IPIN 2015

International Conference on
Indoor Positioning and Indoor Navigation

EvAAL-ETRI

October 13-16, 2015
Banff, Alberta, Canada

2015 EvAAL-ETRI Indoor Localization Competition

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WHAT IS IPIN ?

Location information of devices in indoor environments has become a key issue for many emerging applications.

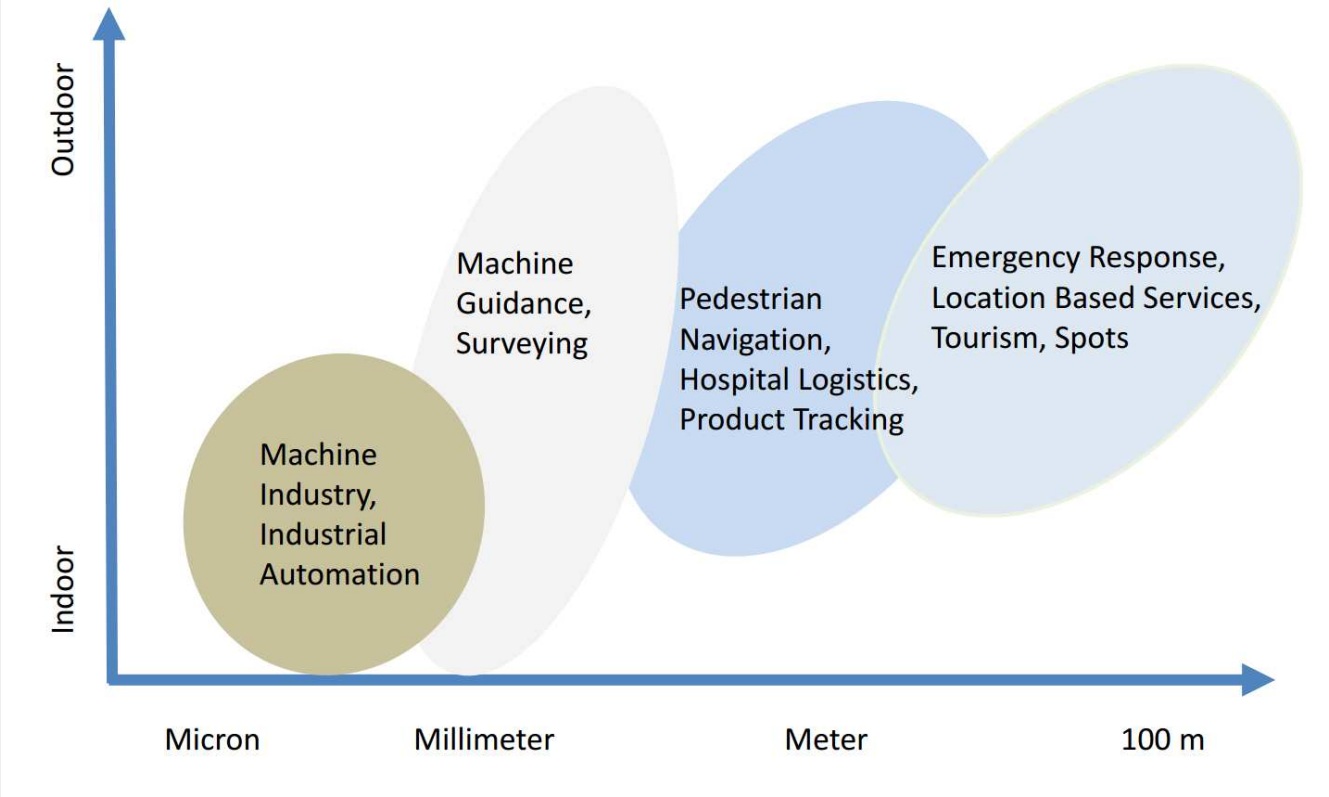
However, there is no overall and easy solution:

IPIN brings together experts in electronics, surveying and informatics.

Researchers, system providers and users contribute with papers, presentations, posters, demonstrations, exhibitions, competition and discussions to create synergies between indoor positioning techniques.

WHY DO WE NEED IPIN ?

- Outdoor positioning is covered by GPS -> GNSS
- Lack of standard solutions in “NON-GPS-AREAS”



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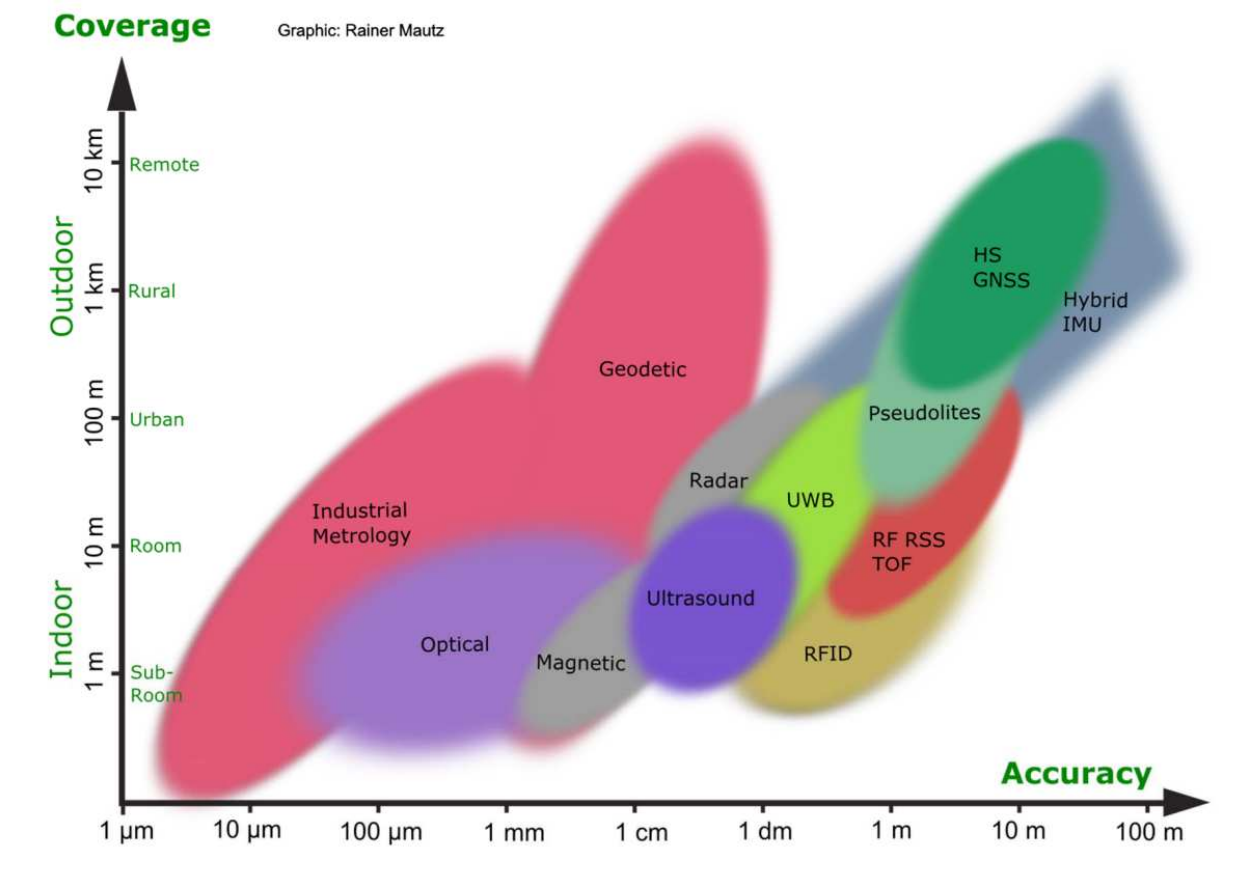
INDOOR POSITIONING

An open research issue...
- solved by means of ad hoc solutions

...extremely wide range of signaling technologies:
- types (infrared, ultrasound, UWB, RFID, packet radio)
- metrics (AOA, TOA, TDOA, RSS)
- processing (range-based and range free algorithms)

Each solution has advantages and shortcomings
- trade-off between metrics: accuracy, size, installation complexity, others

MATCHING APPLICATIONS TO POSITIONING TECHNIQUES



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THE NEED FOR BENCHMARKS

No standards exist yet for indoor navigation systems.

No generally accepted way of measuring performance.

Set of benchmark needed for

- focusing research
- allowing comparison of commercial solutions

Creating benchmarks and evaluation criteria is the aim of EvAAL, the competition for AAL systems that, has focused in the past four years on indoor localization systems.

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2010 – FIRST EDITION OF IPIN

The IPIN conference starts in **2010**, hosted by ETH Zurich and organised primarily by Reiner Mautz.

With **hundreds of participants**, both from academia and industry, it highlights a large and very active community.

IPIN immediately emerges as **the forum of excellence** to meet researchers, system developers and service providers working in indoor positioning and navigation worldwide.

2011 – EvAAL IS BORN

While IPIN is in its second year, this time in Guimarães, Portugal, EvAAL is born: Valencia (Spain) hosts its first edition.

- EvAAL is founded and financed by the **universAAL** European project (a universal platform for AAL)
- EvAAL aims in the **long term** at defining benchmarks for the evaluation of complete Ambient Assisted Living systems
- The **short-term goal** is to define benchmarks for AAL subsystems
- First competition: "**Indoor localization and Tracking**"

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2012 – 2013 EvAAL grows

The EU universAAl research project finances EvAAL
Two internationally recognised competitions:

- **indoor localization and tracking** (Madrid)
- **indoor activity recognition** (Valencia)

Academic and industrial competitors from all around the world gather in the two living labs in Spain and conclude with a workshop and award ceremony two months later at the **AAL Forum**. Proceeding are published by Springer.

All data are published on <http://evaal.aaloa.org> for everyone to review and study.

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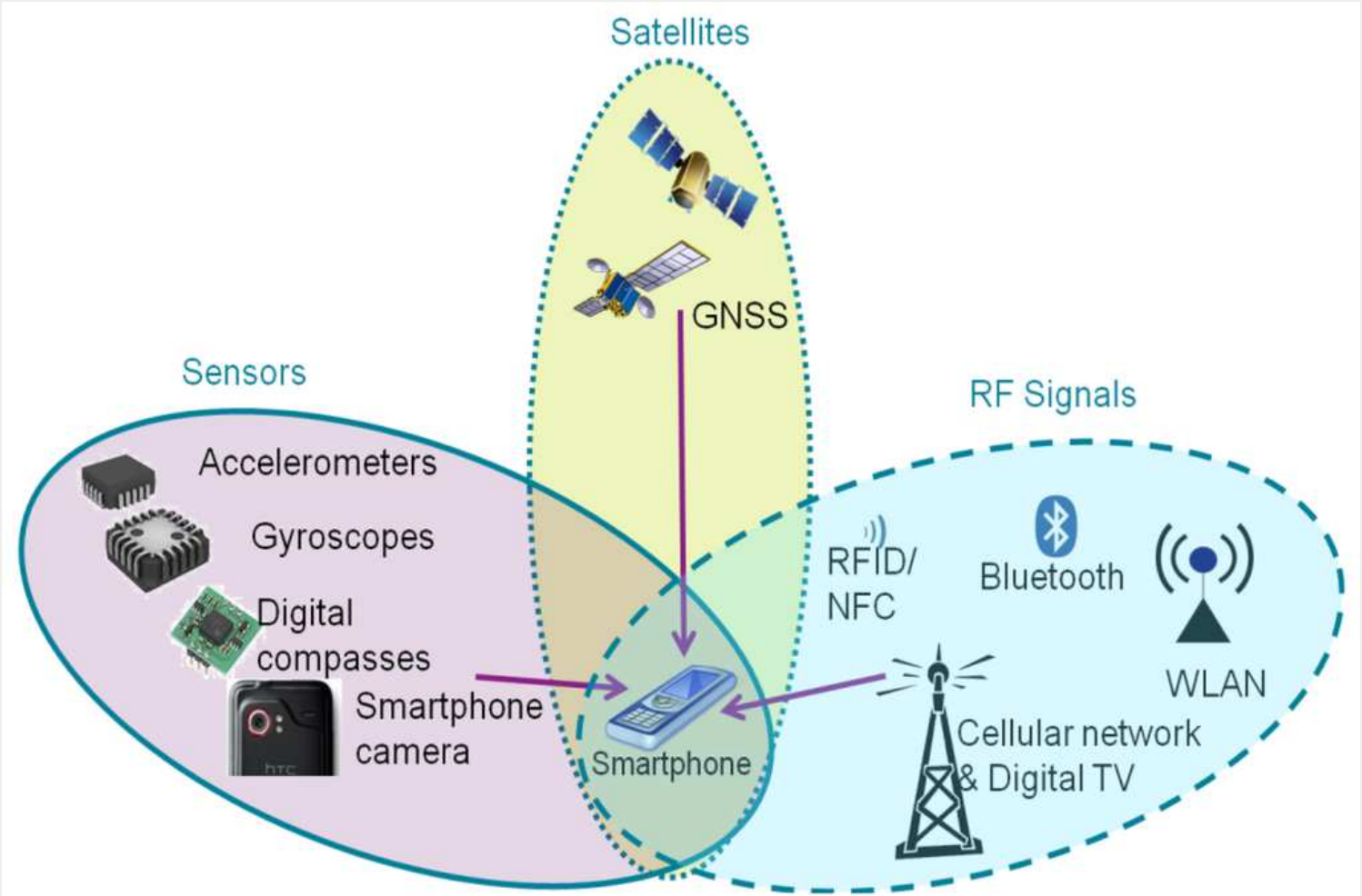
Competitions: IPIN and the others

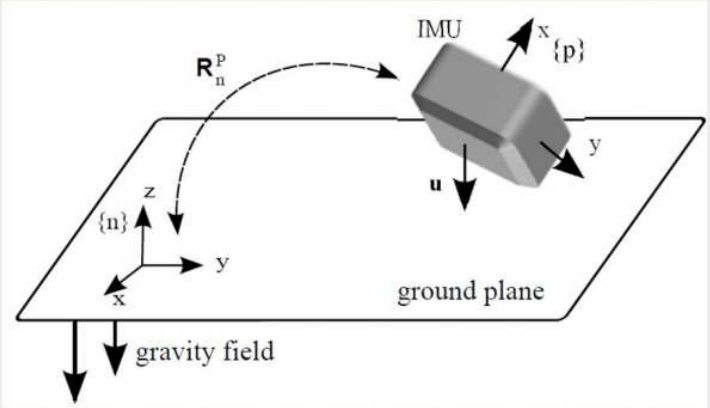
IPIN	year	EvAAL – IPSN
Zurich, Switzerland	2010	universAAL is launched
Guimarães, Portugal	2011	**EvAAL**: indoor localization
Sidney, Australia	2012	**EvAAL**: + activity recognition
Montbéliard, France	2013	**EvAAL**: same as 2012
Busan, Korea 1st **IPIN** competition	2014	**EvAAL**: 3 floors, smartphone **IPSN**: infrastruc. based + free
Banff, Canada **EvAAL-ETRI** comp.	2015	**EvAAL**: 6 floors, on/off-site **IPSN**: same as 2014

SMARTPHONE PLATFORMS



FOOT-MOUNTED PDR AID

Measuring Principle	dead reckoning
Accuracy	0.1 % - 10 % of distance
Coverage	building
Required Infrastructure	none – initial position & updates
Application	pedestrian navigation
Strengths	infrastructure free
Drawbacks	drift, position updates



Panahandeh et al. (2010)

Skog et al. (2010)

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THE LOCATION – BANFF CENTER

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ON-SITE TRACKS OVERVIEW

Track 1: Smartphone based positioning
Competitors can use any sensor available on the smartphones used. Only recently advances in research and smartphones have made it possible to have a reasonably working localization system on a smartphone.

Track 2: Foot-mounted Pedestrian Dead Reckoning
Devices should be mounted under the ankle: recent algorithmic advances make it possible to have an purely inertial working system.

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OFF-SITE TRACK OVERVIEW

Track 3: Wi-Fi fingerprinting in large environments
While Wi-Fi fingerprinting is the most mature of indoor localization techniques, it is still the object of intense research and is far from established. This track uses a huge database of fingerprinting measures and asks for offline identification of a given path.

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ON-SITE MEASUREMENT CRITERIA

An evaluator (the 'actor') starts moving while holding the competing smartphone (track 1), or wearing the foot-mounted device (track 2).

The actor walks at a natural pace along a loosely-defined reference path, equal for all competitors.

The path connects 60 indoor keypoints in **two three-level buildings** about 200m apart, plus 2 outdoor keypoints, for a length of about 300m indoors and more than 20 minutes walk for track 1. Track 2 only uses the first building (42 keypoints, three floors).

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A SERIOUS CHALLENGE

The first and by far the most challenging indoor localization competition out there.

Realistic setting in big multifloor buildings.

On-site: natural movement, no artificial pause at key points. long path, 300+ m indoor, 20+ min walking time, 50+ reference points, WGS84 coordinates for seamless integration with outdoor GPS localization.

Scientifically sound comparison criteria and setup.

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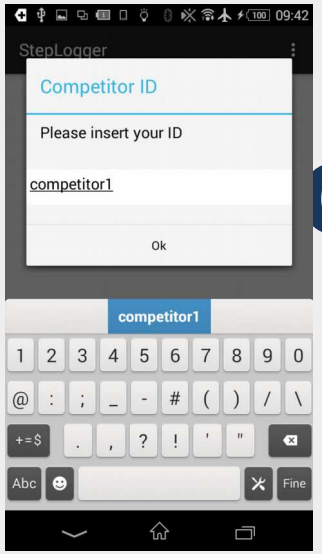
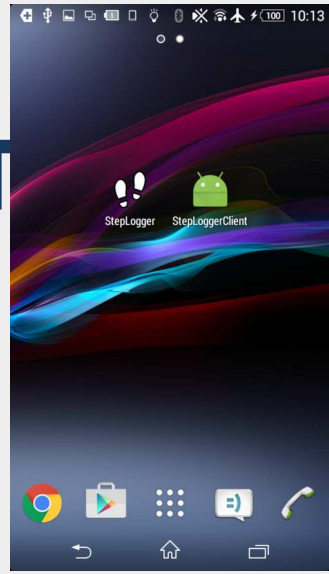
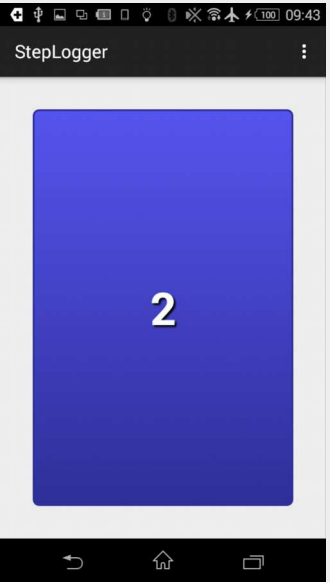


ON-SITE MEASUREMENT APPLICATION



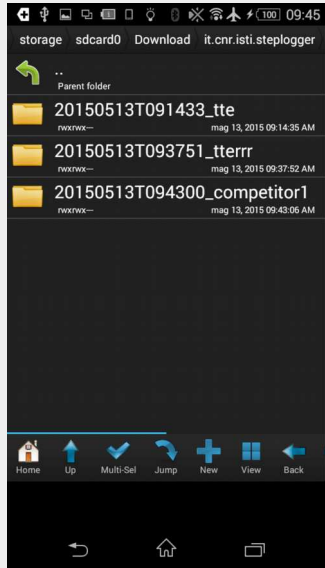
We provide an Android-based application called **StepLogger**, which

- logs the position computed by the competing application
- timestamps the screen taps the actor does when passing over a keypoint



To ease integration with the competing application, we provide a dummy competing app which

- generates fake positions
- calls the StepLogger log API



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ON-SITE EVALUATION

The localization error for each keypoint is the Euclidean distance between the competitor's estimate and the real position of a keypoint, plus a 15m wrong floor penalty.

The accuracy score is the **third quartile** of the localization errors at the keypoints.

Final scores for the winners are disclosed at the end of the competition.

Scores and logs are published on the EvAAL web site.

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OFF-SITE EVALUATION

Training set of 20000 points, 500+ Wi-Fi access points.

A private set of 5000+ samples is used .

The final score is the mean of the error, that is, the Euclidean distance from ground truth to estimate on the horizontal plance, plus a $penalty_b$ for wrong building plus a $penalty_f$ for wrong floor.

$Penalty_b$ = 50 m

$Penalty_f$ = 4m

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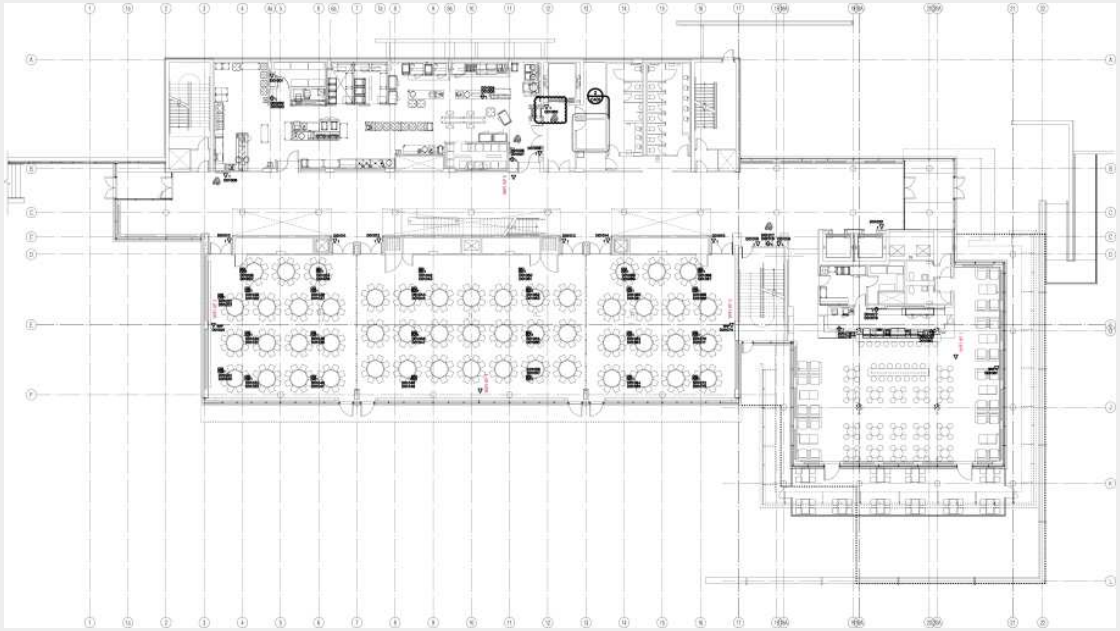
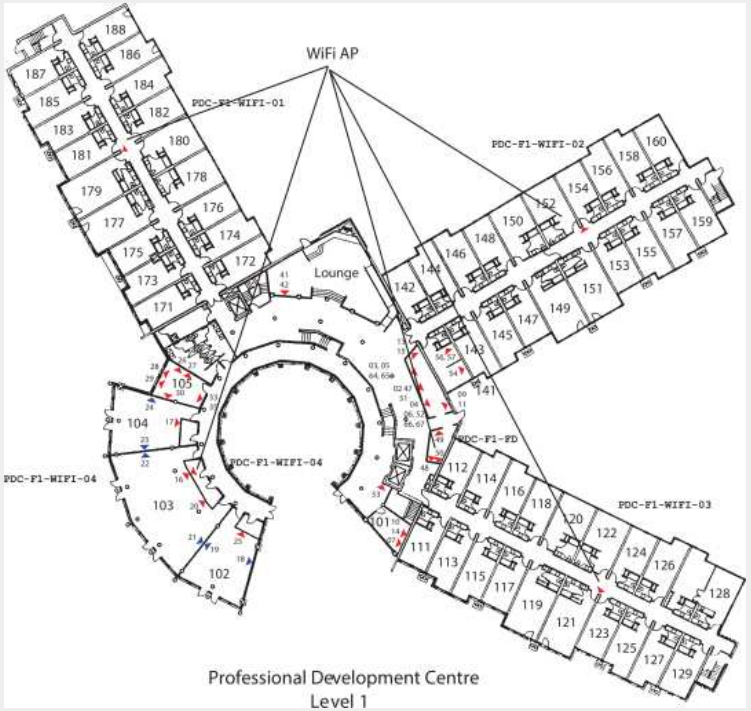
ON-SITE: BANFF AREA

KCCI building



PDC building



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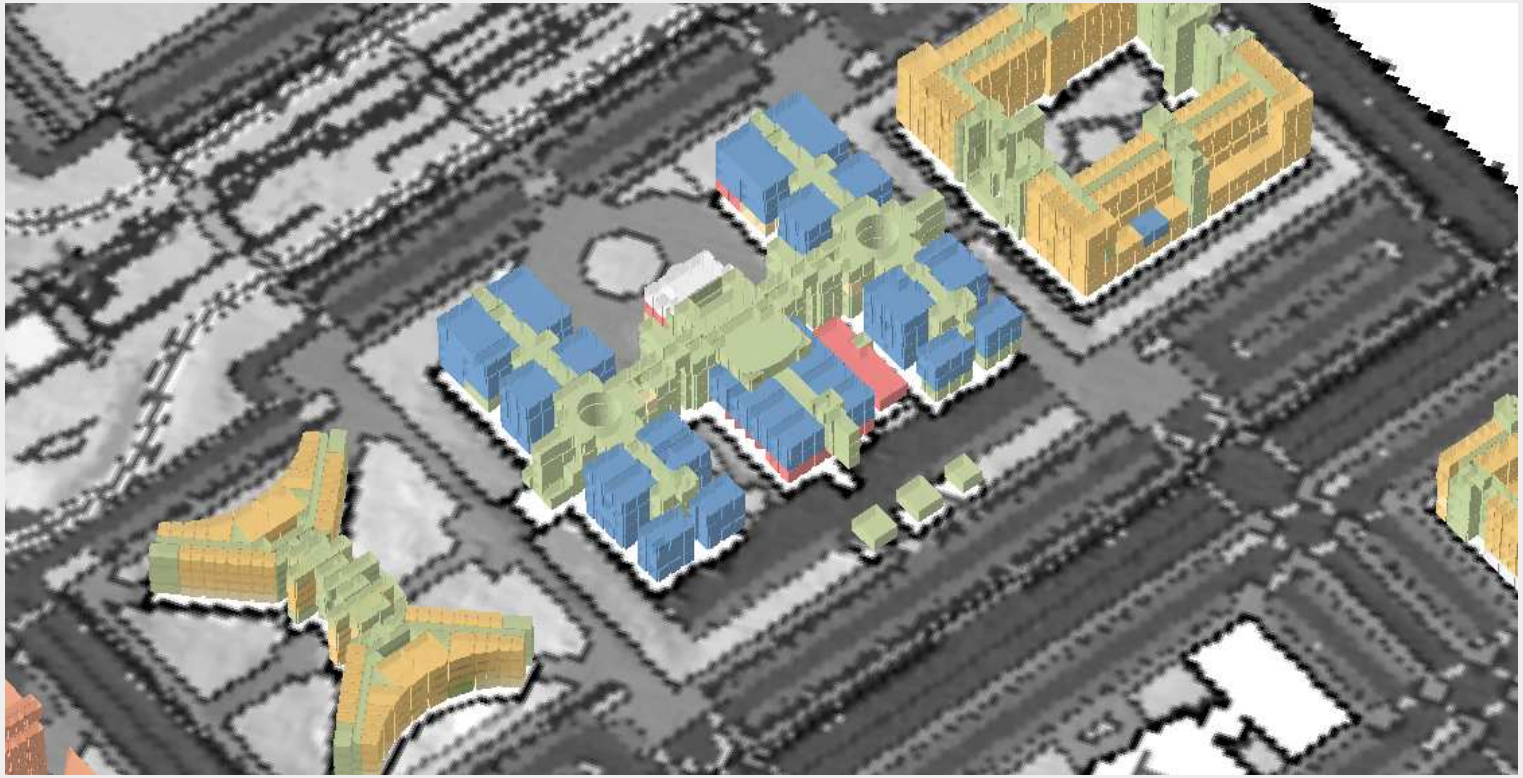
OFF-SITE: UJII AREA

http://smartways.init.uji.es/indoor



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SUBMISSIONS AND RESULTS

- 7 submissions for track 1 (smartphone based)
  - 2 have withdrawn the proposal
  - 1 last-minute withdrawal
  - 2 non-working systems
- 3 submissions for track 2 (foot-mounted)
  - 1 has withdrawn the proposal
  - 1 non-working system
- 4 submission for track 3 (off-site fingerprinting)

Results 2014 – single building

Competitor	System	3rd quartile of error
SPIRIT Navigation	Indoor navigator	6.7 m
Hanyang University	PDR/fingerprinting fusion	
HKU EEE	WiFi Positioning System (WPS)	
U. C. Berkeley	Berkeley Indoor Positioning (BIP)	
Hubilon	SmartInside	6.6 m
Navix Indoor Navigation	Navix	
KIOS	Airplace	
Off-track participant	**System**	**3rd q of err**
KAILOS	KAIST Indoor locating system	5.7 m
Franche Comté	CoLDE	
IPS-DLR	Integrated Positioning Sys. (IPS)	

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RESULTS 2015

	smartphone, two buildings	3rd quartile
Matteo Tomasi	Zetesis (IT)	
J.C. Aguilar Herrera	Navix Indoor Navigation (MX)	
You Li	MMSS U. Calgary / Wuhan (CA/CH)	6.6 m
Pawel Wilk	Samsung R&D (PL)	10.0 m
	foot-mounted, one building	
Hojin Ju	NESL U. Seoul (KR)	2.4 m
Rinara Woo	DATA Embedd. Sw Tech. Daegu (KR)	
	off-site wi-fi fingerprinting	
Adriano Moreira	RTSL@UM U. Minho (PT)	8.3 m
Stefan Knauth	HTFloc U. Stuttgart (DE)	11.6 m
Rafael Berkvens	MOSAIC U. Antwerp (BE)	12.1 m
H. Jin Kim	ICSL U. Seoul (KR)	10.9 m