4	5,9	3,9	1,4	1,4
5	1,0	0,7	3,4	4,2
6	3,2	3,6	1,2	1,8
7	2,8	4,8	1,4	1,4
8	1,0	0,3	77,5	1,0
9	3,4	1,7	18,4	0,9
10	1,8	6,1	13,9	8,8
11	8,7	6,1	7,5	2,3
12	2,9	3,1	2,8	3,6
13	1,1	1,1	33,5	1,3
14	8,4	6,2	32,1	2,5
15	2,6	6,0	4,0	2,0
16	1,6	1,1	1,3	0,5
17	1,0	10,5	17,7	6,3
18	5,5	5,0	16,4	1,7
19	14,3	16,1	48,9	5,9
20	4,4	2,6	0,4	0,4
avg	4,5	4,9	14,8	2,6
std	3,4	3,8	19,8	2,2

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## Outlook



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The top portion of the image is a photograph of a modern, multi-story building with a glass facade and white panels, situated along a waterfront. A large cruise ship is docked at a pier in the background. Below the photograph is a black bar with the email address [steffen.kagerah@hcu-hamburg.de](mailto:steffen.kagerah@hcu-hamburg.de).

The bottom portion of the image contains three technical visualizations:

- Heatmap:** A 2D heatmap showing spatial data distribution over a rectangular area. The color scale ranges from blue (low values) to red (high values). The axes are labeled with coordinates in meters (m).
- Floor Plan:** A green wireframe floor plan of the building shown in the photograph. It includes a legend with three entries: a blue square for 'WALLS', a blue line for 'DOORWAYS', and a blue circle for 'COLUMNS'. The axes are also labeled with coordinates in meters (m).
- Mobile App:** A screenshot of a mobile application interface titled 'MapHCU'. It displays a map with a blue location marker and a data table:

Ship	Orientation	Height	QR code
7	78.4	15.7	66610.052
			66610.052
			66610.052

At the bottom of the image, the text reads: **Steffen Kagerah, Sören Leitz, Friedrich Keller, Thomas Willemsen, Harald Sternberg** Geomatik | Hafencity Universität **HCU** Hafencity University Hamburg