Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Channel Characteristics Study for Future Indoor Millimeter And Submillimeter Wireless Communications

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Source: Bile Peng, Sebastian Rey, Thomas Kürner Company TU Braunschweig
Address Schleinitzstr. 22, D-38092 Braunschweig, Germany
Voice:+495313912416, FAX: +495313915192, E-Mail: peng@ifn.ing.tu-bs.de

Re: n/a

Abstract: This paper presents a preliminary study of channel characteristics in the frequency ranges of 75 - 110 GHz and 270 - 320 GHz. We select a small office as a typical application scenario and carried out extensive measurements with the Vector Network Analyzer (VNA) and frequency extension units in the room. A ray tracing simulator is applied for reproduction of the measurement results and a good match in spatial distribution of prop-agation paths between measurement and simulation is achieved.

Purpose: Information of IEEE 802.15 IG THz

Channel Characteristics Study for Future Indoor Millimeter And Submillimeter Wireless Communications

Bile Peng, Sebastian Rey, Thomas Kürner
TU Braunschweig

The results presented in this contribution are based on [1]

Outline

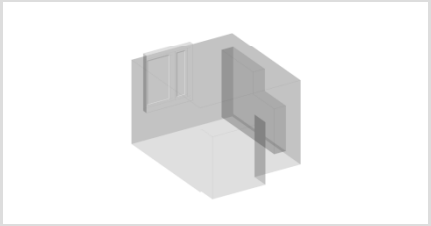
- **Motivation**
- Channel Measurement with VNA
- Channel Simulation with Ray Tracing Simulator
- Conclusion

Motivation

- The millimeter and sub-millimeter wave communication is a competitive solution to the future multi-Gigabit short range data transmission in femto cell environments
  - Carrier frequencies of 100 GHz and 300 GHz
  - Bandwidths of several GHz
  - Data rates of several tens of Gbit/s
- Technology for this application at 90 GHz and 300 GHz is being developed within the European H2020-IBROW-Projekt [2]
- The channel characteristics are crucial for the system development.
  - Extremely high free space path loss
  - Different reflection and diffraction characteristics
  - Specular spatial distribution of propagation paths
- This study aims at providing some channel knowledge and comparison of target frequencies via measurement with Vector Network Analyzer (VNA).

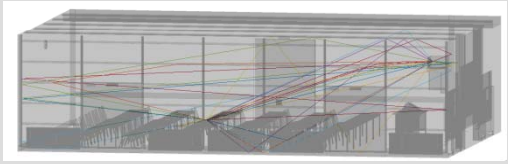
iBROW Referene Scenarios for Measurements and Simulations

Small Office



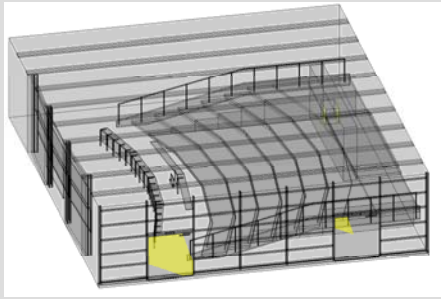
Length	4.52 m
Width	3.59 m
Height	2.60 m

Lecture Hall



Length	13.95 m
Width	9.69 m
Height	3.26 m

Auditorium



Length	13.95 m
Width	16.43 m
Height	3.68 m

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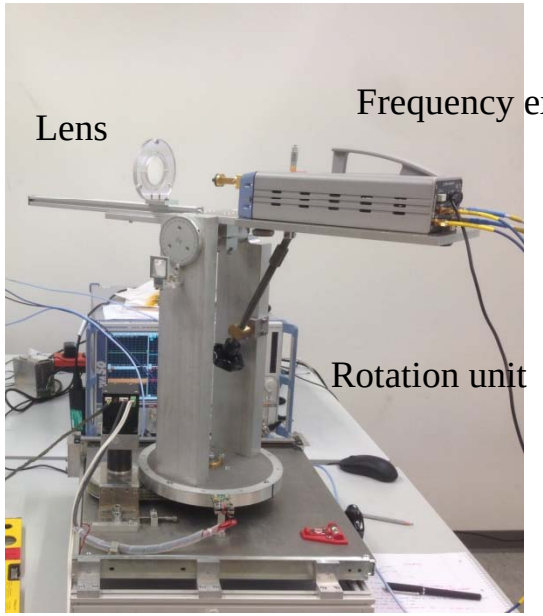
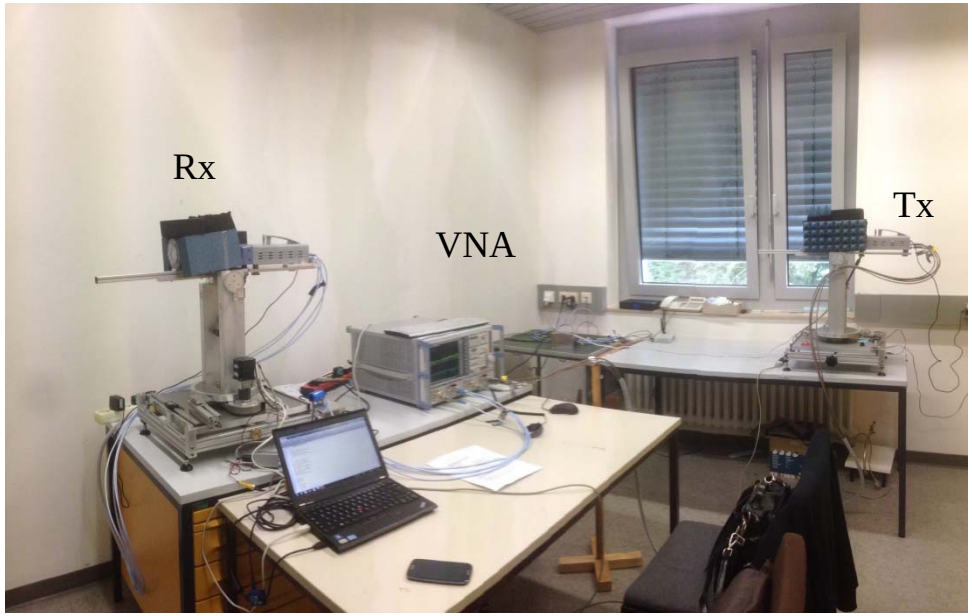
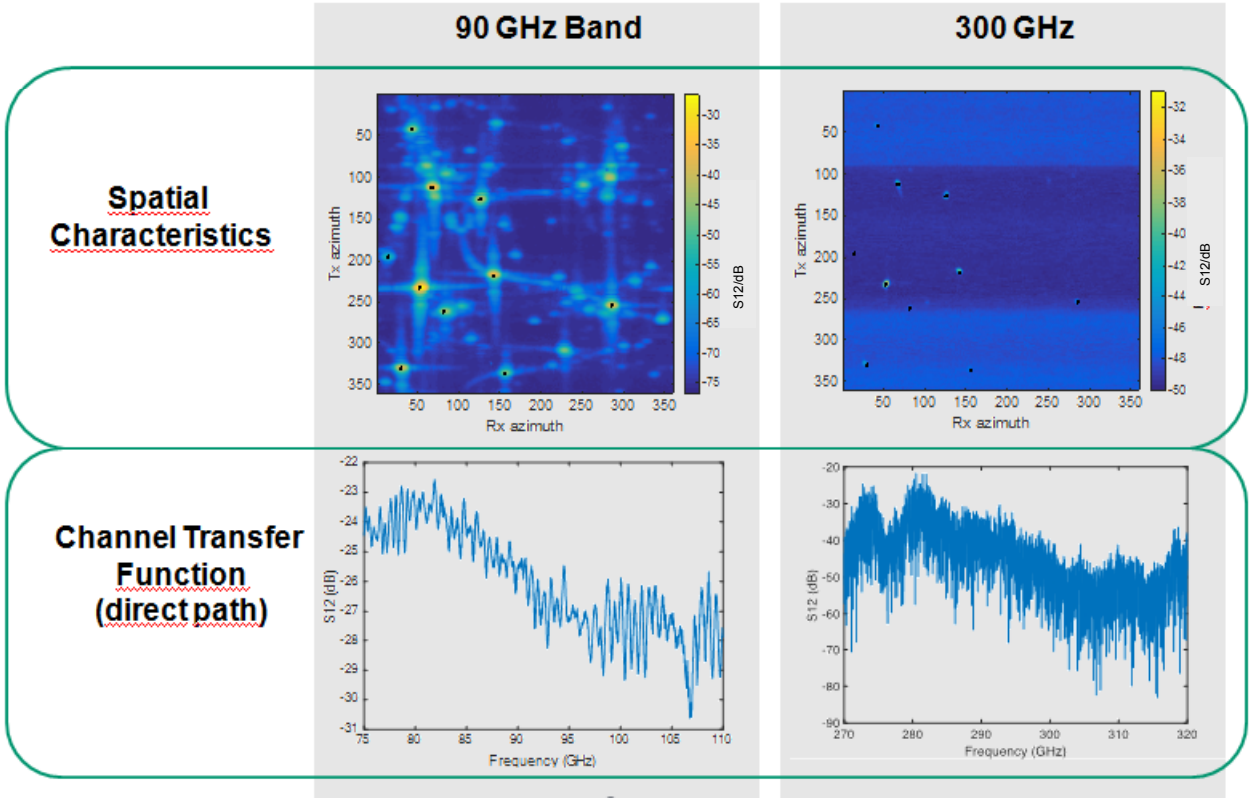
Measurement Setup

- Rohde & Schwarz ZVA-50 vector network analyzer
- Rohde & Schwarz ZVA-Z110, ZVA-Z325 frequency extensions
- Horn antenna
- PE lens → Half-Power beam with of 3° (for 100 GHz) and 2° (for 300 GHz)
- Frequency range: 75 GHz – 110 GHz and 270 GHz – 320 GHz
- Two rotation units enables measurement of all combinations of Tx and Rx azimuth.





Measurement Results



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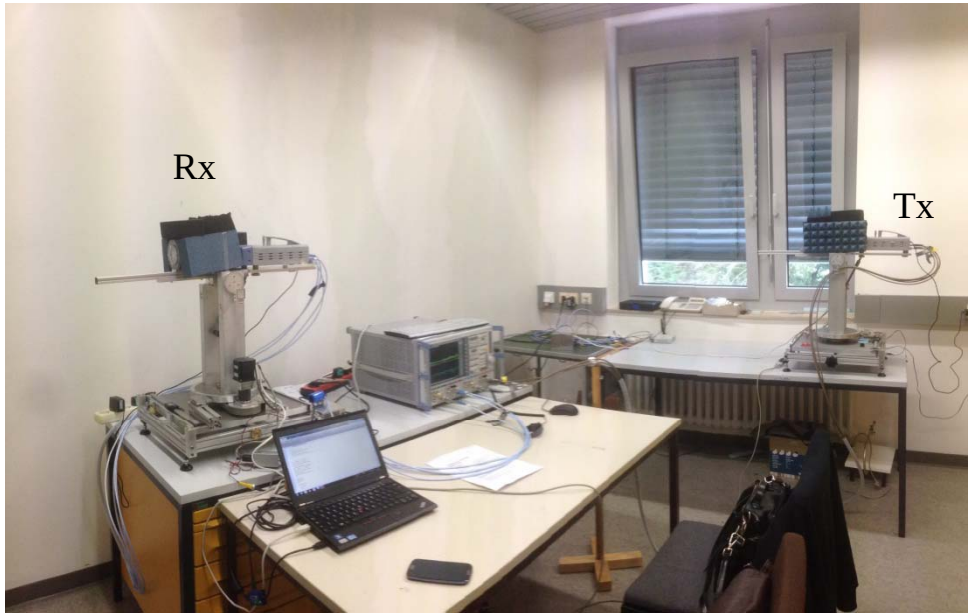
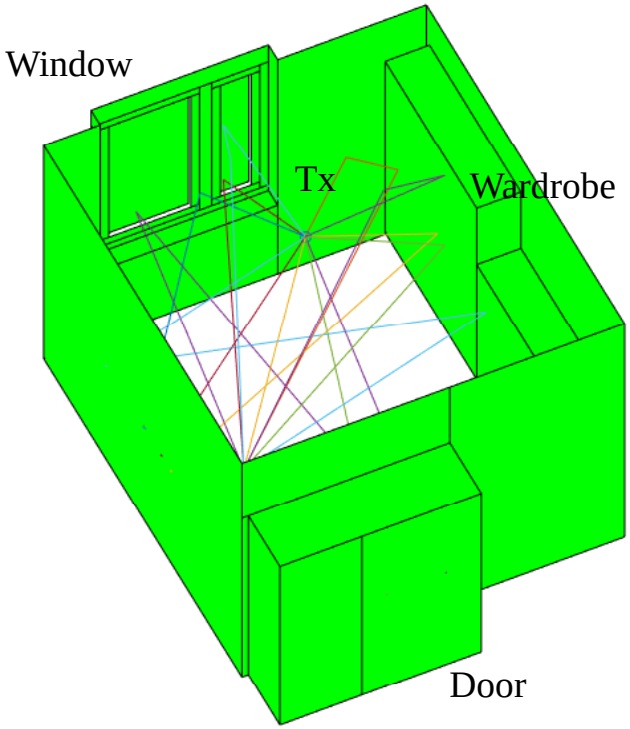
The Ray Tracing Model

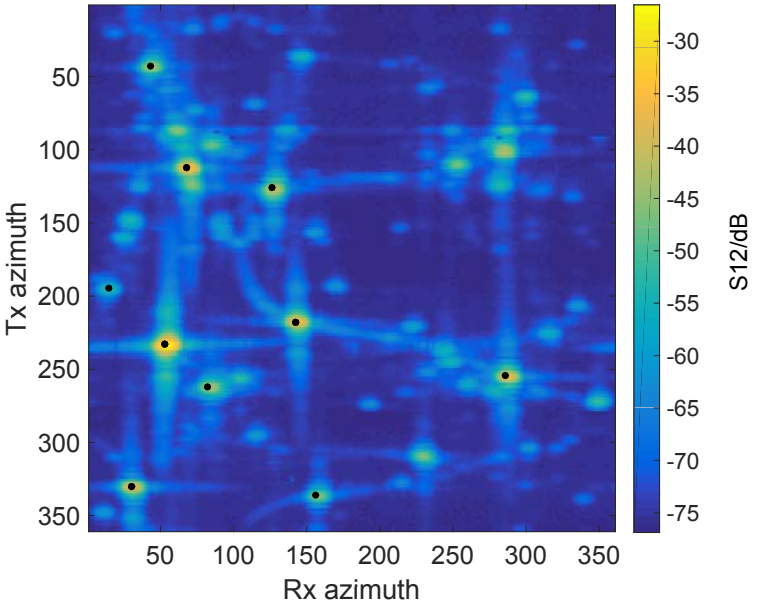
- A detailed model of the small office is built for theapplication of a ray tracing simulator.
- The EM parameters are calibrated according to [3].



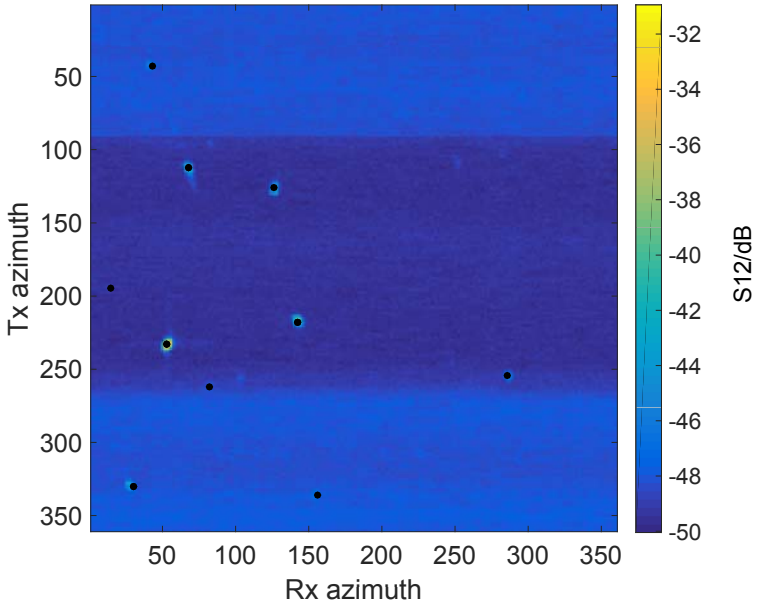


Spatial Distribution (Geometry Part)

- The received power is illustrated as the color.
- The raytracing paths are denoted with black dots.
- Good agreement of paths found by measurement and ray tracing



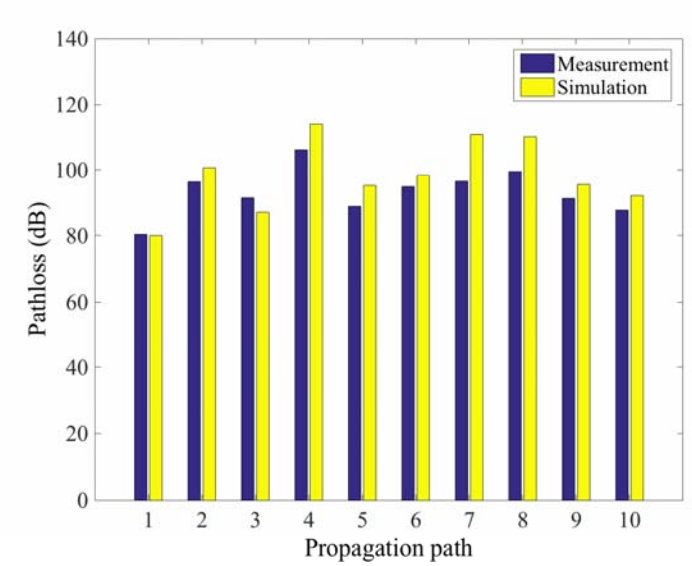
75 – 110 GHz



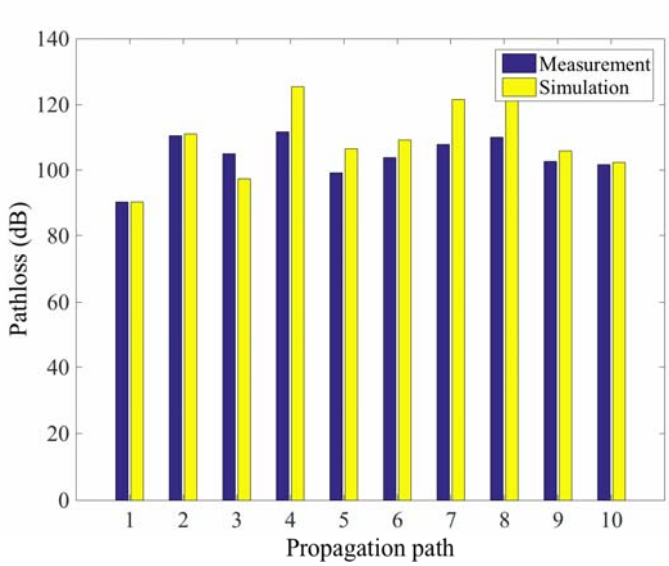
270 - 320 GHz

Propagation Path Loss (EM Part)

- The propagation path losses of different paths from measurement and simulation are shown.
- The antenna gain is subtracted from the raw measurement data.
- The path loss at 300 GHz is as expected higher than at 100 GHz.
- Difference between measurement and simulation suggests a further calibration.



75 – 110 GHz



270 - 320 GHz

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Conclusion

- Channel measurements are done at 100 GHz and 300 GHz with VNA.
- Ray Tracing simulation is carried out to reproduce the measurement results.
- A good match is achieved between measurement and simulation in spatial distribution.
- A calibration of EM parameters is necessary for a better match of propagation path losses.
- The channel at 300 GHz has higher path loss, more serious fast fading and more specular spatial distribution.

Reference

[1] Peng, S. Rey, T. Kürner, “Channel Characteristics Study for Future Indoor Millimeter and Submillimeter Wireless Communications”, accepted for publication in Proc. European Conference on Antennas and Propagation, Davos/CH, 10-15 April 2016

[2] Kürner, T., “Innovative ultra-BROadband ubiquitous Wireless communications through terahertz transceivers - H2020 iBROW,” IEEE 802.15 Document 15-15-0516-00-0thz, Waikoloa/Hawaii, July 2015.

[3] Priebe, S.; Jacob, M.; Kürner, T.:Calibrated Broadband Ray Tracing for the Simulation of Wave Propagation in mm and sub-mm Wave Indoor Radio Channels. In Proc. 18th European Wireless Conference (EW), Poznan, April 2012.