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**Abstract:** The implementation of IEEE standard 802.15.3d enables the wireless backhaul links operating at 300 GHz to provide >100 Gbit/s data rate. One of the goals of the EU-JAPAN Horizon 2020 project (ThoR) is to develop suitable automatic planning algorithms for the backhaul/fronthaul links. In this presentation first simulation results of the developed automatic planning algorithm for the 300 GHz backhaul in the are provided in the Hannover scenario, which is one of the ThoR simulation scenarios..

**Purpose:** Information of the Technical Advisory Group THz

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## **Simulation and Automatic Planning of 300 GHz Backhaul Links First Results from H2020 ThoR**

**Bo Kum Jung**, Nils Dreyer, Johannes Eckhardt, Thomas Kürner

# Acknowledgement

- This presentation is based on B. K. Jung, N. Dreyer, J. Eckhardt, T. Kürner, „Simulation and Automatic Planning of 300 GHz Backhaul Links“ accepted for publication at IRMMW-THz 2019, Paris September 2019.
- 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).

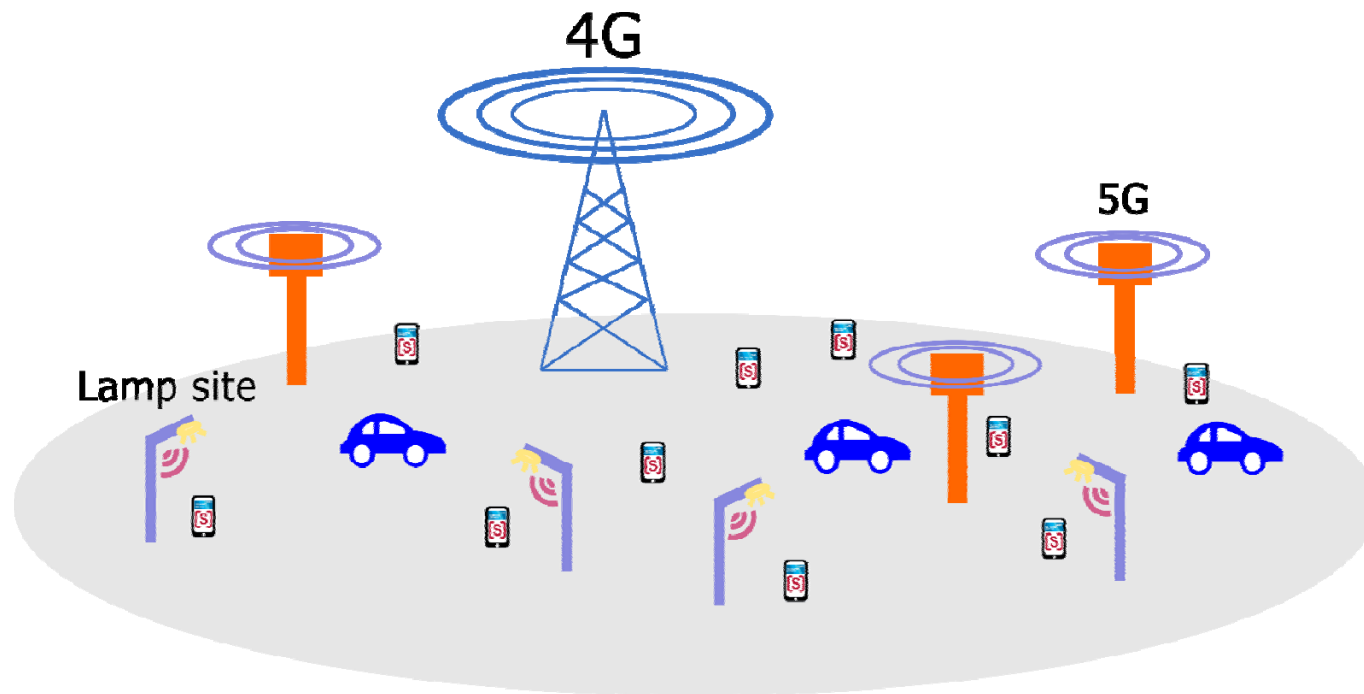
# Outline

1. Introduction
2. Planning Approaches
3. Simulation Results
4. Conclusion



# Introduction

## 5G Integration with 4G



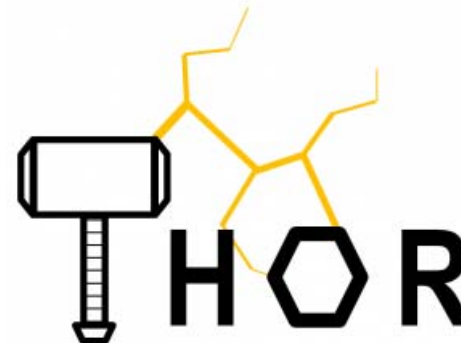
## Backhaul



## Fibre vs Wireless

# Introduction

- IEEE Standard 802.15.3d
  - Wireless backhaul at 300 GHz with 100+ Gbit/s Data rate
- ThoR project(European Horizon 2020)
  - >40 Gbit/s real data transmission
  - Developing algorithms for the automatic planning front/backhaul links
  - Deriving planning guidelines

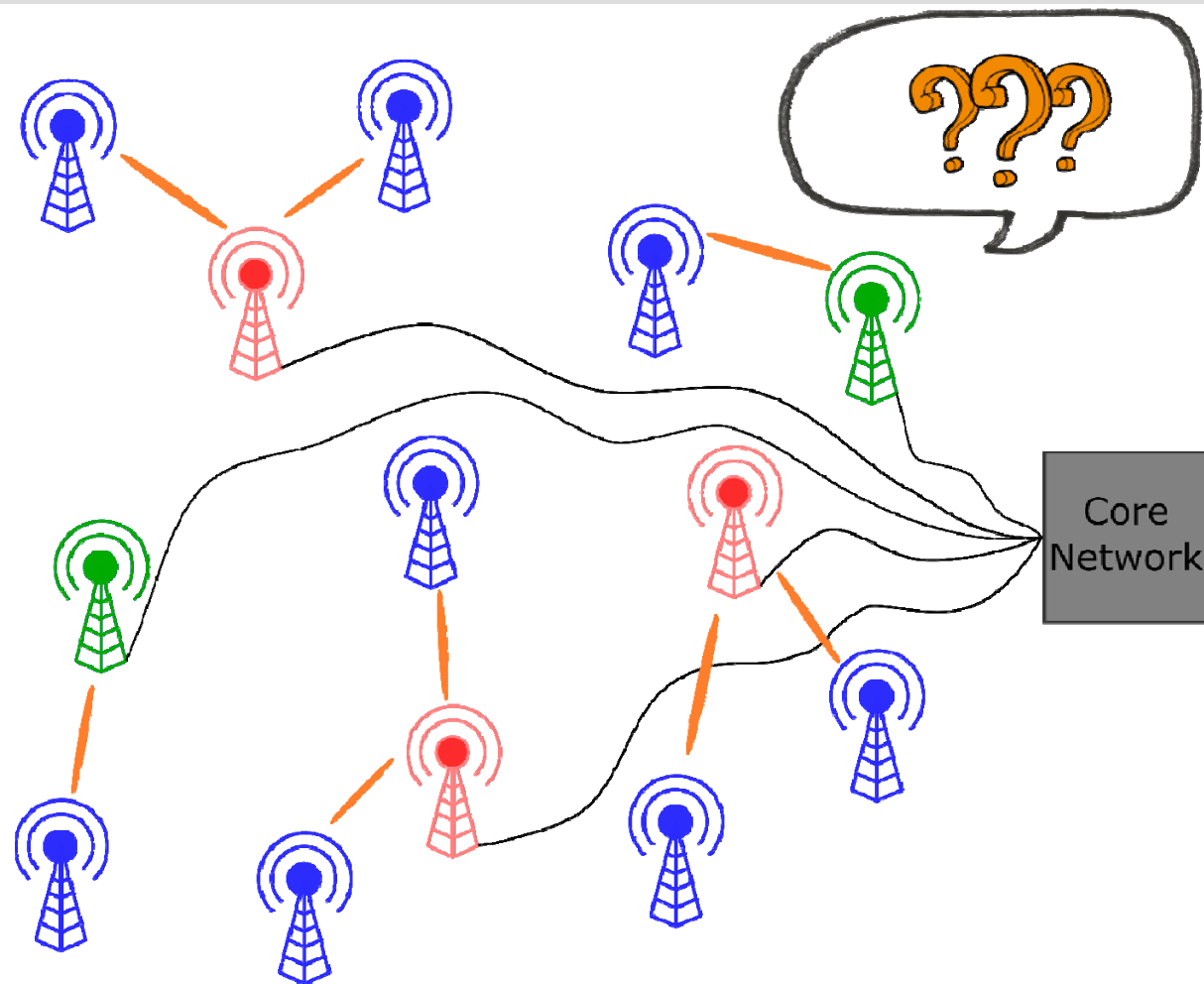


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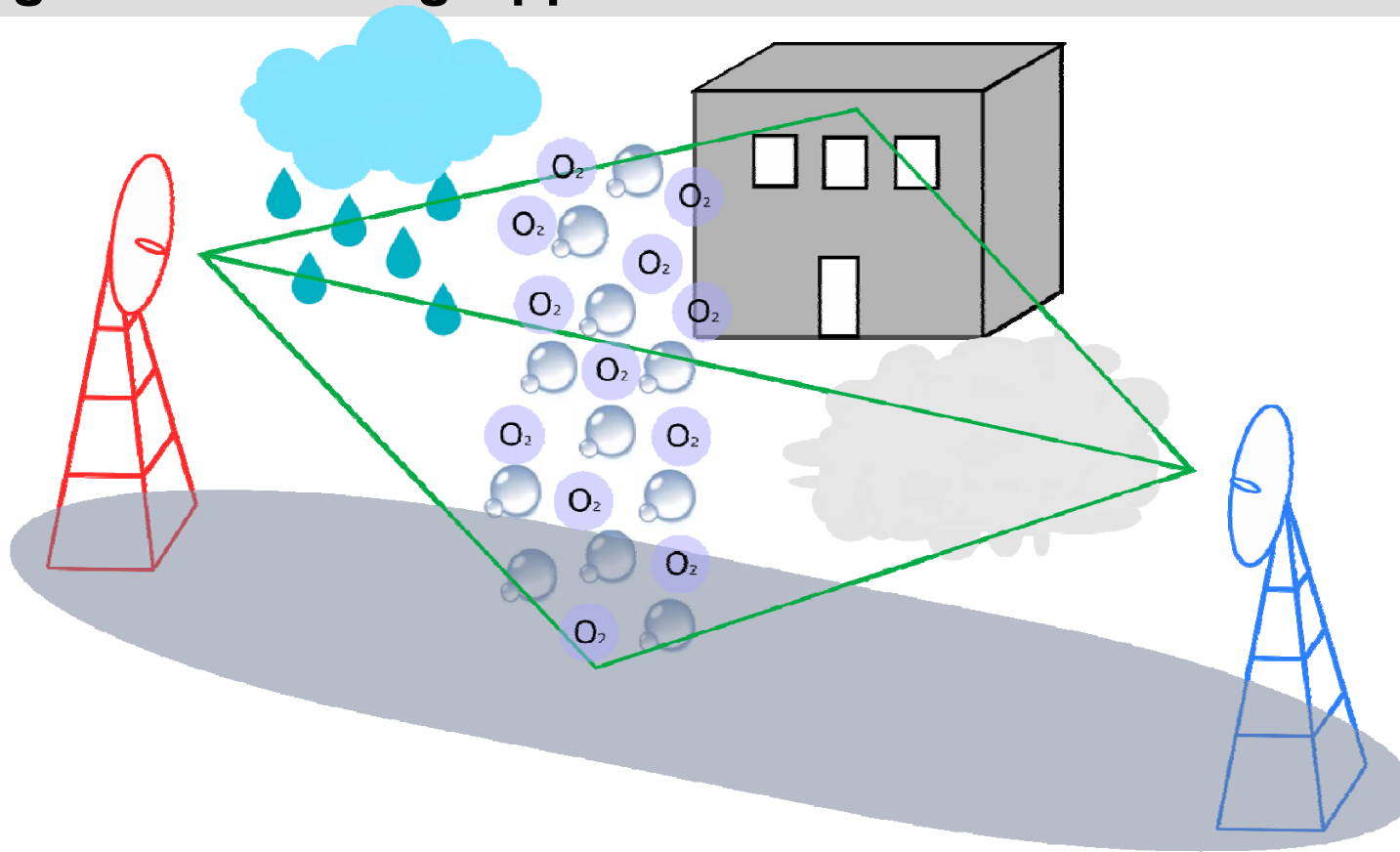


# General Approach





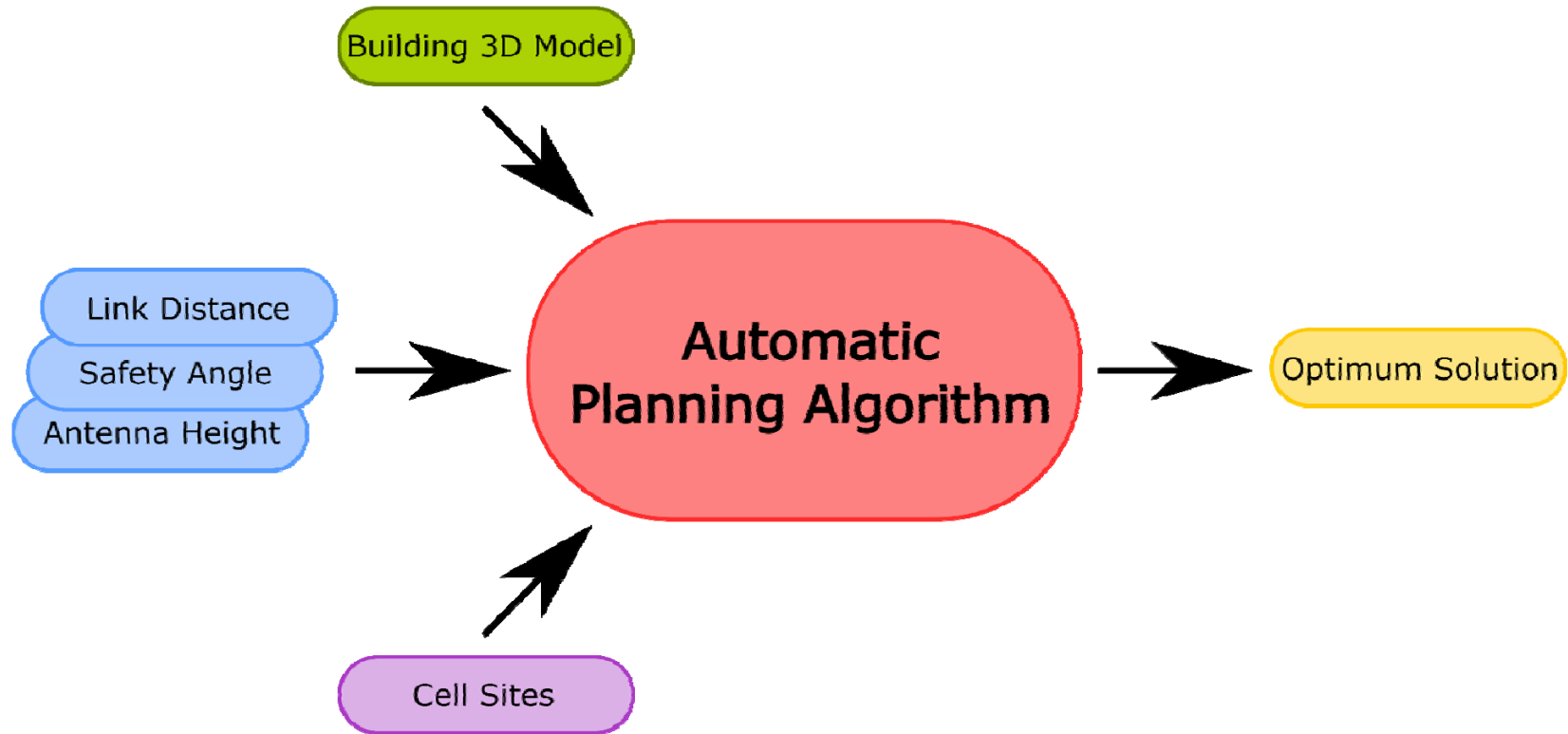
# Propagation Modeling Approach



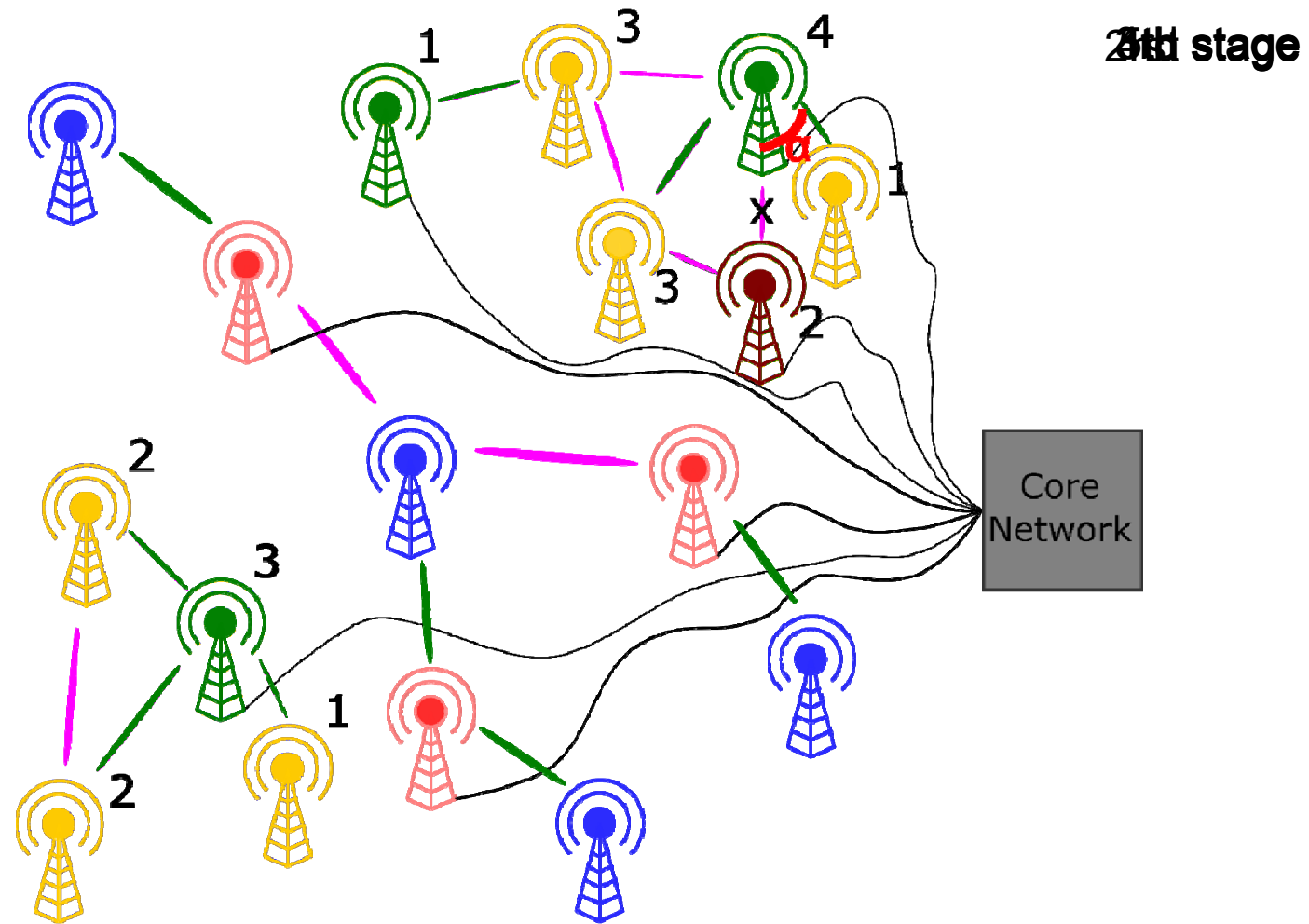
$$\text{Path Loss / dB} = 92.4 + 20 \log( r / \text{km} ) + 20 \log( f / \text{MHz} ) + (\gamma_0 + \gamma_w + \gamma_R + \gamma_c) r / \text{km}$$



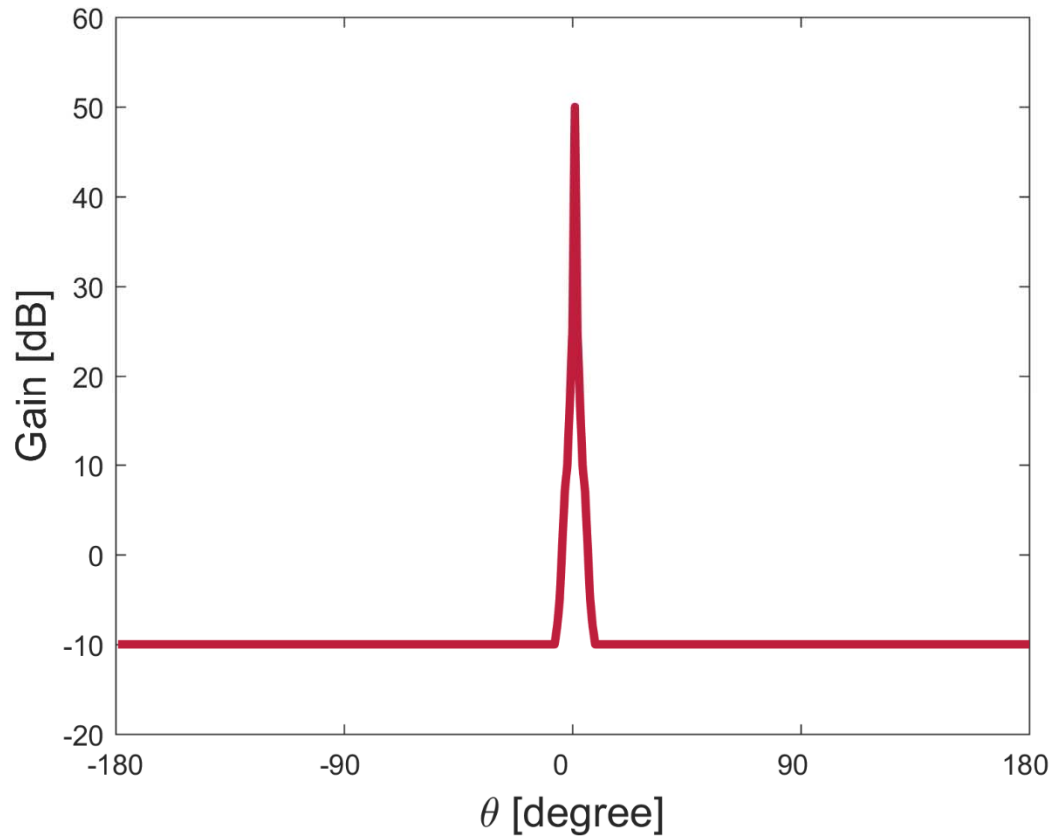
# Automatic Planning Approach



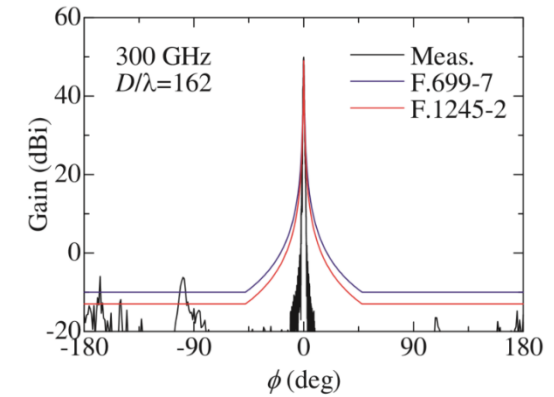
# Algorithm



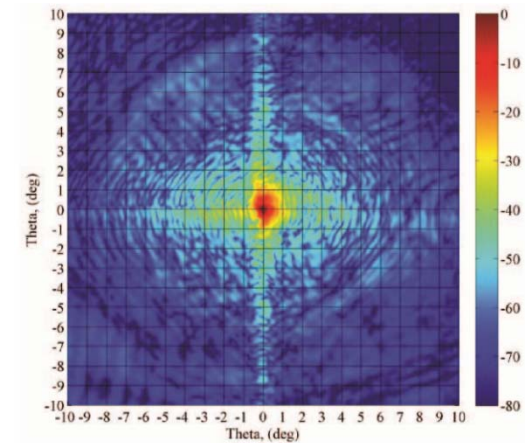
# Antenna Diagram



- A simplified radiation pattern of 50 dBi antenna



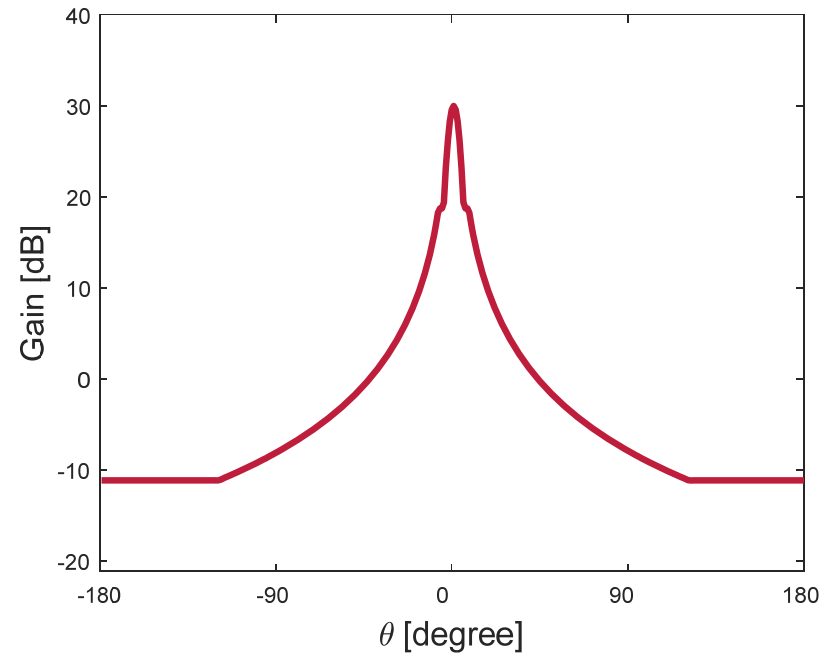
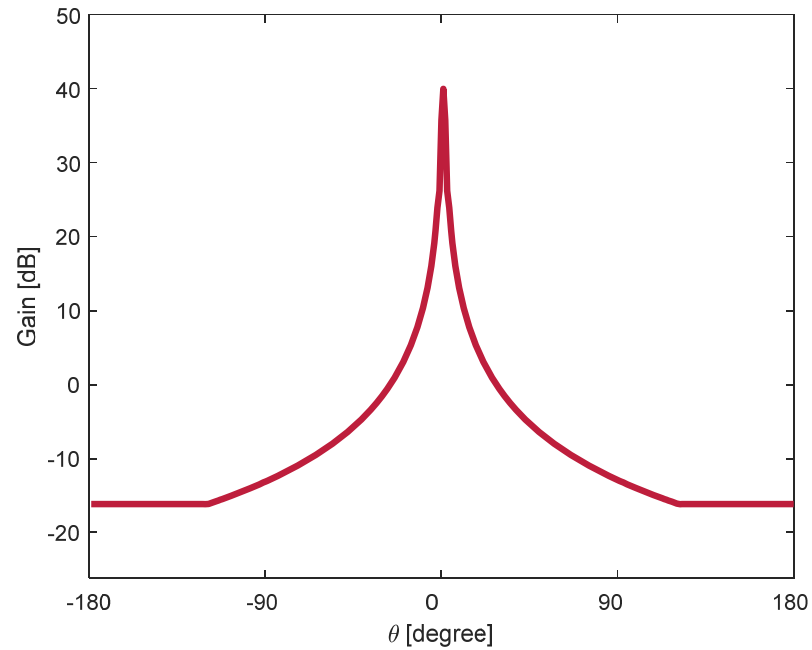
Sawada, H and Kanno, Atsushi and Yamamoto, Nobuyuki and Fujii, Katsumi and Kasamatsu, A and Ishizu, K and Kojima, F and Ogawa, H and Hosako, I, "High gain antenna characteristics for 300 GHz band fixed wireless communication systems", Progress in Electromagnetics Research Symposium in Singapore, pp. 1409-1412, Nov 2017.



A. Martínez, I. Maestrojuan, D. Valcazar and J. Teniente, "High gain antenna for sub-millimeter wave communications," 2016 46th European Microwave Conference (EuMC), London, 2016, pp. 37-40.



# Antenna Diagram



- ITU-R F.1245-3 Mathematical model of radiation patterns

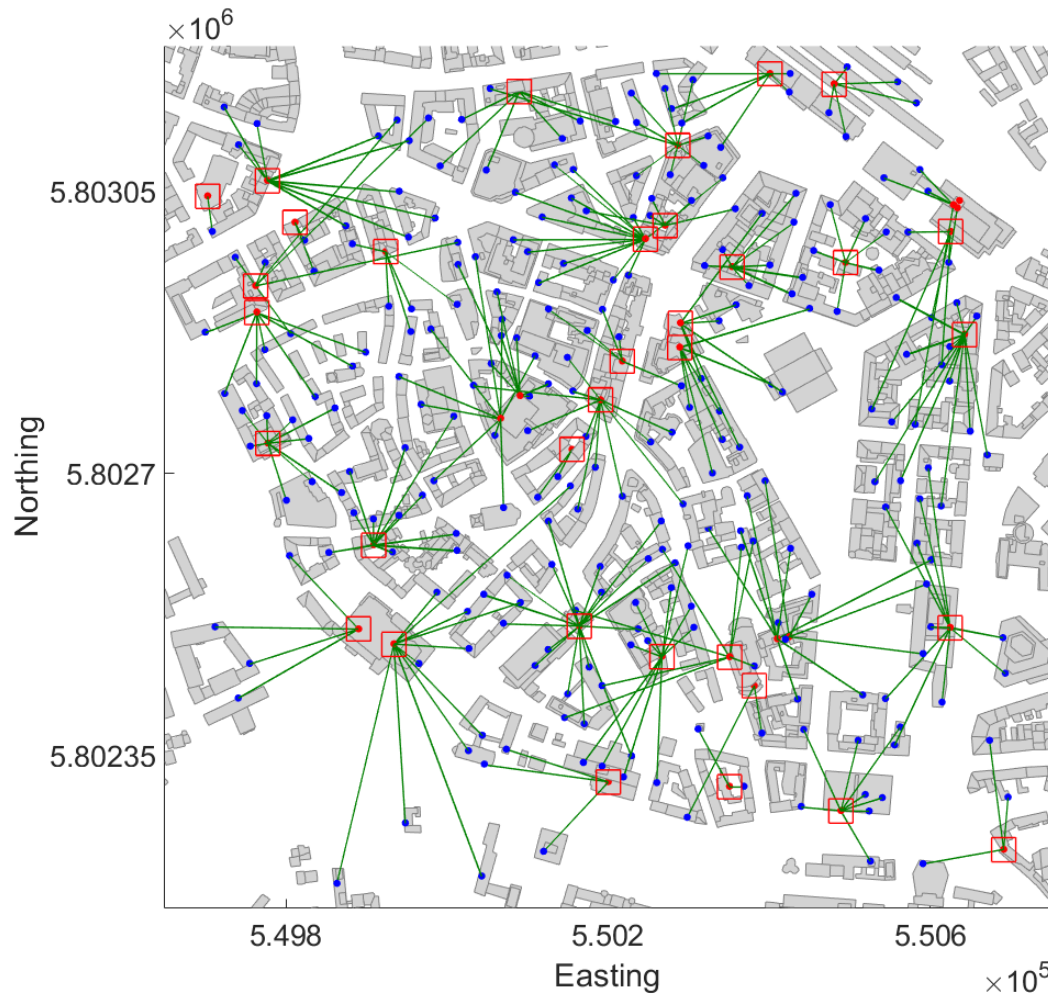


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# Automatic planned wireless Backhaul Links



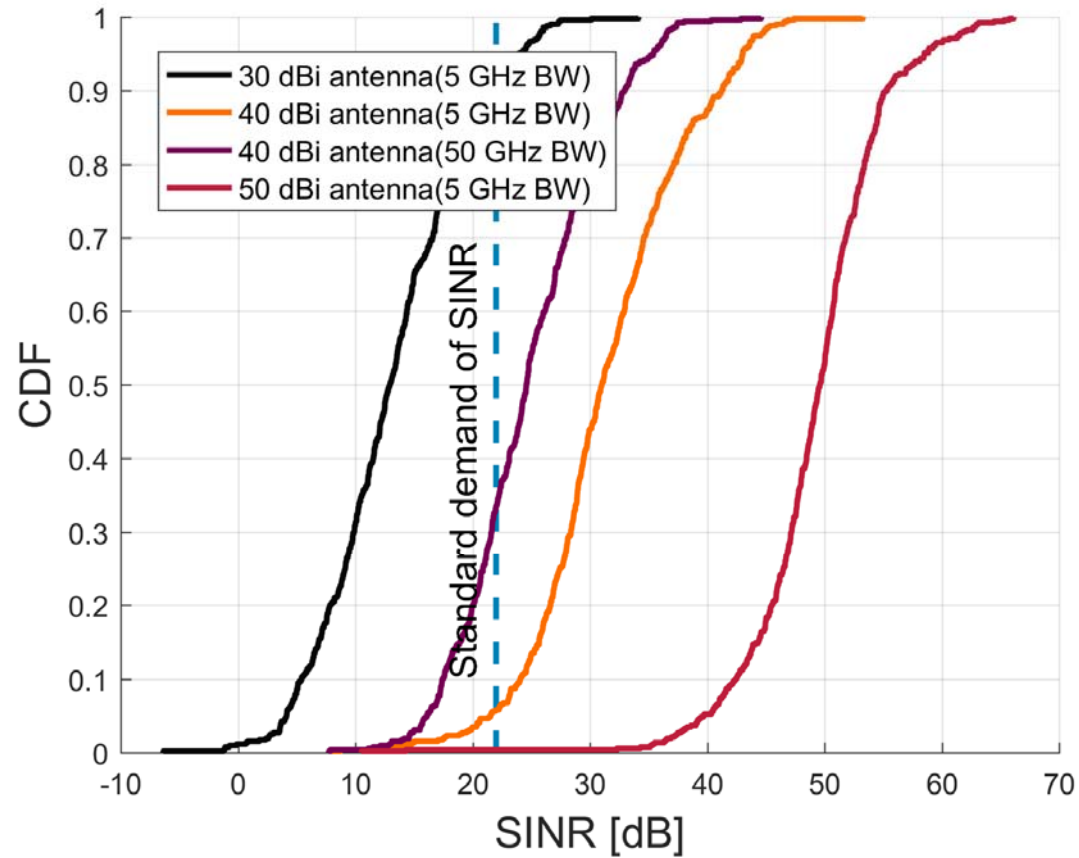
- Hannover scenario
  - 3 Macro cell sites (7 sector antennas)
  - 300 new cell sites



- 34 from 300 cell sites
  - Fibre required
  - ~ 89% wireless link

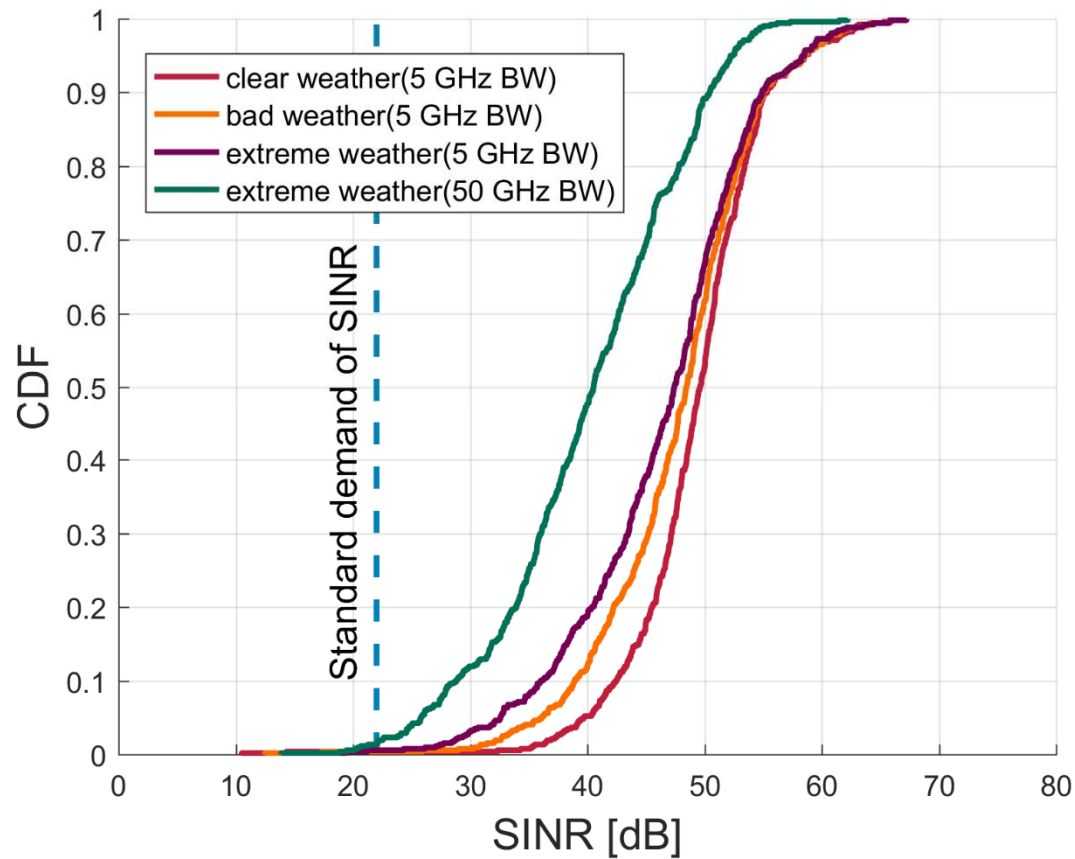


# SINR various Antenna Gain



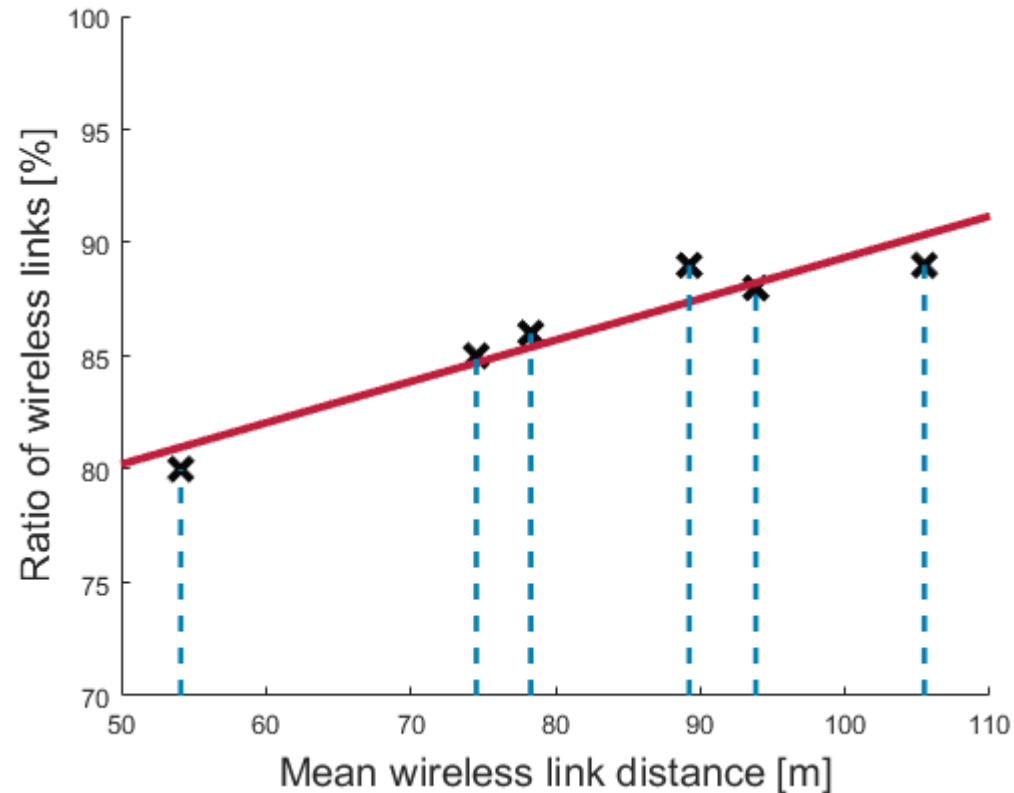


# SINR various Weather Condition



# Ratio of wireless links comparing with fibre links

allowed link distance [m]	100	150	200	250	300	350
mean link distance [m]	54.1	74.5	78.3	93.8	89.2	105.5



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# Conclusion

- Automatic planning algorithm determines wireless backhaul
- Dependency of the planned network on the cell sites and inputs
- Requirement of the high gain antenna (Interference)



# Thank you for your attention

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