

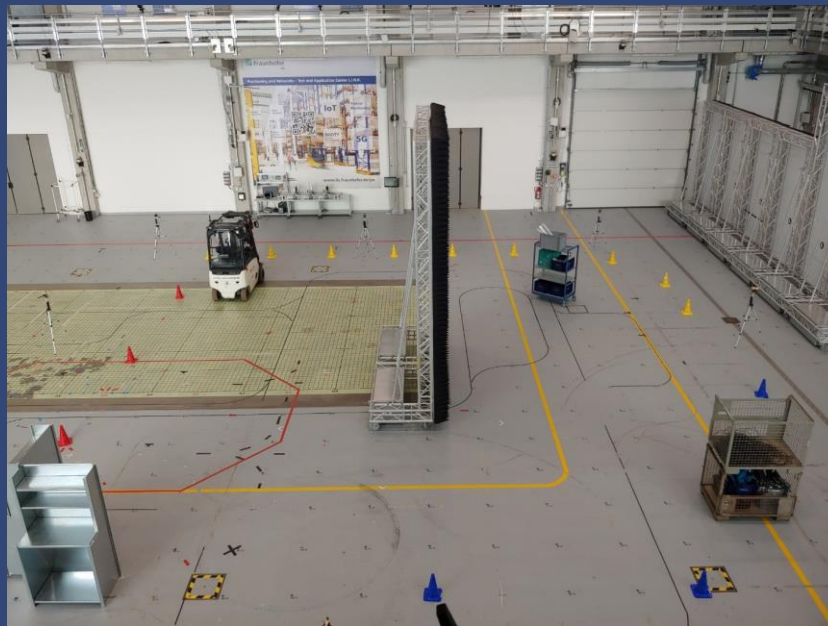


IPIN 2021
ELEVENTH INTERNATIONAL CONFERENCE ON
**INDOOR POSITIONING
AND INDOOR NAVIGATION**
29 Nov. – 2 Dec. 2021, Lloret de Mar, Spain

Track 7

Channel impulse responses

Sebastian Kram, Maximilian Stahlke, Christopher Mutschler

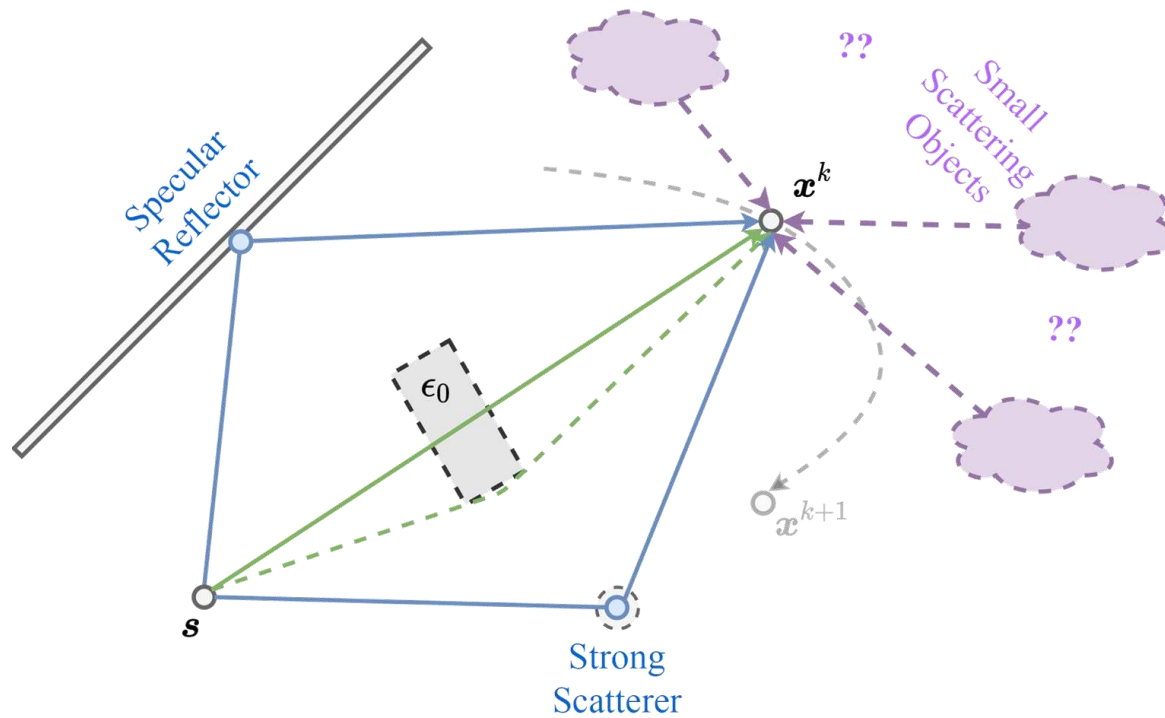


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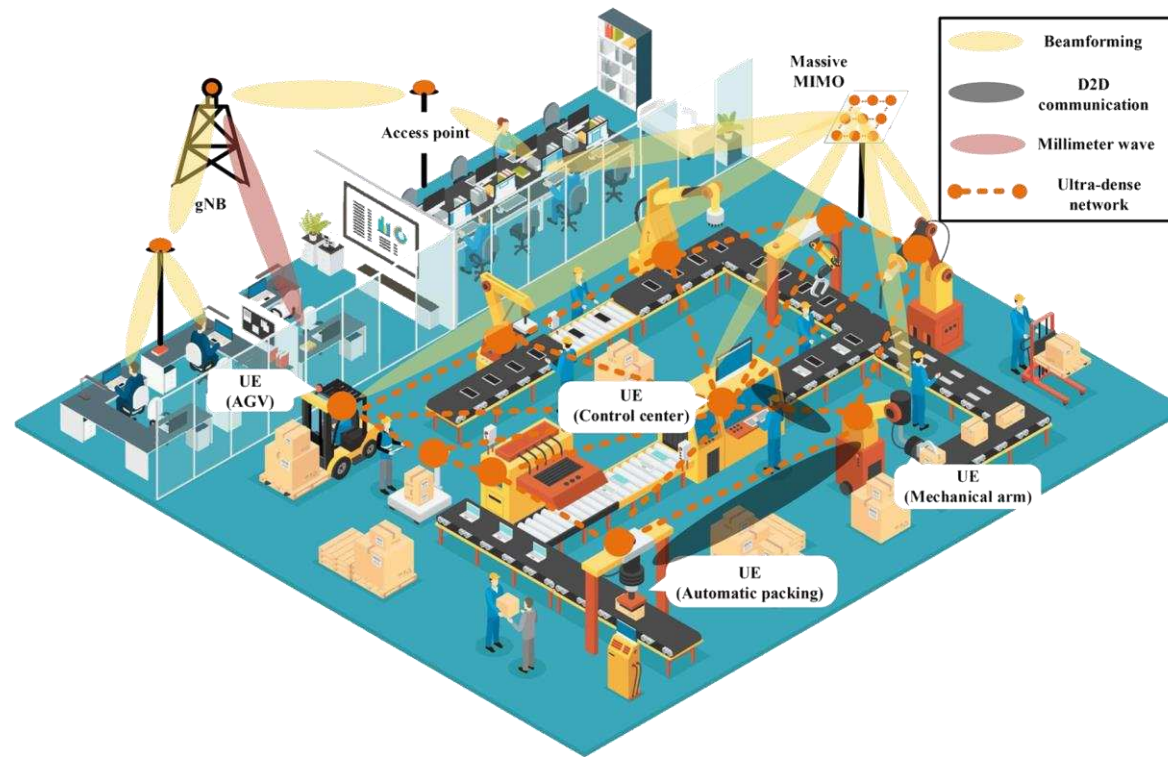
Background



Spatial information in wideband RF propagation



Background



Signal Propagation in a connected IoT environment

Competition Setup

Hardware Platform

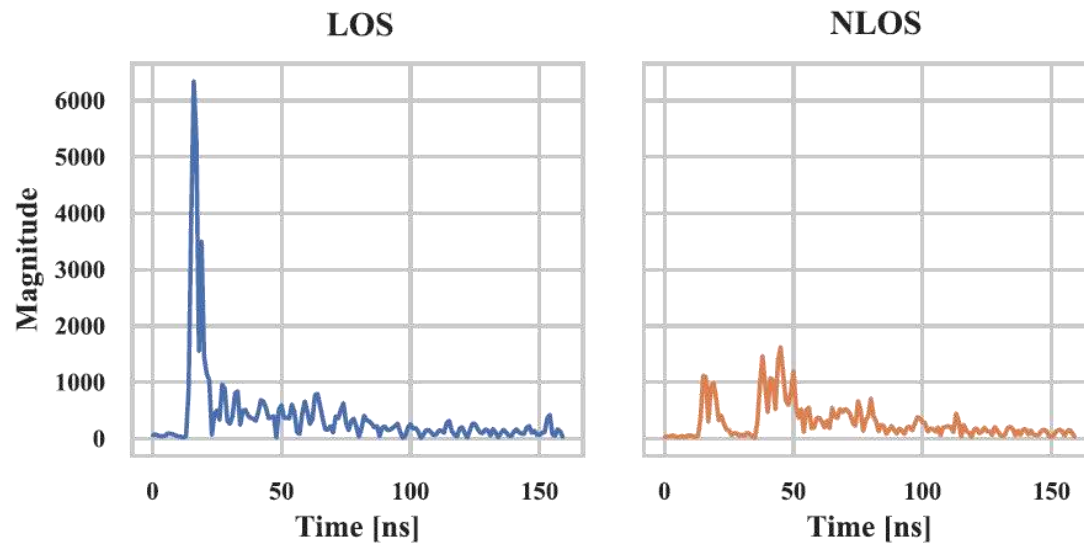
8 WiSmt Sensor Platforms: 6 fixed
infrastructure receivers,
1 mobile transmitter,
UWB Module Decawave 1000
 BW 500 MHz
 Center Frequencies 3.5 – 6.5 GHz
Omnidirectional Antenna

Reference System

Qualysis optical tracking system
Accuracy ~1-5mm



UWB Channel Measurements



Example channel measurements

Available Data

- Anchor IDs
- Real/Imag Channel Measurements
- Corresponding propagation time indices (\sim ns)
- Recording time (global time \sim s)
- Anchor positions

Example Methods

- **Fingerprinting:** e.g. DNN regression [3]
- **TOF error mitigation:** e.g. SVM or DNN-based NLOS classification / LOS error regression [4,5], Lateration based tracking
- **Channel SLAM:** Multipath component extraction, probabilistic data association [6,7]

[3] Niitsoo, A. et al., "Convolutional Neural Networks for Position Estimation in TDoA-Based Locating Systems", 9th Intl. Conf. Indoor Positioning and Indoor Navigation, 2018

[4] H. Wymeersch et al., "A Machine Learning Approach to Ranging Error Mitigation for UWB Localization," in IEEE Transactions on Communications, June 2012.

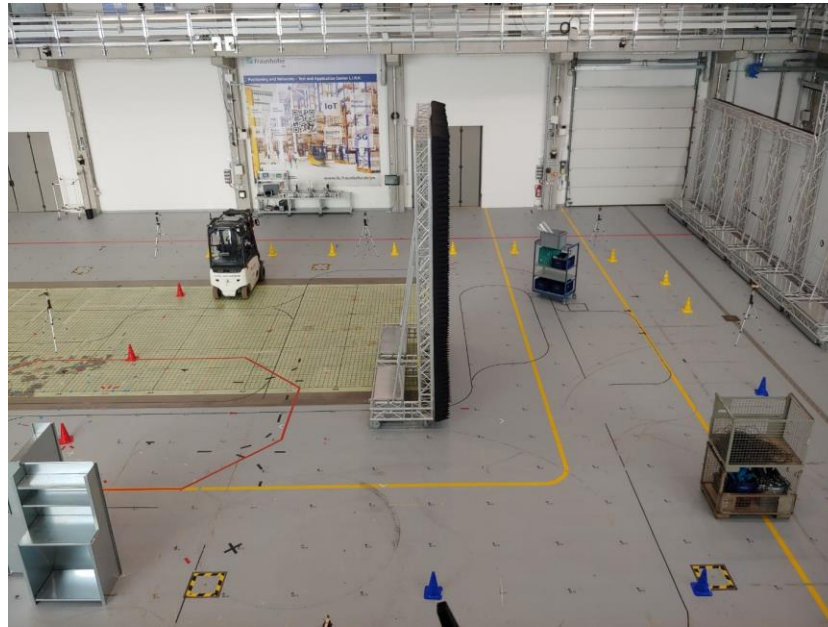
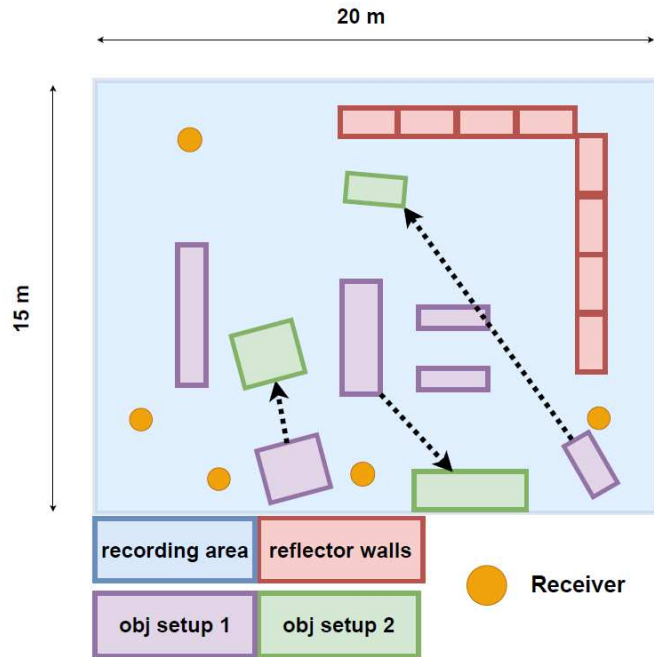
[5] M. Stahlke et. al, "NLOS Detection using UWB Channel Impulse Responses and Convolutional Neural Networks," International Conference on Localization and GNSS (ICL-GNSS), Tampere, Finland, 2020

[6] E. Leitingner et al., "A Belief Propagation Algorithm for Multipath-Based SLAM." IEEE Transactions on Wireless Communications, 2019

[7] C. Gentner et al., "Multipath Assisted Positioning with Simultaneous Localization and Mapping," in IEEE Transactions on Wireless Communications, 2016



Competition Setup



Environment changes (T1/T2)

Competing Teams

Team Name	Affiliation	Country	Participants	AE75 (test 1) in m	AE75 (test 2) in m	AE75 (av.) in m
CUMT	China University of Mining and Technology	China	Kuiyuan Zhang, Tieyang Zhang, and Pengpeng Chen			
IDLab	Ghent University –Internet technology and data science lab	Belgium	Ben Van Herbruggen, Jaron Fontaine			
ISCAS	Institute of Software, Chinese Academy of Science	China	Fusang Zhang, Chang Su, Junqi Ma, Zhi Wang, Zhaoxin Chang			
YAI	Yuan Ze University, National Ilan University	Taiwan	Chia-An Yu, ShihHau Fang, NienTing Lee, YingRen Chien			
SPSC	Technical University Graz	Austria	Alexander Venus, Erik Leitinger, Klaus Witrissal			
UT_PS	Twente University	Netherlands	Nguyen Minh Son, Le Viet Duc, Paul Havinga			
Waves	Ghent University – Waves research group	Belgium	Sander Coene, Chenglong Li			

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CUMT	China University of Mining and Technology	China	Kuiyuan Zhang, Tieyang Zhang, and Pengpeng Chen			
IDLab	Ghent University –Internet technology and data science lab	Belgium	Ben Van Herbruggen, Jaron Fontaine	0.1734		
ISCAS	Institute of Software, Chinese Academy of Science	China	Fusang Zhang, Chang Su, Junqi Ma, Zhi Wang, Zhaoxin Chang			
YAI	Yuan Ze University, National Ilan University	Taiwan	Chia-An Yu, ShihHau Fang, NienTing Lee, YingRen Chien	0.7573		
SPSC	Technical University Graz	Austria	Alexander Venus, Erik Leitinger, Klaus Witrisal	0.1592		
UT_PS	Twente University	Netherlands	Nguyen Minh Son, Le Viet Duc, Paul Havinga	0.4032		
Waves	Ghent University – Waves research group	Belgium	Sander Coene, Chenglong Li			

Competing Teams

Team Name	Affiliation	Country	Participants	AE75 (test 1) in m	AE75 (test 2) in m	AE75 (av.) in m
CUMT	China University of Mining and Technology	China	Kuiyuan Zhang, Tieyang Zhang, and Pengpeng Chen	0.1531		
IDLab	Ghent University –Internet technology and data science lab	Belgium	Ben Van Herbruggen, Jaron Fontaine	0.1734		
ISCAS	Institute of Software, Chinese Academy of Science	China	Fusang Zhang, Chang Su, Junqi Ma, Zhi Wang, Zhaoxin Chang	0.0879		
YAI	Yuan Ze University, National Ilan University	Taiwan	Chia-An Yu, ShihHau Fang, NienTing Lee, YingRen Chien	0.7573		
SPSC	Technical University Graz	Austria	Alexander Venus, Erik Leitinger, Klaus Witrisal	0.1592		
UT_PS	Twente University	Netherlands	Nguyen Minh Son, Le Viet Duc, Paul Havinga	0.4032		
Waves	Ghent University – Waves research group	Belgium	Sander Coene, Chenglong Li	<u>0.0723</u>		

Competing Teams

Team Name	Affiliation	Country	Participants	AE75 (test 1) in m	AE75 (test 2) in m	AE75 (av.) in m
CUMT	China University of Mining and Technology	China	Kuiyuan Zhang, Tieyang Zhang, and Pengpeng Chen	0.1531	0.1754	
IDLab	Ghent University –Internet technology and data science lab	Belgium	Ben Van Herbruggen, Jaron Fontaine	0.1734	1.073	
ISCAS	Institute of Software, Chinese Academy of Science	China	Fusang Zhang, Chang Su, Junqi Ma, Zhi Wang, Zhaoxin Chang	0.0879		
YAI	Yuan Ze University, National Ilan University	Taiwan	Chia-An Yu, ShihHau Fang, NienTing Lee, YingRen Chien	0.7573	2.650	
SPSC	Technical University Graz	Austria	Alexander Venus, Erik Leitinger, Klaus Witrisal	0.1592		
UT_PS	Twente University	Netherlands	Nguyen Minh Son, Le Viet Duc, Paul Havinga	0.4032	0.979	
Waves	Ghent University – Waves research group	Belgium	Sander Coene, Chenglong Li	<u>0.0723</u>		

Competing Teams

Team Name		Affiliation	Country	Participants	AE75 (test 1) in m	AE75 (test 2) in m	AE75 (av.) in m	
CUMT	?	China University of Mining and Technology	China	Kuiyuan Zhang, Tieyang Zhang, and Pengpeng Chen	0.1531	0.1754	0.1643	
IDLab	F	Ghent University –Internet technology and data science lab	Belgium	Ben Van Herbruggen, Jaron Fontaine	0.1734	1.073	0.6236	
ISCAS	T	Institute of Software, Chinese Academy of Science	China	Fusang Zhang, Chang Su, Junqi Ma, Zhi Wang, Zhaoxin Chang	0.0879	<u>0.0912</u>	<u>0.0896</u>	1
YAI	F	Yuan Ze University, National Ilan University	Taiwan	Chia-An Yu, ShihHau Fang, NienTing Lee, YingRen Chien	0.7573	2.650	1.704	
SPSC	C	Technical University Graz	Austria	Alexander Venus, Erik Leitinger, Klaus Witrisal	0.1592	0.1597	0.1594	3
UT_PS	?	Twente University	Netherlands	Nguyen Minh Son, Le Viet Duc, Paul Havinga	0.4032	0.979	0.6914	
Waves	T	Ghent University – Waves research group	Belgium	Sander Coene, Chenglong Li	<u>0.0723</u>	0.1059	<u>0.0891</u>	1

Thank you very much for competing!

Feel free to contact us for additional datasets, feedback and cooperation
sebastian.kram@iis.fraunhofer.de

