

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

Submission Title: Link-Level and System-Level Simulation of 300 GHz Wireless Backhaul Links

Date Submitted: 19 January 2021

Source: Bo Kum Jung **Company:** TU Braunschweig, Institut für Nachrichtentechnik

Address: Schleinitzstr. 22, D-38092 Braunschweig, Germany

Voice: +495313912439 FAX: +495313915192, E-Mail: bokumjung@ifn.ing.tu-bs.de

Re: n/a

Abstract: One of the goal of the EU-Japan joint project ThoR is to demonstrate the feasibility of the IEEE Standard 802.15.3d-2017 for backhaul/fronthaul links. This will be done in a realistic deployment scenario using both system-level and link-level simulations integrated in the same tool. Based on the system-level simulations, a wireless backhaul network for a given ultra-dense mobile network is automatically planned and analyzed. Exemplary links are then simulated using the link-level simulations. Preliminary results of both simulations are presented from a scenario in Hanover, Germany and showing the achievability of >100 Gbit/s data rate fully considering the current IEEE Std 802.15.3d-2017.

Purpose: Information of IEEE 802.15 SC THz

Notice: This document has been prepared to assist the IEEE P802.15. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release: The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15.



Technische
Universität
Braunschweig



Institut für Nachrichtentechnik



Link-Level and System-Level Simulation of 300 GHz Wireless Backhaul Links

Bo Kum Jung, Christoph Herold, Johannes M. Eckhardt and Thomas Kürner
TU Braunschweig, 27 January 2021

Announcement

- This presentation is based on B. K. Jung, C. Herold, J. Eckhardt, T. Kürner „Link-Level and System-Level Simulation of 300 GHz Wireless Backhaul Links“ accepted for publication at ISAP2020, Osaka, January 2021.

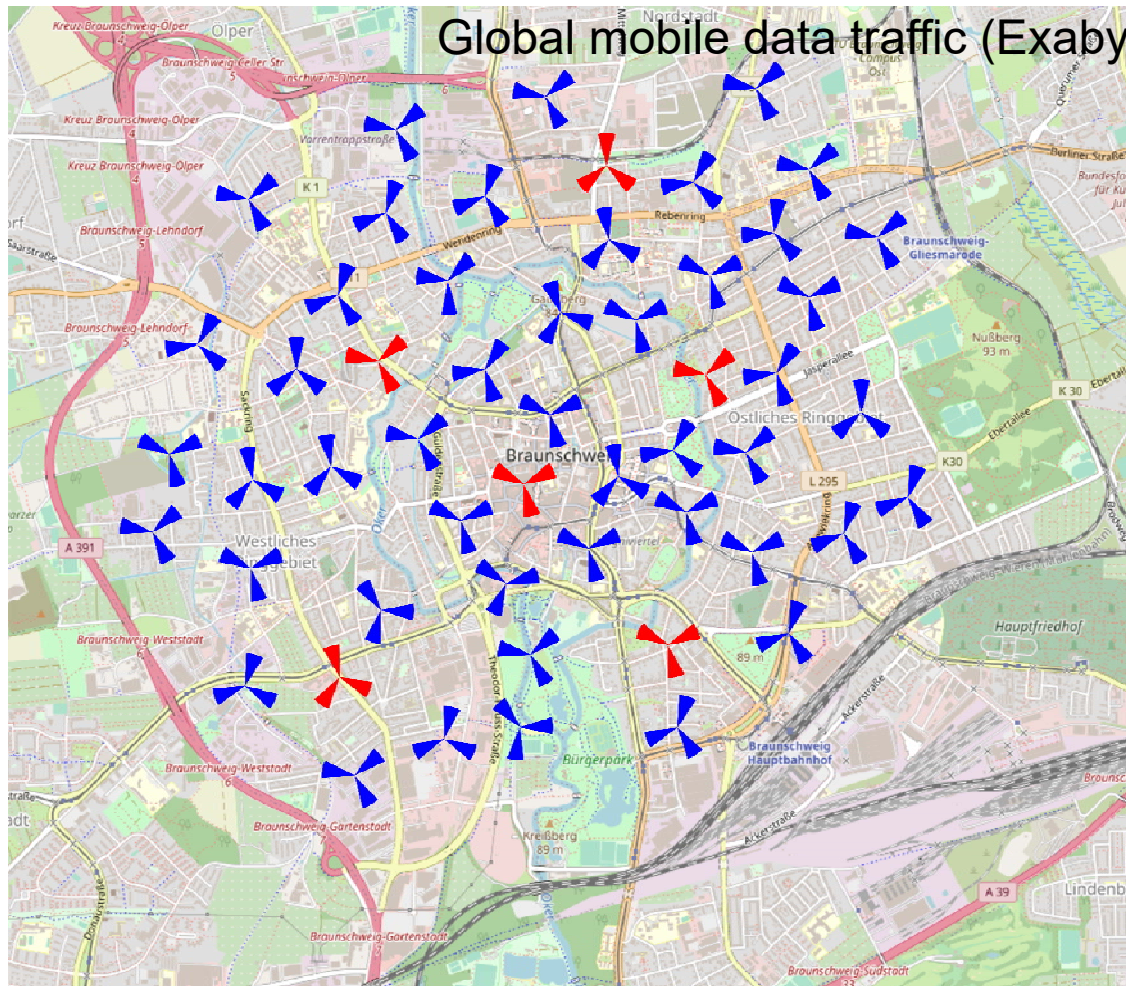


Outline

1. Introduction
2. SiMoNe – Link Level and System Level Simulator
3. Simulation Results
4. Conclusion



Introduction



■ Cable backhaul

- Time & Cost intensive
- Huge men's labour
- Geographical limits
- Poor maintenance performance

■ Alternative

- Wireless backhaul at 300 GHz [THz communication]
 - Lage available bandwidth



Existing base station



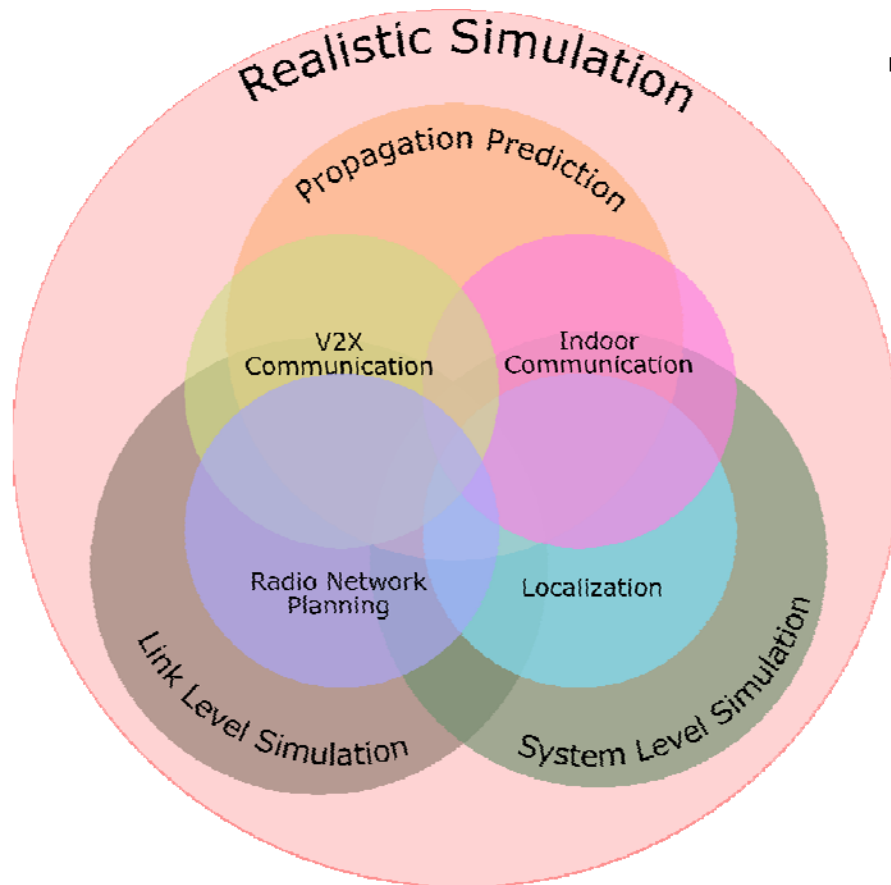
New base station for ultra-densification

Introduction



- An application of THz communication : Wireless backhaul link

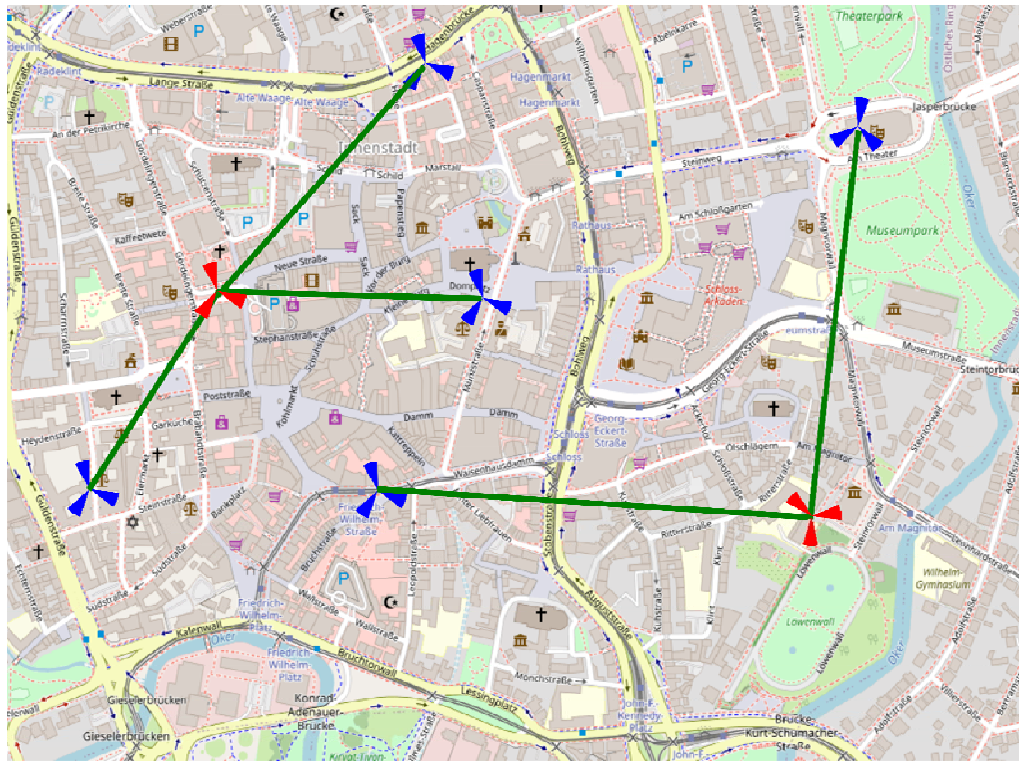
SiMoNe – Link Level and System Level Simulator



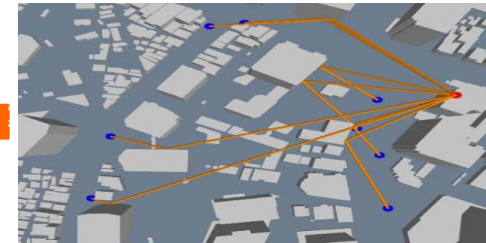
- In-house developed simulation framework
- Simulator for Mobile Networks (SiMoNe)



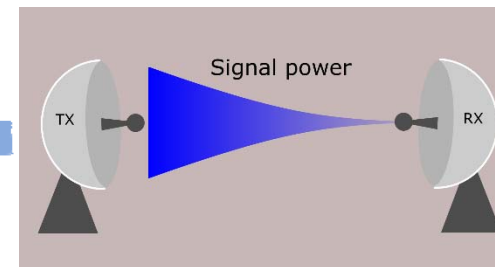
SiMoNe – Link Level and System Level Simulator



Wide functional features



3D raytracing

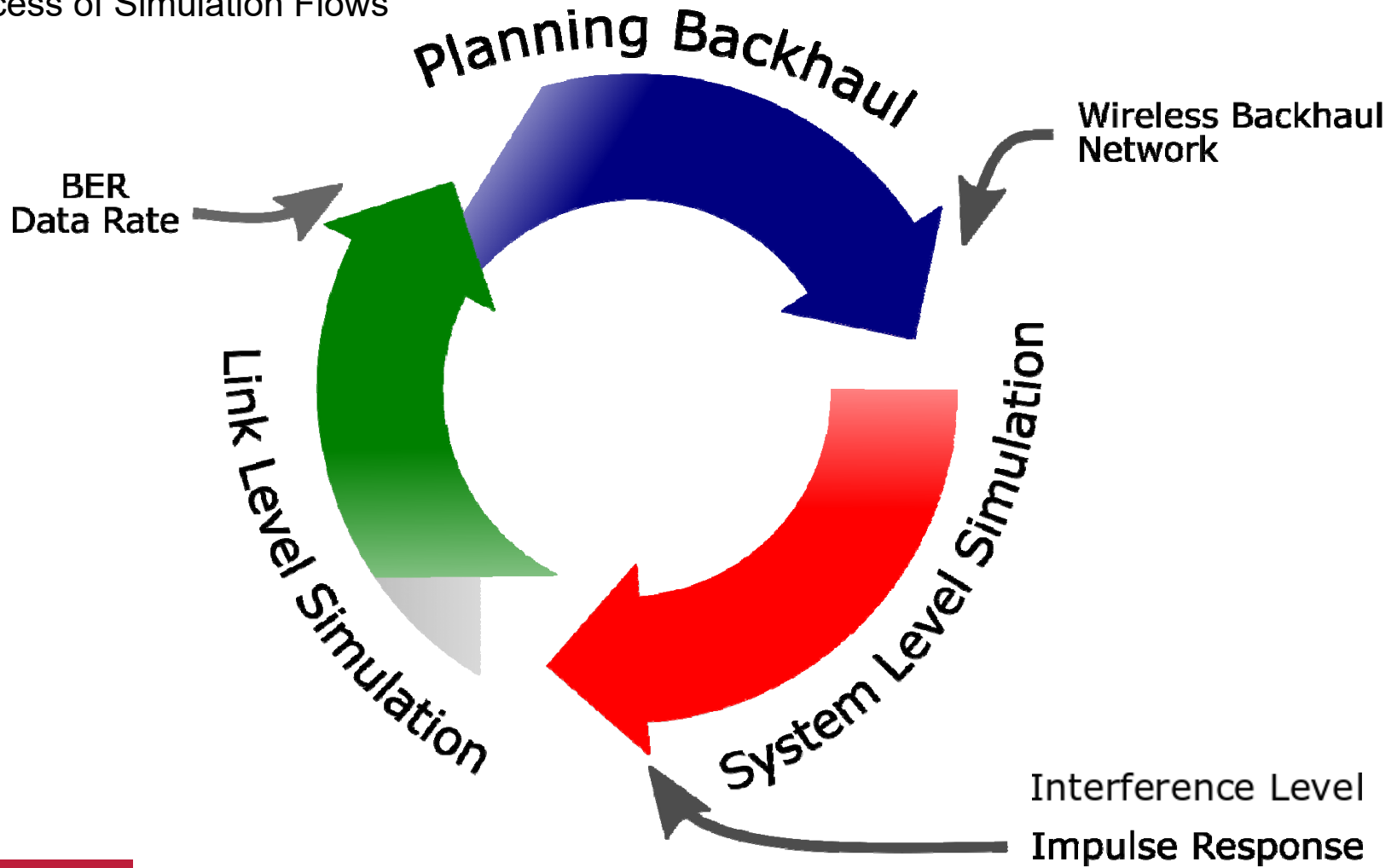


Path-loss prediction

Various output parameters

Simulation Results

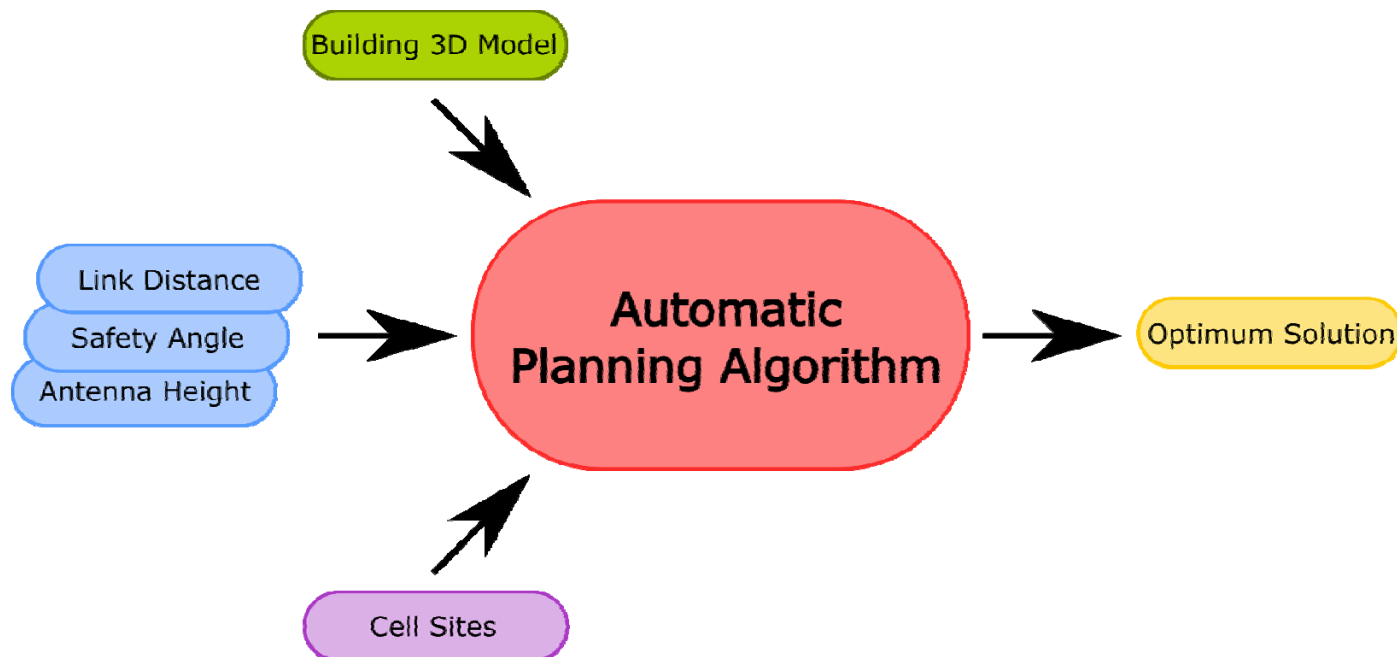
Process of Simulation Flows



Simulation Results

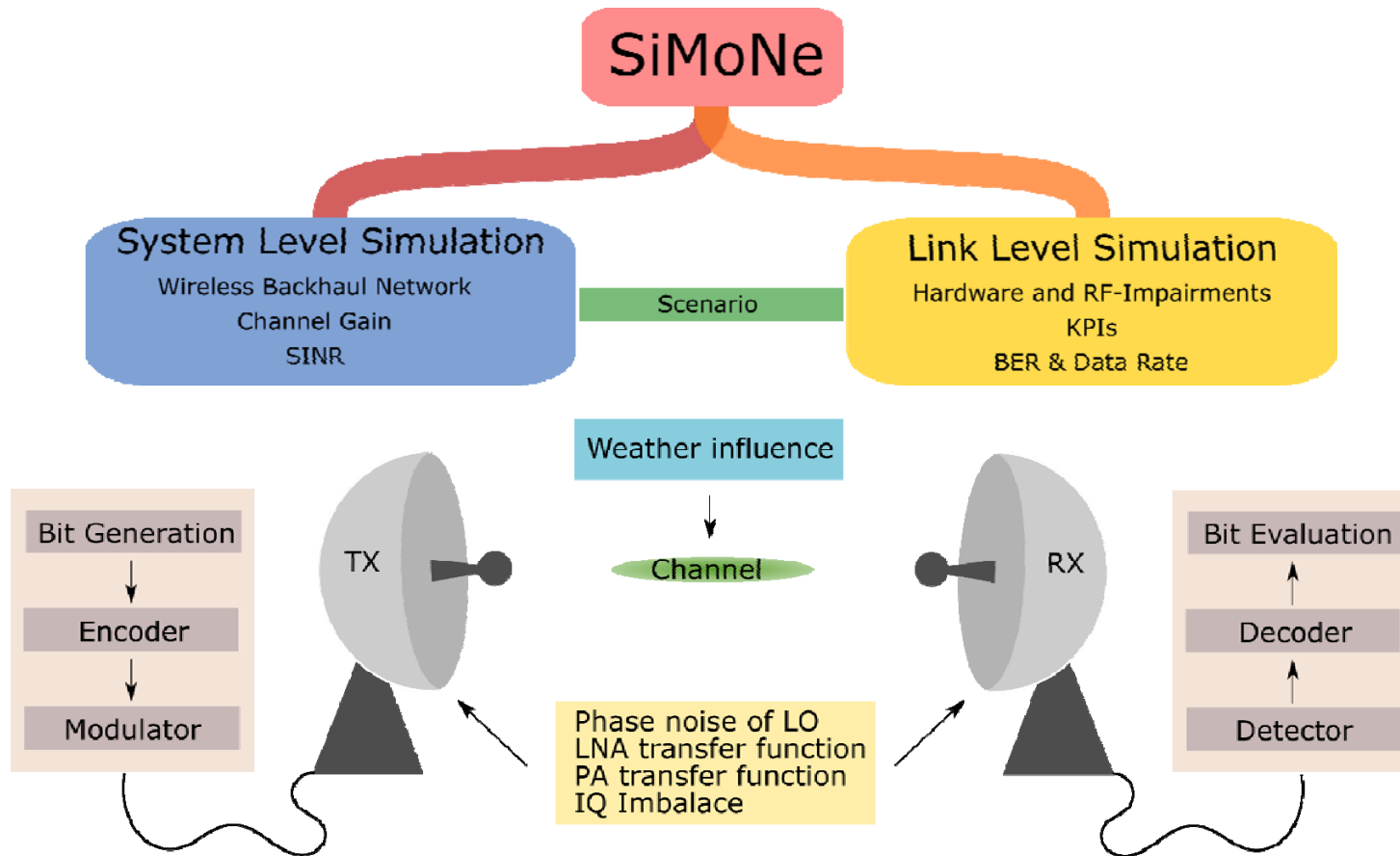
Automatic Planning Algorithm

- Provision of wireless backhaul network through automatic planning algorithm
 - Decision of possibly less fibre backhaul connection
 - Optimization factor => Cost reduction



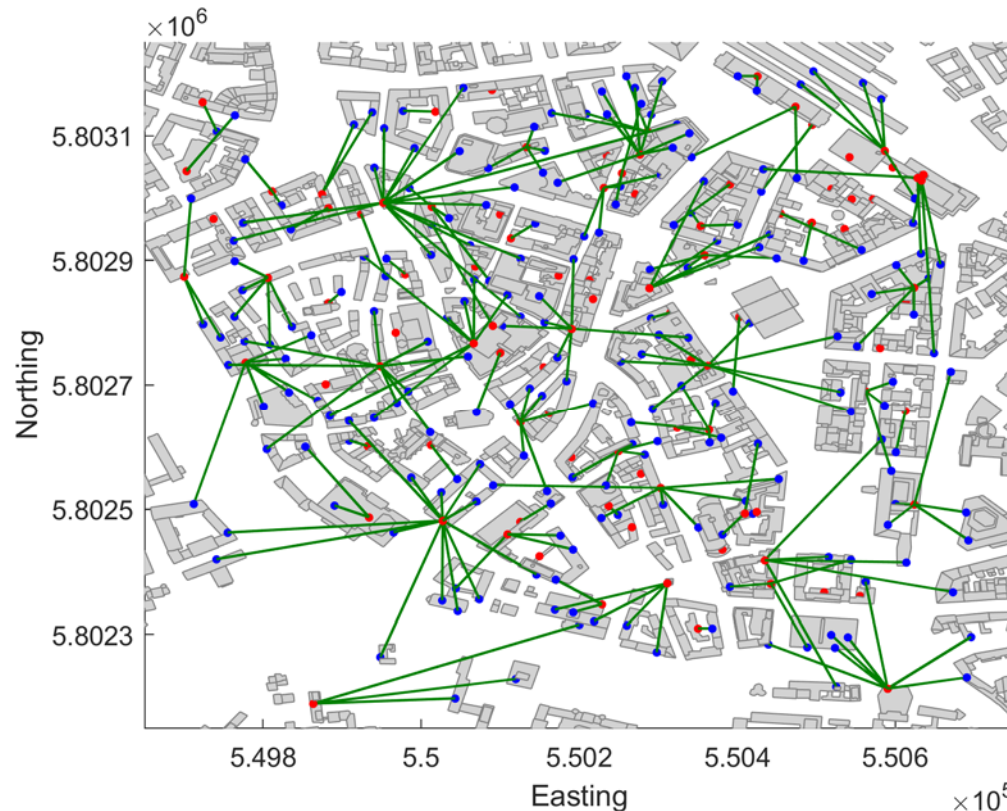
Simulation Results

Structure of Link and System Level Simulation



Simulation Results

Automatic Planning of Wireless Backhaul Network



- Hanover 1 km x 1km region
- 7 existing cell sites
- 300 new cell sites

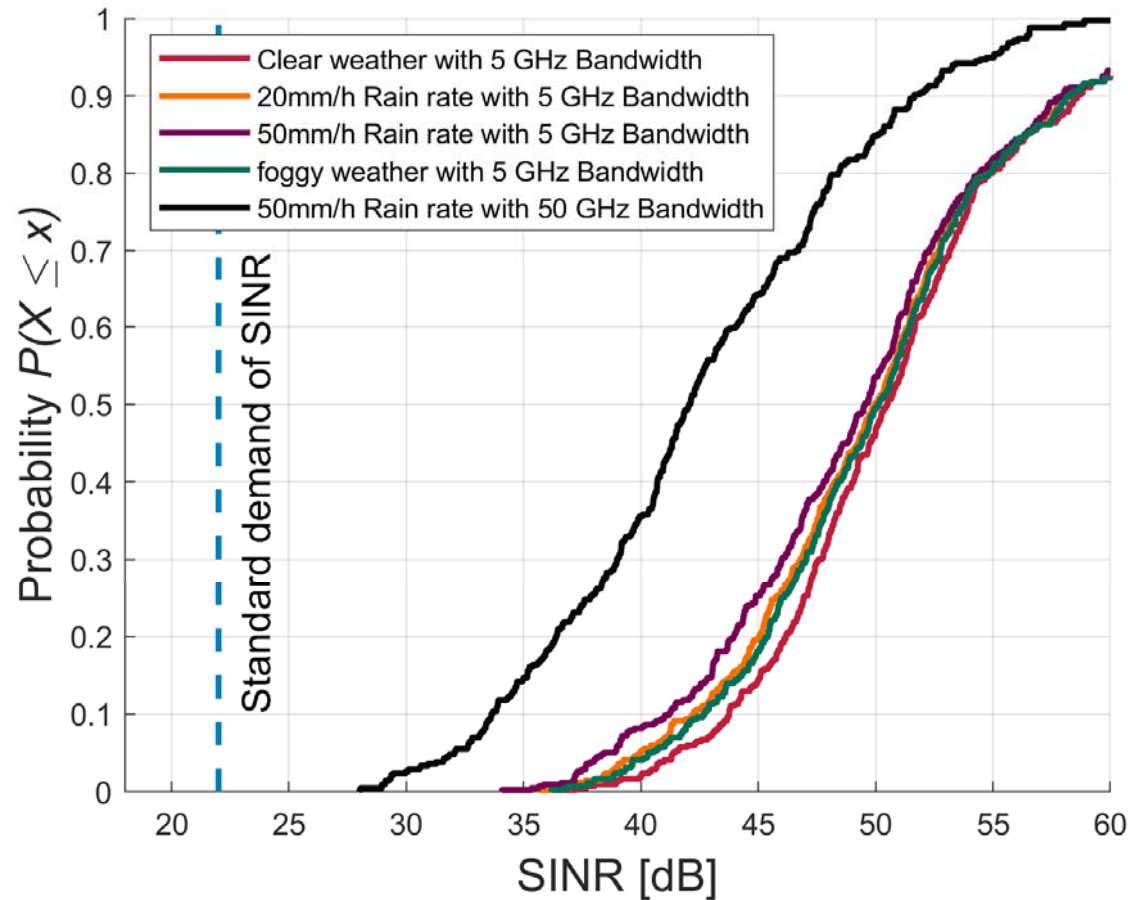
- 88 cable connection
- 212 wireless connection
- **~71%** reduction of cable

- Fibre Backhauled Cellsites
- Wireless Backhauled Cellsites
- Wireless Backhaul Links



Simulation Results

System Level Simulation Result

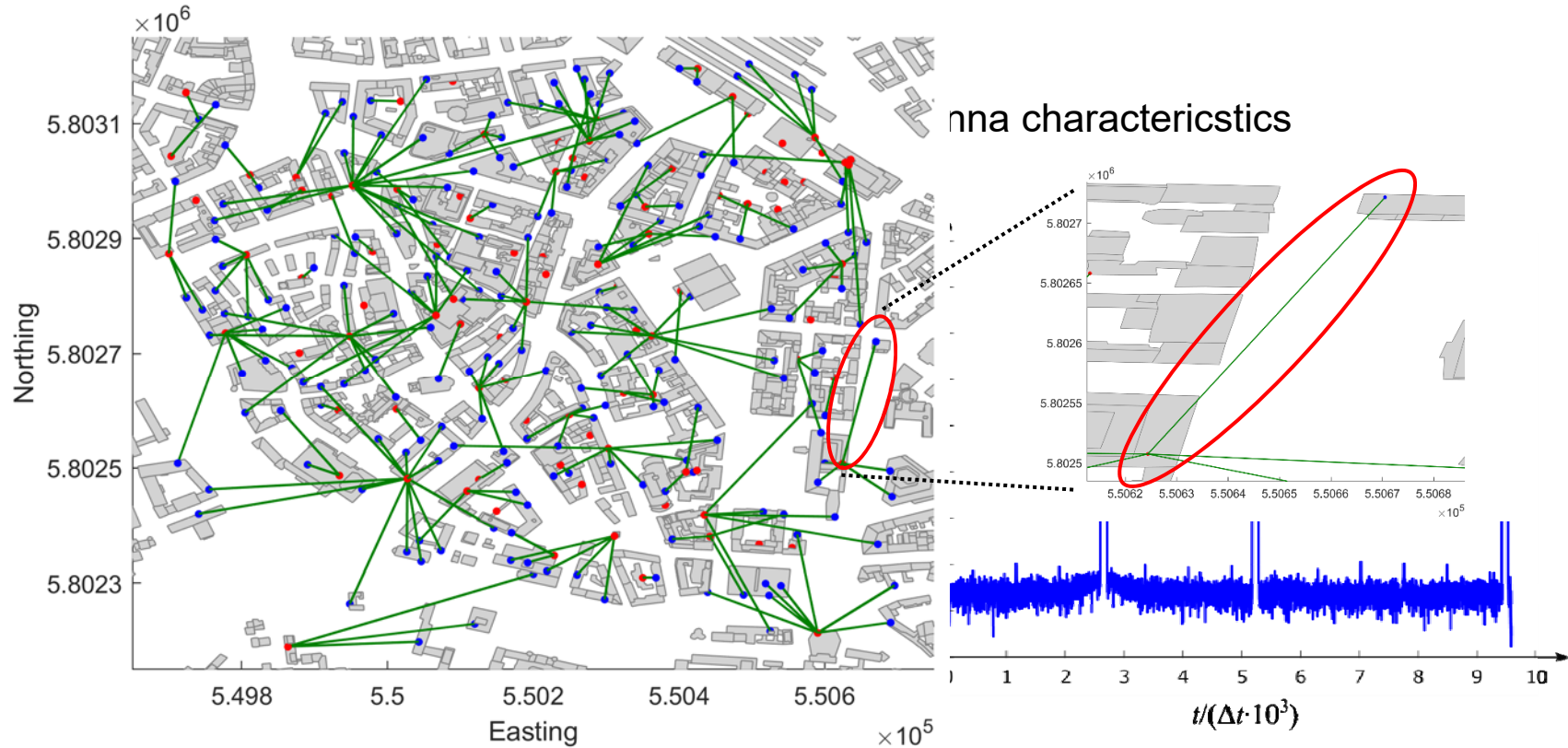


- 0 dBm TX power
- 50 dBi Antenna
 - TX and RX

- Stable operation regardless of weather conditions

Simulation Results

Preparation of Link Level Simulation

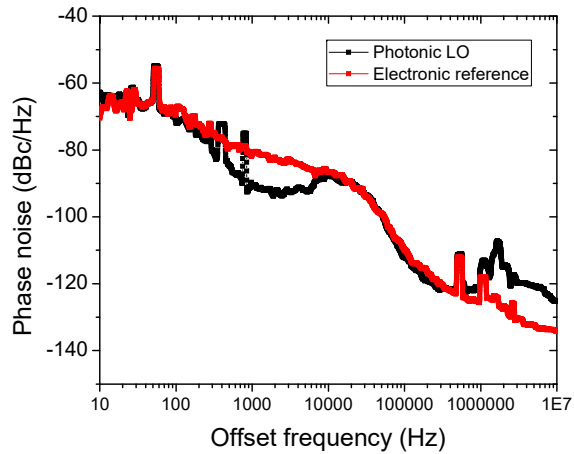


Ray optical paths

Impulse response from raytracing

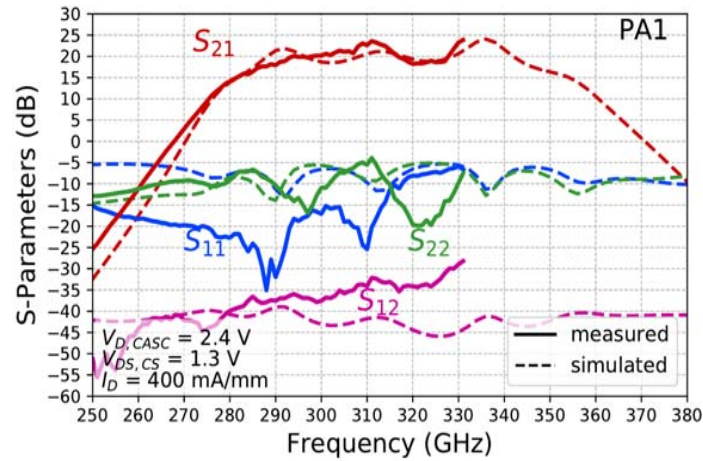
Simulation Results

- Hardware impairments



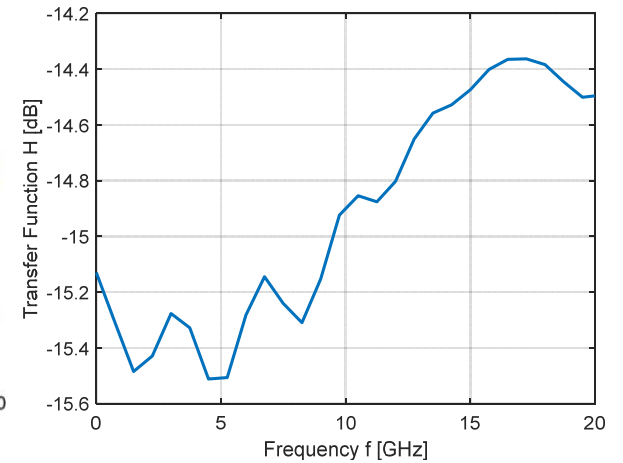
Phase Noise

ThoR D6.1
Horizon 2020



Transfer function (PA)

ThoR D4.3
Horizon 2020



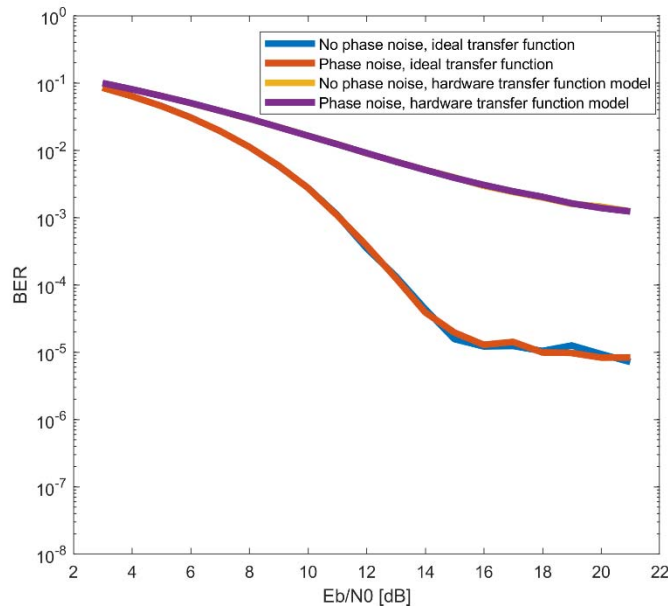
Transfer function (LNA)

TERAPOD D5.2
Horizon 2020

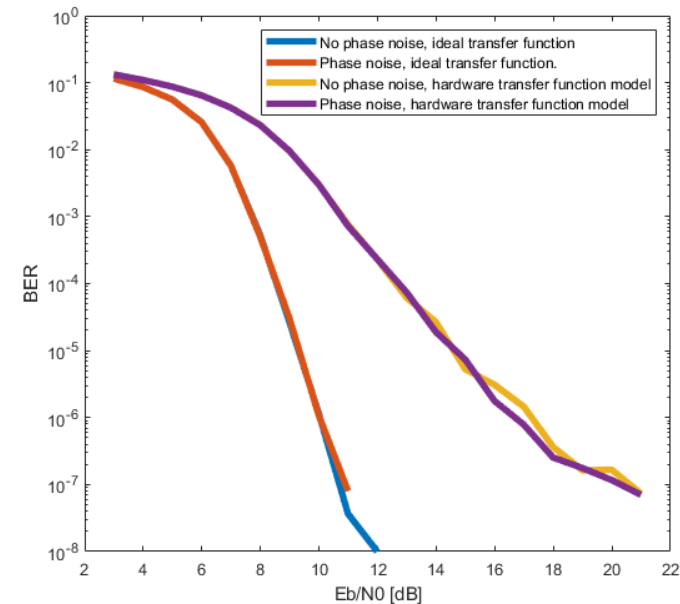
Simulation Results

Link Level Simulation Result

- Simulation of different parameter settings to investigate the effect of single influence factors on the resulting KPIs
- Mandatory to model RF impairments for realistic results



without coding



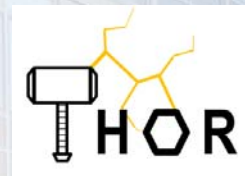
LDPC & 11/15 FEC & 2.16 GHz BW

Conclusion

- System-level simulation show the possibility of wireless backhaul links
 - Feasibility of wireless backhaul network
 - Planning methods and guidelines of the backhaul network
- Link-level simulation show BER and data rate of IEEE Standard 802.15.3d
 - Best suitable modulation and coding schemes
 - Can be used to show the scalability of the ThoR approach
- Same tool and scenario for both of system level and link level simulation

Thank you for your attention

The work presented here, has been performed within the Horizon 2020 ThoR project. This project has received funding from Horizon 2020, the European Union's Framework Programme for Research and Innovation, under grant agreement No. 814523. ThoR has also received funding from the National Institute of Information and Communications Technology in Japan (NICT).



Bo Kum Jung, M.Sc.

bokumjung@ifn.ing.tu-bs.de



Technische
Universität
Braunschweig



Institut für Nachrichtentechnik