Poster pitches CWTe 2023 Research Retreat

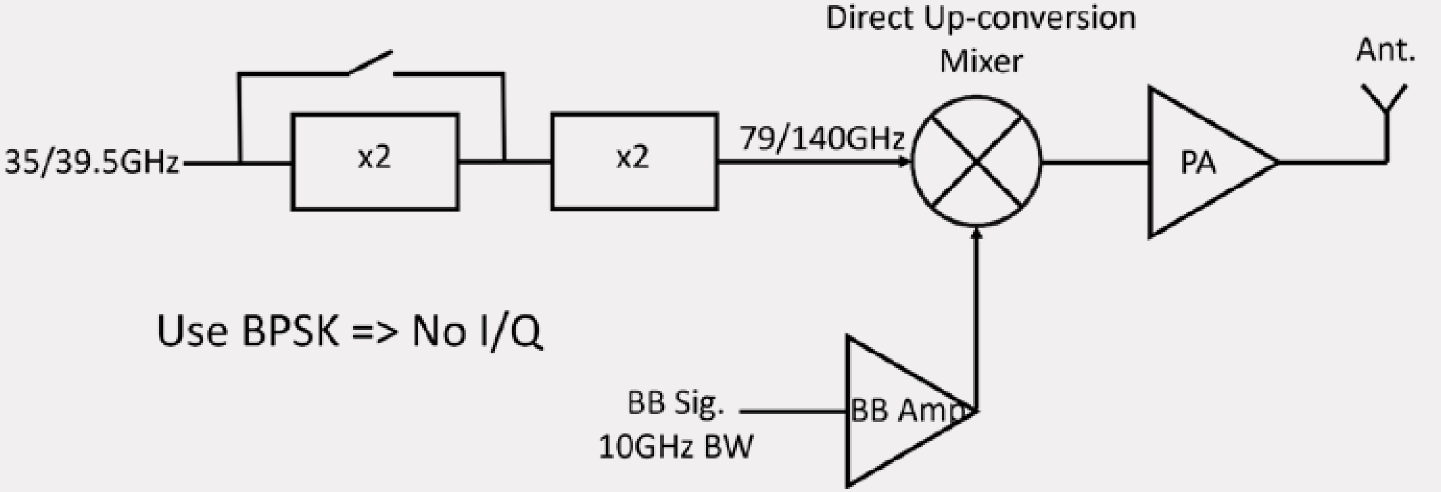
#	Name	Group	Poster Title
1	Yiqin Hou	IC	6G Dual-band Transmitter Front End
2	Kirill Alekseev	EM	LNA – Antenna co-design 35-40 GHz
3	Martijn de Kok	EM	Load-Pull Effects in Co-Designed Active Antenna Arrays
4	Mohammad Khorramizadeh	EES	Assessment of the Effect of a Test Setup on the Input Impedance Measurement of Cables
5	Panagiotis Giannakopoulos	ECO	5G URLLC computing: variability and predictability
6	Bin Shi	ECO	Automatic control of photonic integrated true-time delay for RF beam steering
7	Daan van den Hof	EM	Numerical Convergence of A Hermite interpolation based spatial spectral solver for 2D TE polarization
8	Pieter van Diepen	EM	Time Domain Volume Integral Equations: Scattering from High Contrast Scatterers
9	Eduardo Muller	ECO	Optical wireless transmitter using Piezoelectric Actuators and VCSEL Arrays
10	Bram van Bolderik	ES	Low power hardware design for a dynamic neural network based 6G wireless receiver
11	Rahul Saini	ECO	RAN resource optimisation using Open RAN
12	Rainier van Dommele	IC	Dual band 77/150 GHz Receiver for Automotive Radar
13	Erik Bertram	IC	Wideband Null Steering for Reliable Wireless Intra-aircraft Communication
14	Mohammad Mohammad Shahid	EM	Multi-physics modeling for improving design-time and energy-efficiency of highly integrated active antenna arrays
15	Anudeep Karnam	ECO	Private 5G Architectures for Wireless Avionics Intra-Communications
16	Metodi Belchovski	ECO	Integrated photonics RF front-end for satellite communications
17	Sudha Malik	EM	Assessing 5G mmWave Indoor RF Exposure: Insights from Channel Sounding
18	Paola Escobari Vergas	EM	Material Characterization techniques for 6G applications in the Sub-THz bands
19	Remco Schalk	IC	Power Efficient 140GHz Transmitter Architectures for Next-Gen Automotive Radar
20	Naila Rubab	EM	Dynamic High Pathloss Doppler Enabled OTA Emulator
21	Priscilla Allwin	ES	Run-time Non-uniform Quantization for Dynamic Neural Networks in Wireless Communication
22	Jobish John	ECO	Techniques for Ultra-Reliable Intra-Aircraft Wireless Communications
23	Purnima Yadav	EM	Uncertainties in the Estimation of the Gain of a Standard Gain Horn in the Frequency Range of 90 GHz to 140 GHz
24	Furkan Şahin	EES	Safe and Sustainable Electromagnetic Shielding Solutions for Mobility
25	Elles Raaijmakers	IC	Integrated Circuits – Designed by the Public
26	Ashifa Mohammed Musthafa	EM	Integrated Filtering Antenna for Satellite Communications
27	Hamid Hassani	ECO	Achieving High Data Rate, Low Latency, and High Reliability for Next-Generation XR Applications in Wireless Edge Networks
28	Kevin van Hastenberg	EM	Shared Apertures: Merging Millimeter-wave Wireless Communications and Radar Sensing (SHARE-WAVES)

Dual-band TX design at 79/140 GHz

Contact: Yiqin Hou, y.hou1@tue.nl

- Shared hardware for short/long range radar
  - 79GHz for long range, low resolution
  - 140GHz for short range, high resolution
  - Reduced number of sensors

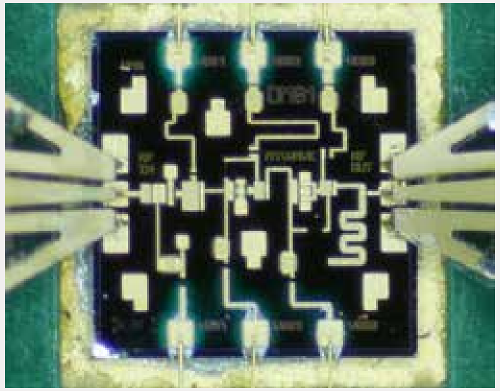
- Dual-band concurrent PA and matching networks
  - Coupled resonators
  - Pole-controlled transformers

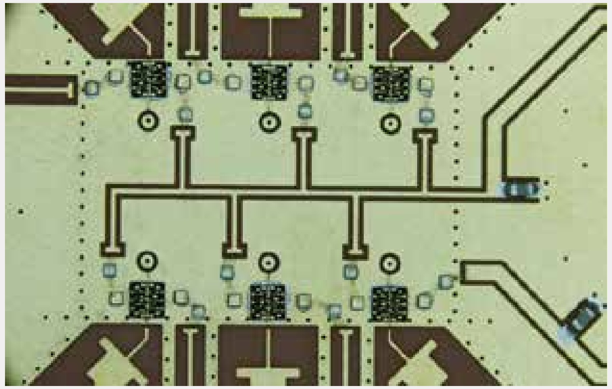


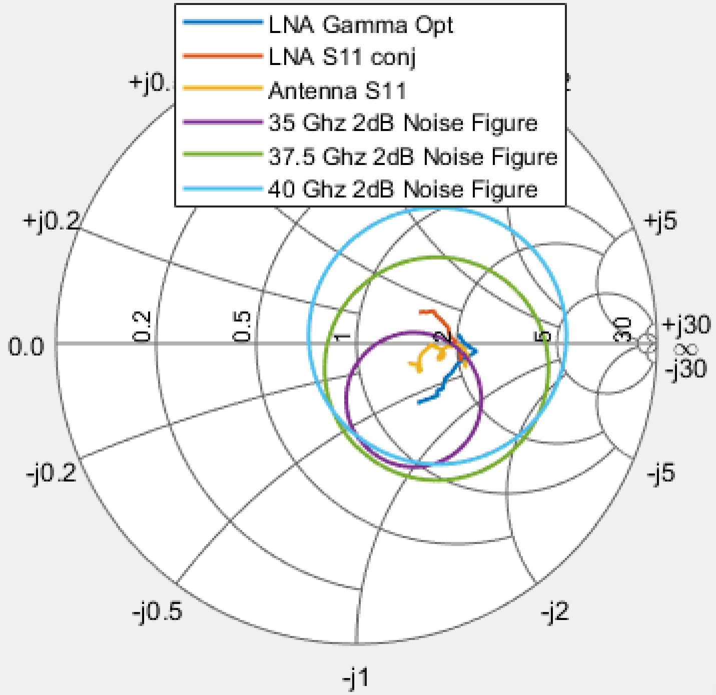
CWTe CENTER FOR WIRELESS TECHNOLOGY EINDHOVEN TU/e

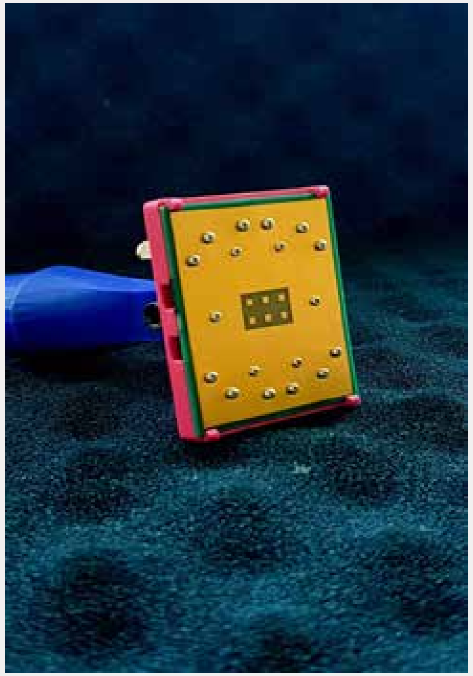
LNA – ANTENNA CO-DESIGN

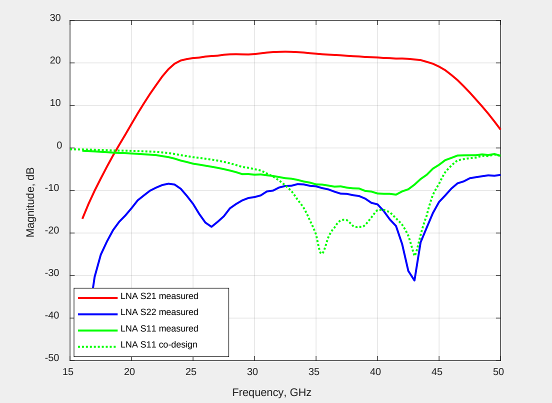
Contact: Kirill, k.alekseev@tue.nl

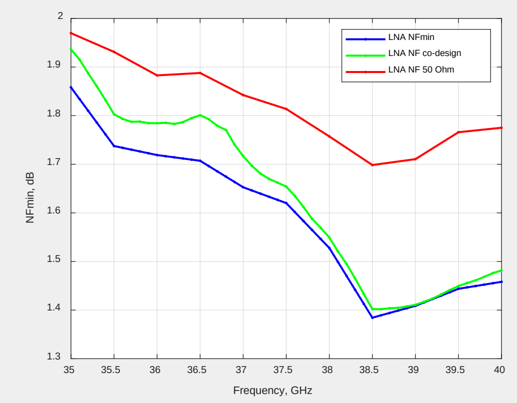


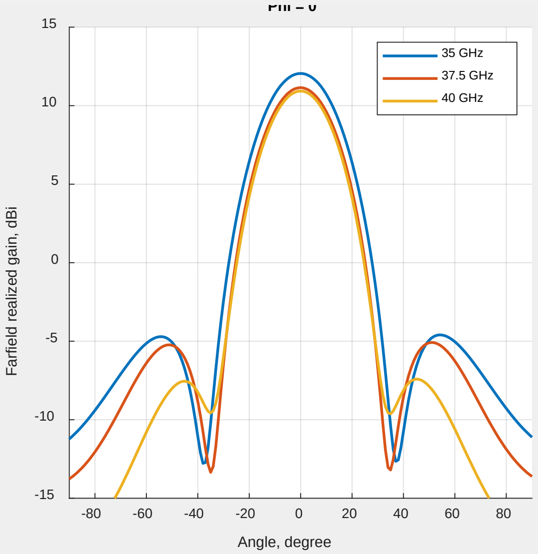


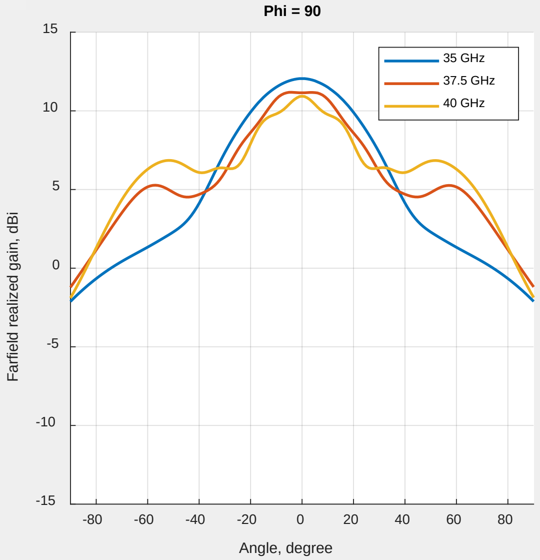












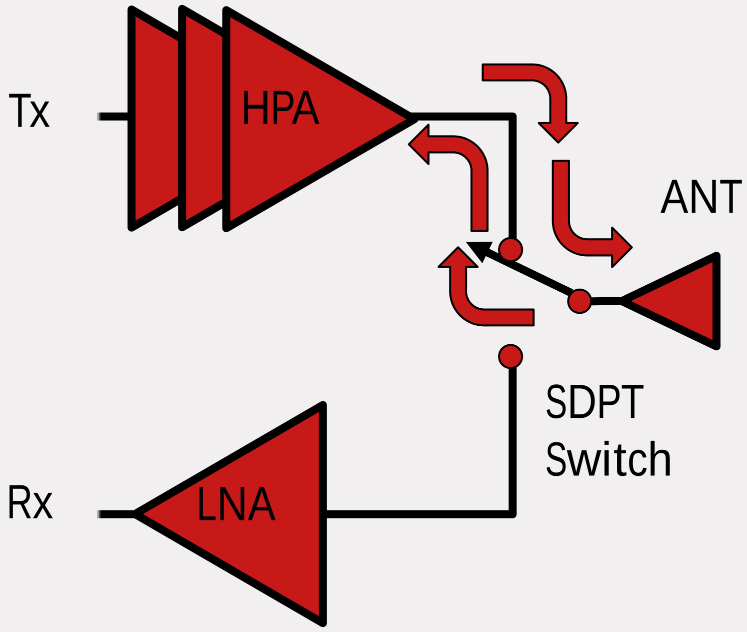
1. Patch antenna BW 13%
2. Broadband noise figure matching
3. Broadband power matching

Load-Pull Effects in Co-Designed Active Antenna Arrays

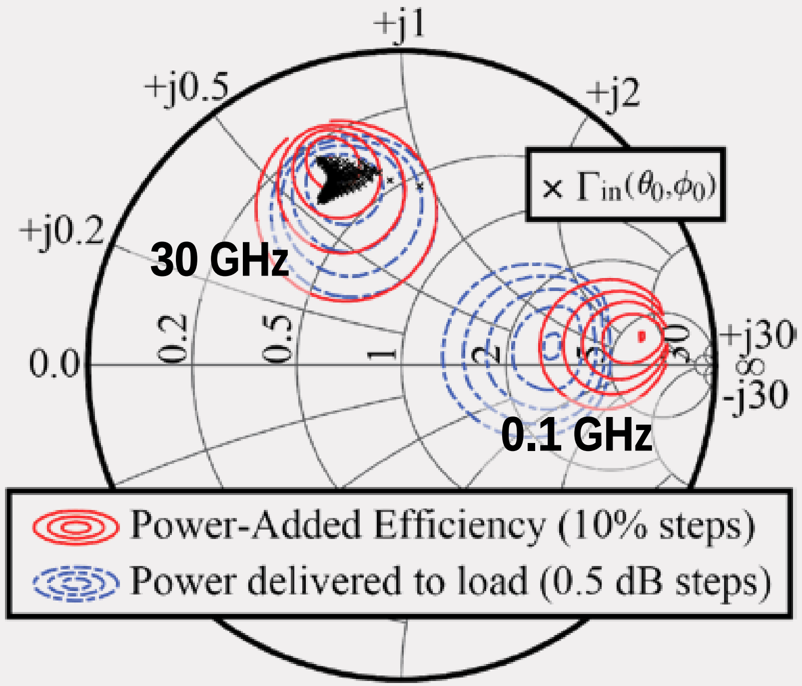
Contact: Martijn de Kok, m.d.kok@tue.nl

or "PA's from an Antenna Designer's Perspective"

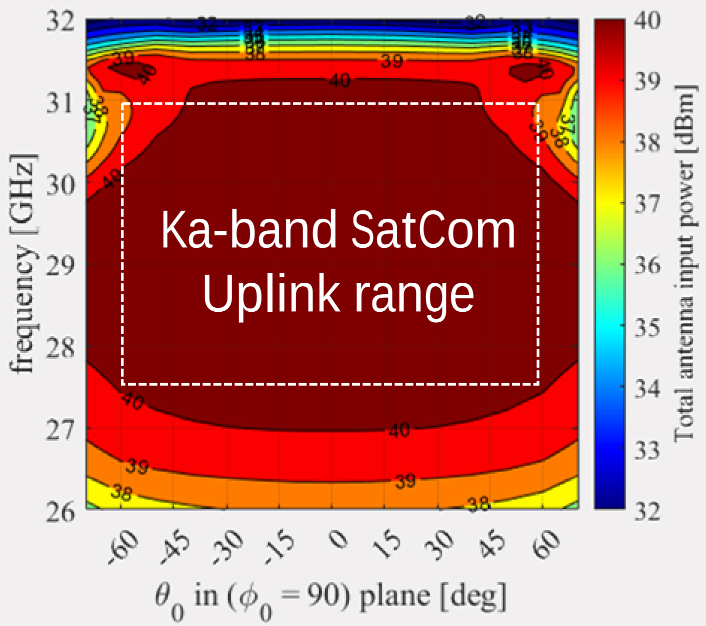
No isolation for mismatch reflections



Effect of scanning on PA performance



Resulting scan performance



Assessment of the Effect of a Test Setup on the Input Impedance Measurement of Cables

Contact: Mohammad Khorramizadeh, m.khorramizadeh@tue.nl

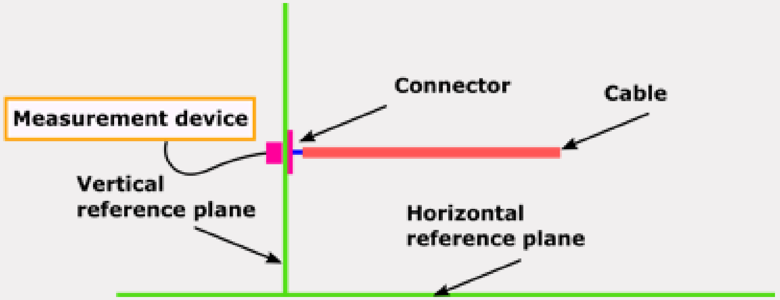


Fig. 1. The test setup in the earlier works used in this work

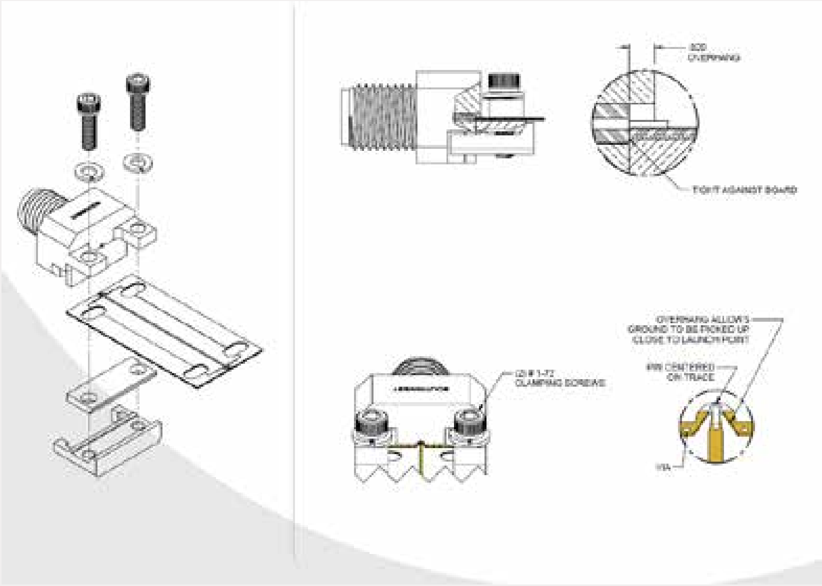


Fig. 2. End-launch connector structure[1,2]

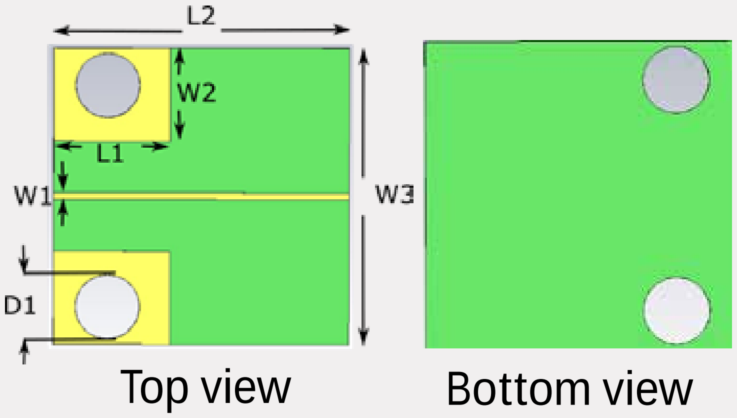


Fig. 3. The schematic of the designed PCB for the end-launch connector

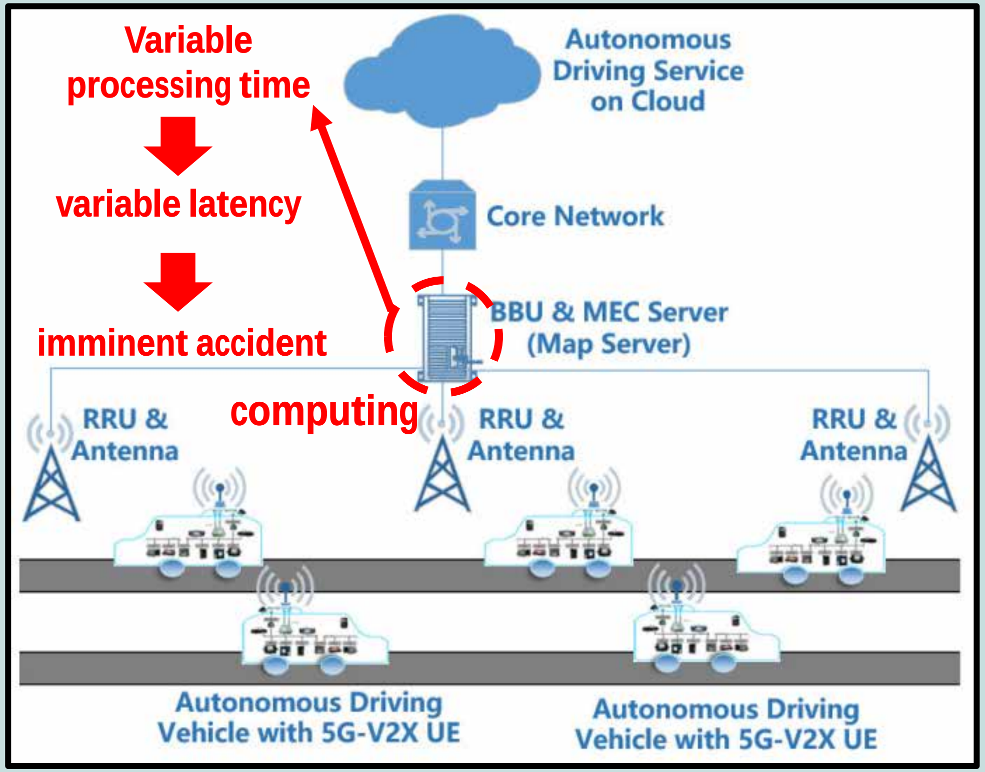
[1] Southwest Microwave, "Southwest Microwave 1092-01A-15 end launch 2.92mm (K) 40 GHz Jack (Female) Extended Length Panel Mount Standard Block (.500) Thread-In." https://mpd.southwestmicrowave.com/wp-content/uploads/2021/02/1092-01A-15.pdf
[2] Southwest Microwave, "End launch connectors DC to 110 GHz" ,https://mpd.southwestmicrowave.com/wp-content/uploads/2021/06/SMI-End-Launch-Connectors.pdf

5G URLLC computing: variability and predictability

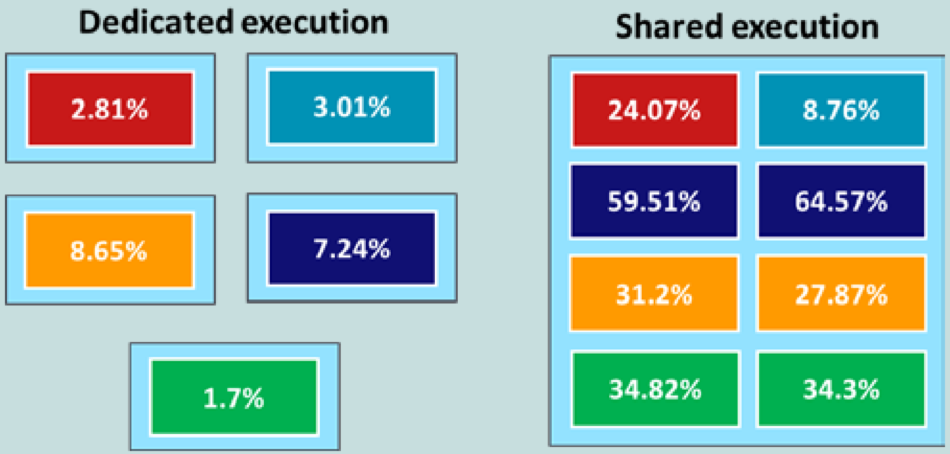
Contact: Panagiotis Giannakopoulos, p.giannakopoulos@tue.nl

GOAL: Enable time-sensitive systems through performance prediction.

5G & AUTONOMOUS DRIVING[1]



COMPUTING VARIABILITY[2]



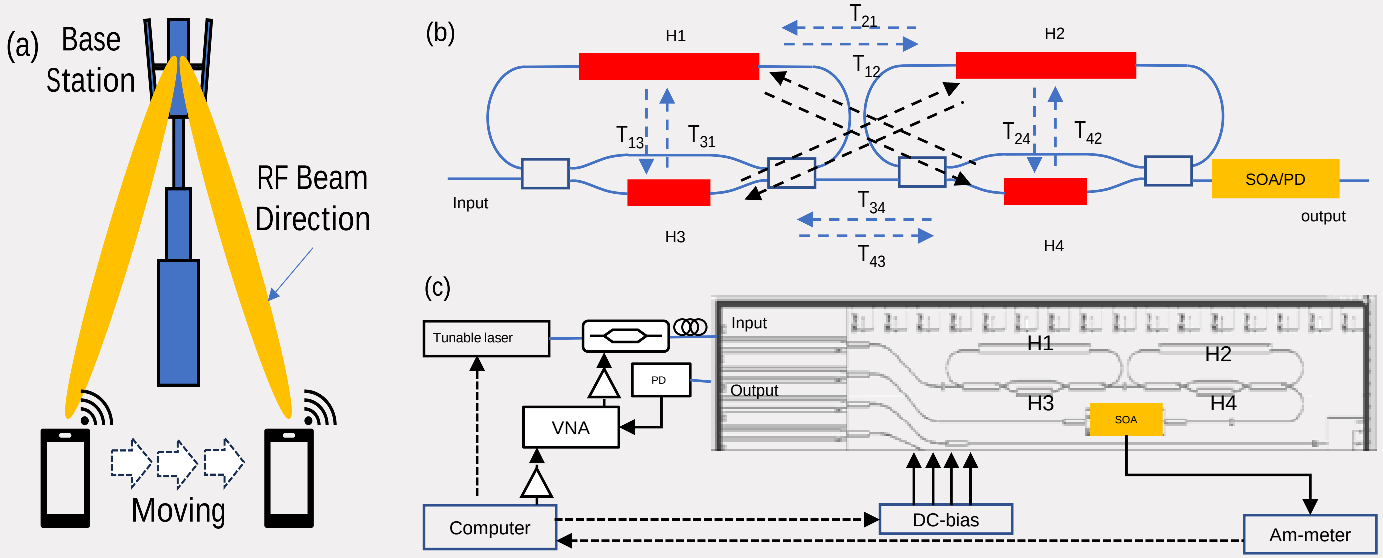
COMPUTING PREDICTABILITY

[1]Ma et al, IEEE Access'20
[2]Kuriata, Illikkal, XP'20

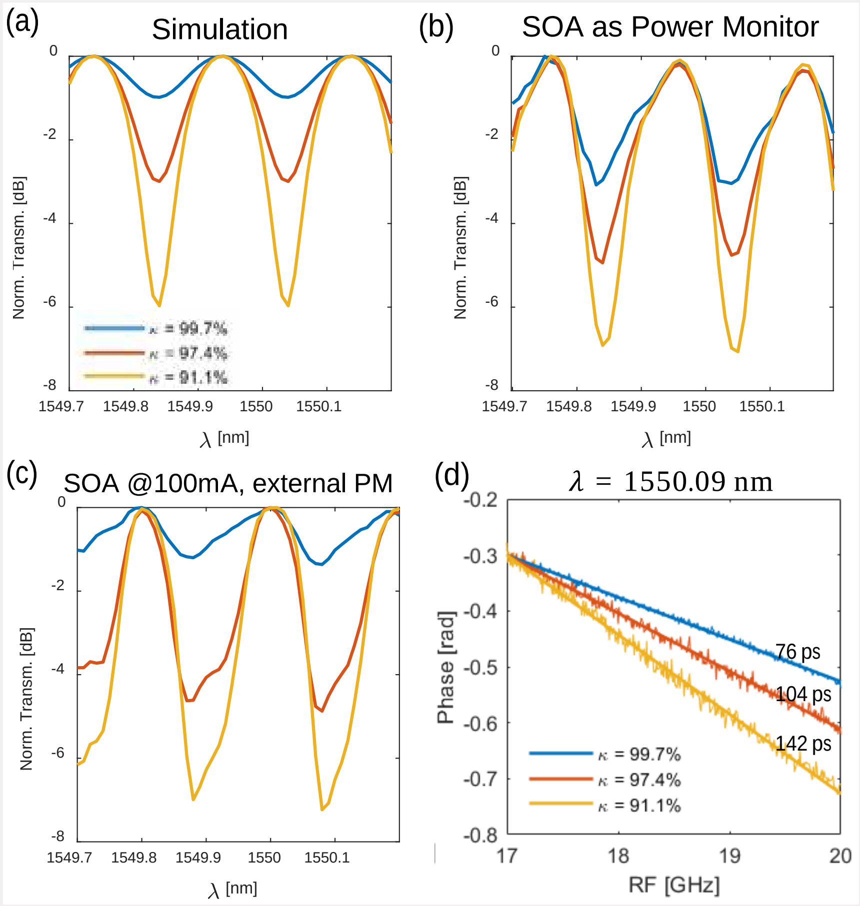
Automatic control of photonic integrated true-time delay for RF beam steering

Contact: Bin Shi, b.shi1@tue.nl

Abstract: We realize and demonstrate the thermal crosstalk compensated automatic voltage control of an ORR-based true time delay on InP photonic integrated circuit, with on-chip power monitoring and continue delay tuning, configurated within 1s.



Concepts and experimental set up

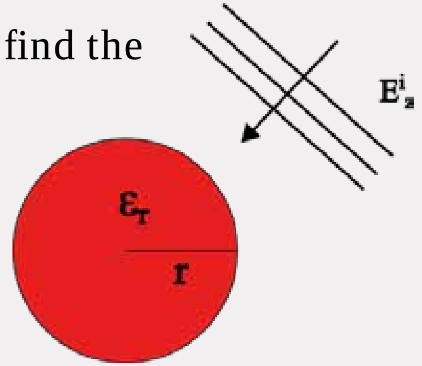


Results on power monitoring and TTD tuning

Numerical Convergence of A Hermite interpolation based spatial spectral solver for 2D TE polarization

D. van den Hof, R. J. Dilz

Setup: We have a homogeneous background medium with a dielectric scatterer on a bounded domain, we want to find the complete field at a given point $\vec{x}$.



Spatial spectral method: Replace the convolution integral by Fourier transformations and multiplications:

$$\vec{E}^i(\vec{x}) = \vec{E}(\vec{x}) - \frac{k_0^\nu}{j\omega\epsilon_0}\int_D \bar{G}(\vec{x}-\vec{x}')\vec{J}(\vec{x}')d\vec{x}' \rightarrow \vec{E}^i(\vec{x}) = \vec{E}(\vec{x}) - \sqrt{2\pi}^\nu \mathcal{F}^{-1}\left(\bar{G}(\vec{k})\mathcal{F}\left(\chi(\vec{x})\vec{E}(\vec{x})\right)\right)$$

Previously developed solver:

- Written in C++ as a python module
- Allows discretization of given function handle
- Implements quick and accurate Fourier transformations
- Extremely flexible

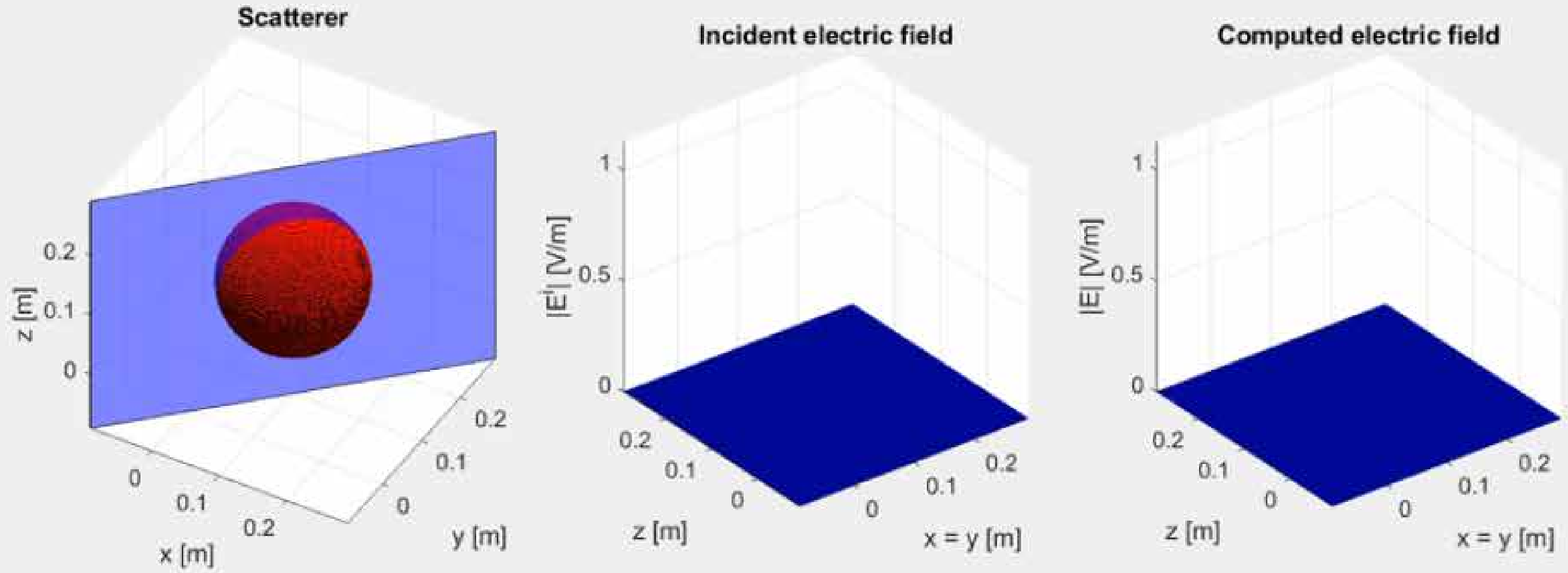
```
def spat_TE_2D_G(x):
    ret = 0
    r =np.sqrt(x[0]**2+x[1]**2)
    if r == 0:
        ret = 0
    else:
        ret = 1J*(np.pi/2)*sp.special.hankel1(0,r)
    return ret

disc = boostwrap.loaddiscretization(disc_file)
GF_spat = disc.create_from_fun(spat_TE_2D_G,(0,0))
cyl = disc.create_from_fun(spec_cyl,(1,1))
cyl.invfourier(0)
cyl.invfourier(1)
d_wave_in = disc.create_from_fun(f_wave_in, (0,0))
solvedSystem,n_taken =  GMRes(Aop,d_wave_in,d_wave_in.copy(),1e-5,100, cyl, GF_spat)
```

We used the solver on a 2D TE problem with a dielectrical cylinder where we used Hermite interpolation as a discretization method. We quantified the relationship between the accuracy, the performance and the simulation parameters.

Time Domain Volume Integral Equations

Scattering from high contrast scatterers

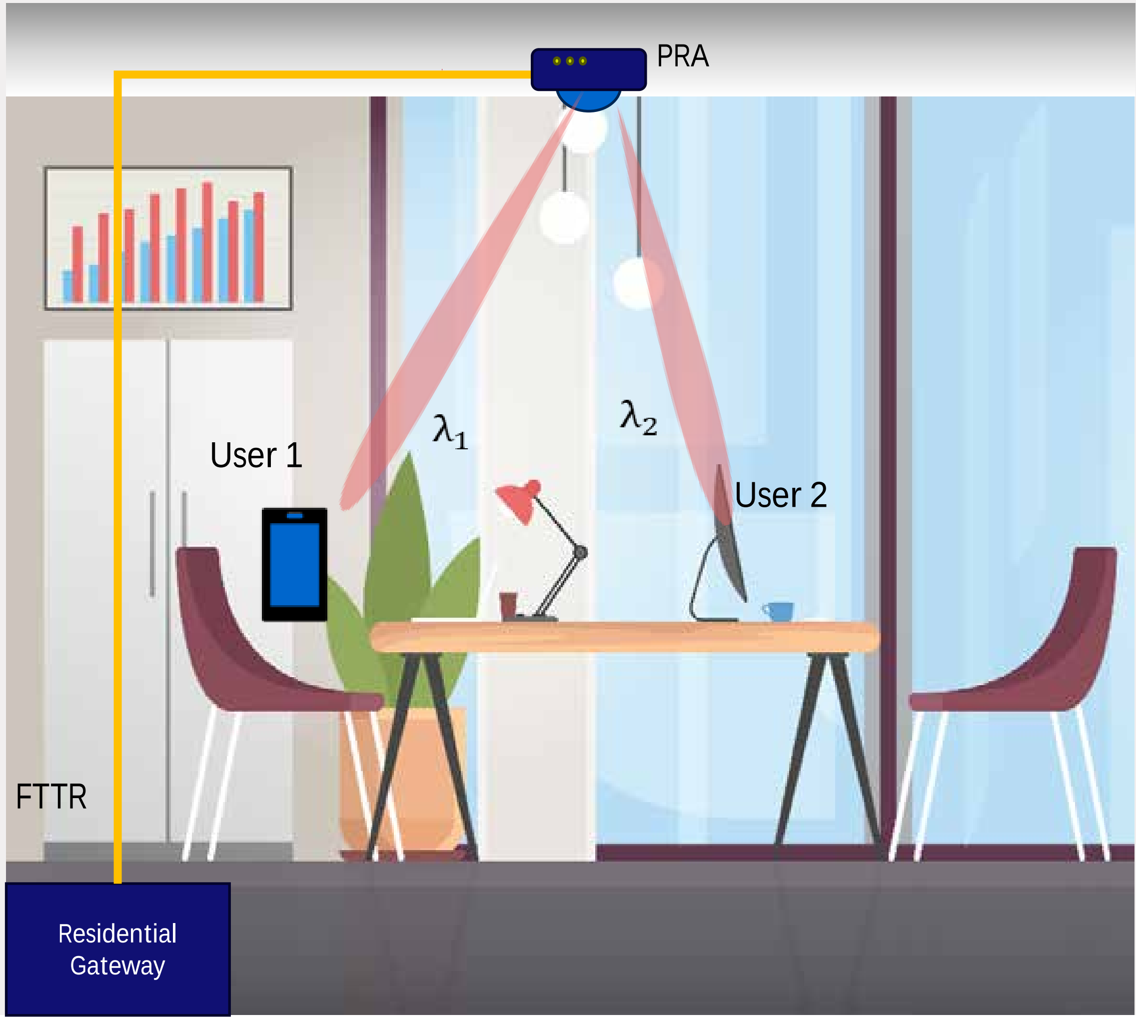
Contact: Pieter van Diepen, p.w.n.v.diepen@tue.nl



Beam-Steered Optical Wireless Communication based on Piezoelectric Actuators and Micro-Lenses

Eduardo Muller, e.muller@tue.nl

- **Challenge:** Wireless network congestion due to limited RF frequencies and IoT growth.
- **Solution:** Optical Wireless Communication (OWC) with MEMs Cantilevers and Piezoelectric Actuators.
- **Advantages of OWC:**
  - Enormous bandwidth.
  - Minimal latency.
  - Enhanced privacy and security.
  - Minimal interference from neighboring networks.
- **Achievements:**
  - Continuous steering with 27.9° field of view (horizontal).
  - 12.8° field of view (vertical).
  - Fast-steering with 3.61π rad/s (horizontal) and 1.22π rad/s (vertical).



Low power hardware design for a dynamic neural network based 6G wireless receiver

Contact: Bram van Bolderik b.v.bolderik@tue.nl

Intelligence in O-RAN Architecture for resource optimization

Contact: <Rahul Saini>, <r.saini@tue.nl>

The fundamental principles of O-RAN architecture are as follows:

- Virtualization of network elements
- Open and well-defined interfaces
- AI-capable RAN for Intelligence

O-RAN Alliance has been recognized by **32 Mobile Operators** and **326 companies** are aligned with the idea of disaggregating RAN elements for a truly open and intelligent Radio Access Network.

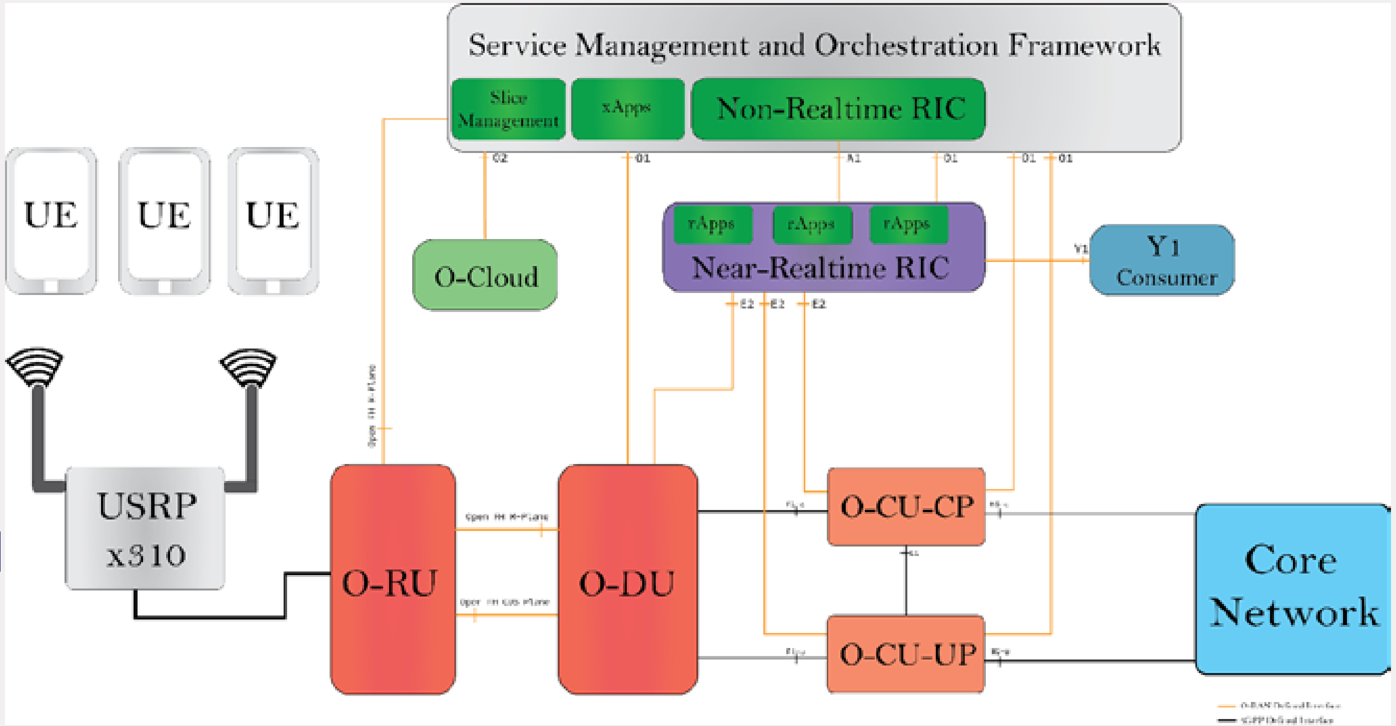


Fig 1. O-RAN Experimentation Architecture

Dual band 77/150 GHz Receiver for Automotive Radar

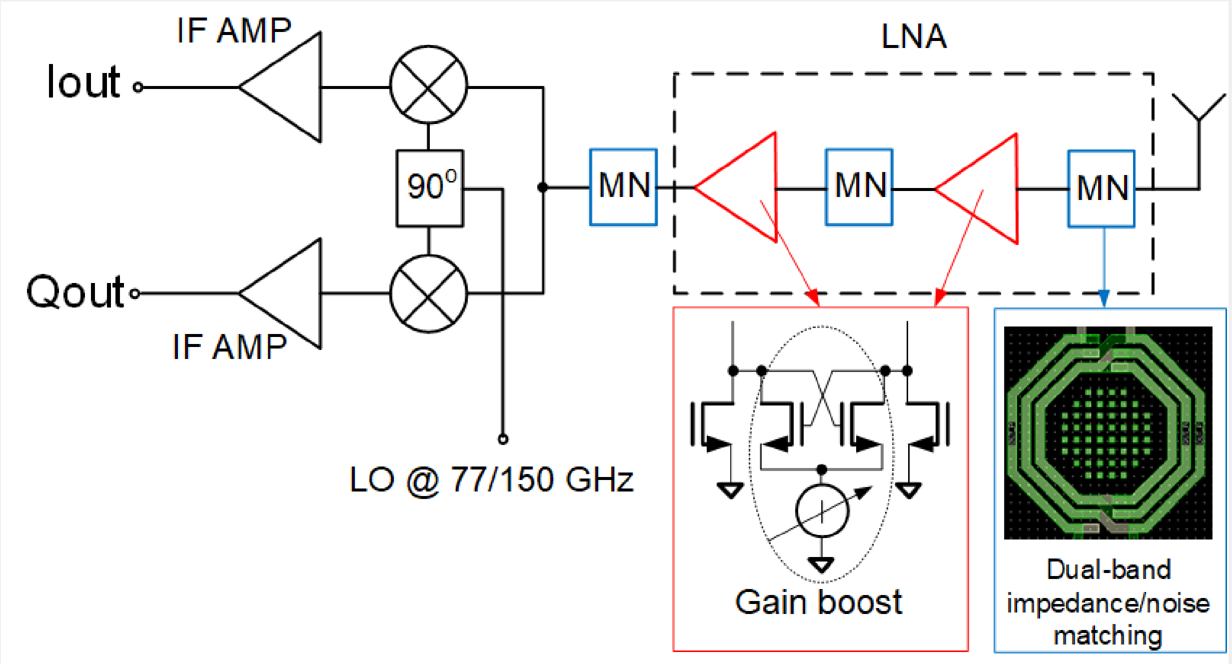
Contact: Rainier van Dommele, a.r.v.dommele@tue.nl

Motivation

In radar, range and resolution are traded:

- 77 GHz provides high range (object detection)
- 150 GHz gives high resolution (object recognition)
- Dual-band TRX is way to trade off performance/cost

Mm-wave RXFE design challenges

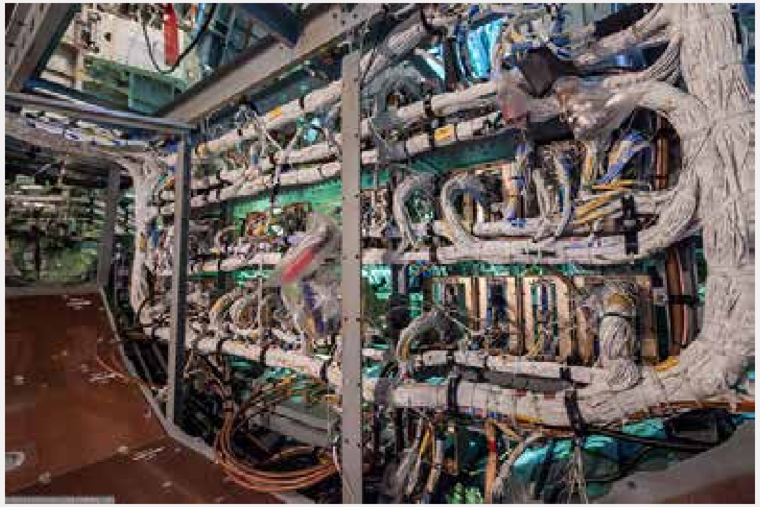


- Single RX line-up for 77/150GHz -> small area in MIMO/phased array
- Gain boosting -> reduced length of line-up -> low power
- Dual-band matching based on transformers -> small area

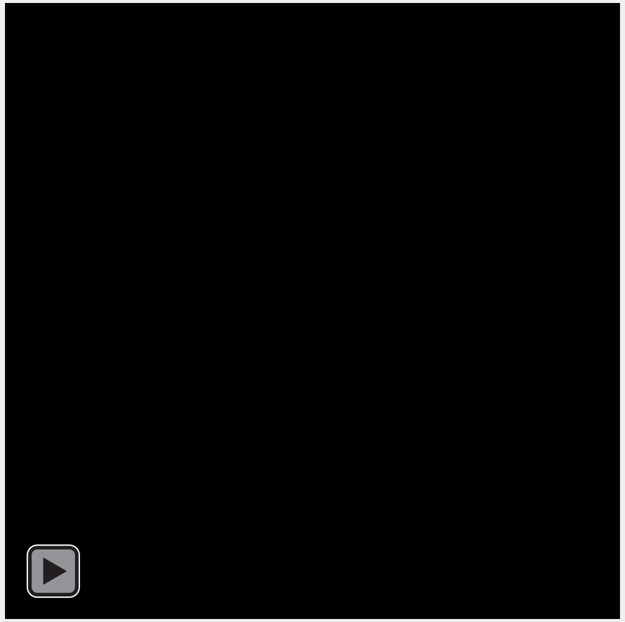
Wideband Null Steering for Reliable Intra-Aircraft Communication

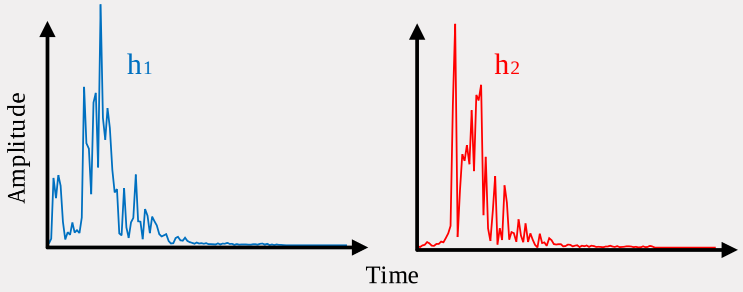
Contact: Erik Bertram, e.s.bertram@tue.nl

- Aircraft have very bulky wiring systems
- ADENEAS hopes to reduce this wire bulk
- Provide Reliable Wireless solutions as replacement

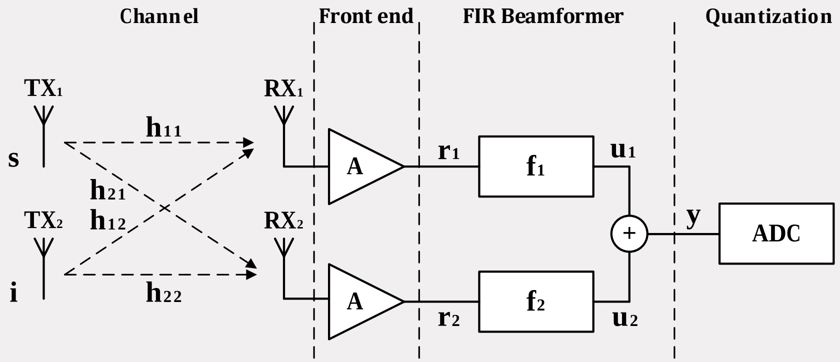


- To find a potential solution, we scanned the MIMO
- Using a network analyzer, we could coherently scan many channel realizations



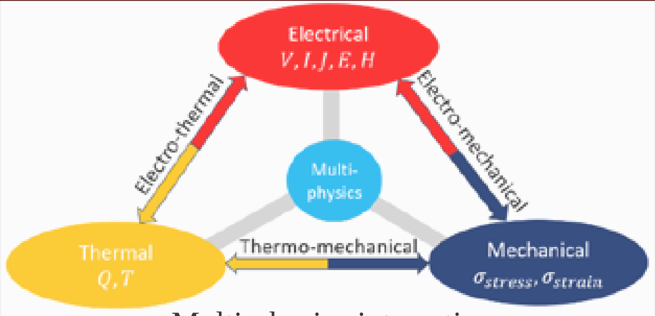


- Create a beamformer that can separate signals in rich scattering
- Use FIR filters to compensate the channel
- Reduce ADC bit resolution



Multi-physics modelling for improving design-time and energy-efficiency of highly integrated active antenna arrays

Contact: <Mohammad Shahid>, <m.s.mohammad.shahid@tue.nl>



Multi-physics interactions

5G advance

Challenges

- High power
- High temperature
- Nonlinearities

Electro-Thermal Passive Intermodulation (ET-PIM)

Motivation

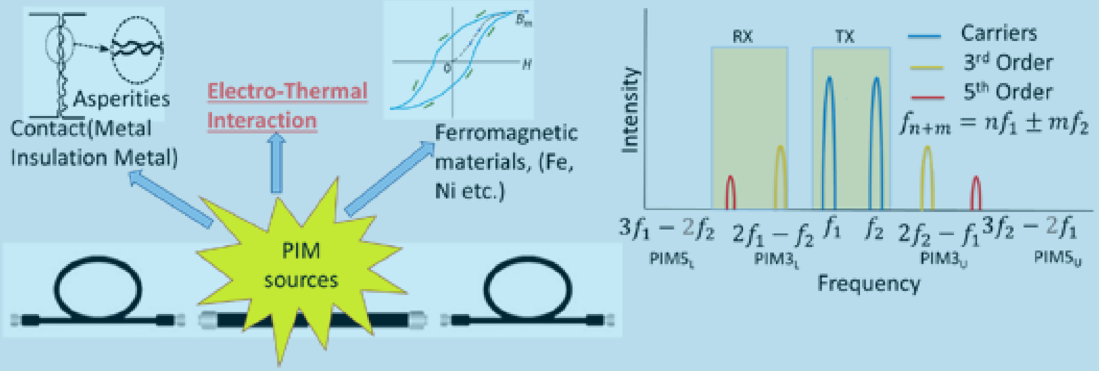


Figure 1. Generation of PIM due to various possible nonlinear sources and an example of Frequency-division multiplexing(FDMP) to demonstrate the generation of PIM signals that fall in receiver band

Heat-Sink Antenna Arrays

Motivation

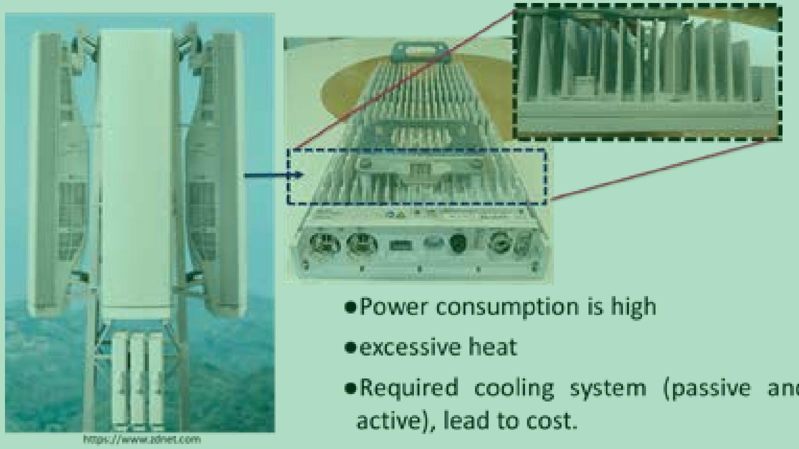


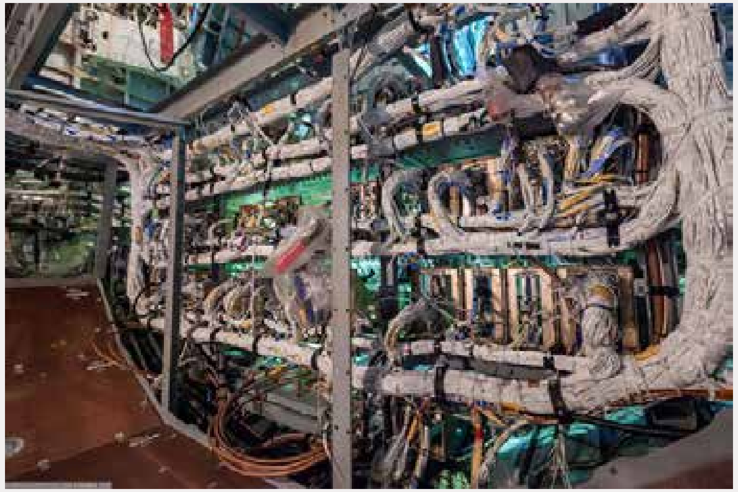
Figure 2. Nokia AirScale 5G base station (left) and pictures from Ericsson Lab(right)

- Power consumption is high
- excessive heat
- Required cooling system (passive and active), lead to cost.
- Combining heat-sink antenna arrays and modern cooling techniques

Private 5G Networks for Intra-Aircraft Communications

Contact: Anudeep Karnam, s.s.a.karnam@tue.nl

- Objective:
  - Harnessing private 5G for intra-aircraft communications, to minimize cabling, weight, and subsequently reduce CO_2 emissions
- Advantages:
  - Potentially 30% of cables can be replaced
  - Estimated 12% fuel savings
- Challenges:
  - Challenging propagation environment within aircraft
  - Strict failure tolerance: 10^{-9}/hr
- Approach:
  - Standalone private 5G network within an aircraft
    1. Device-to-Device based approach
    2. Infrastructure based approach



Airbus 380-800: 470 km of wire, weighing 5700 kg

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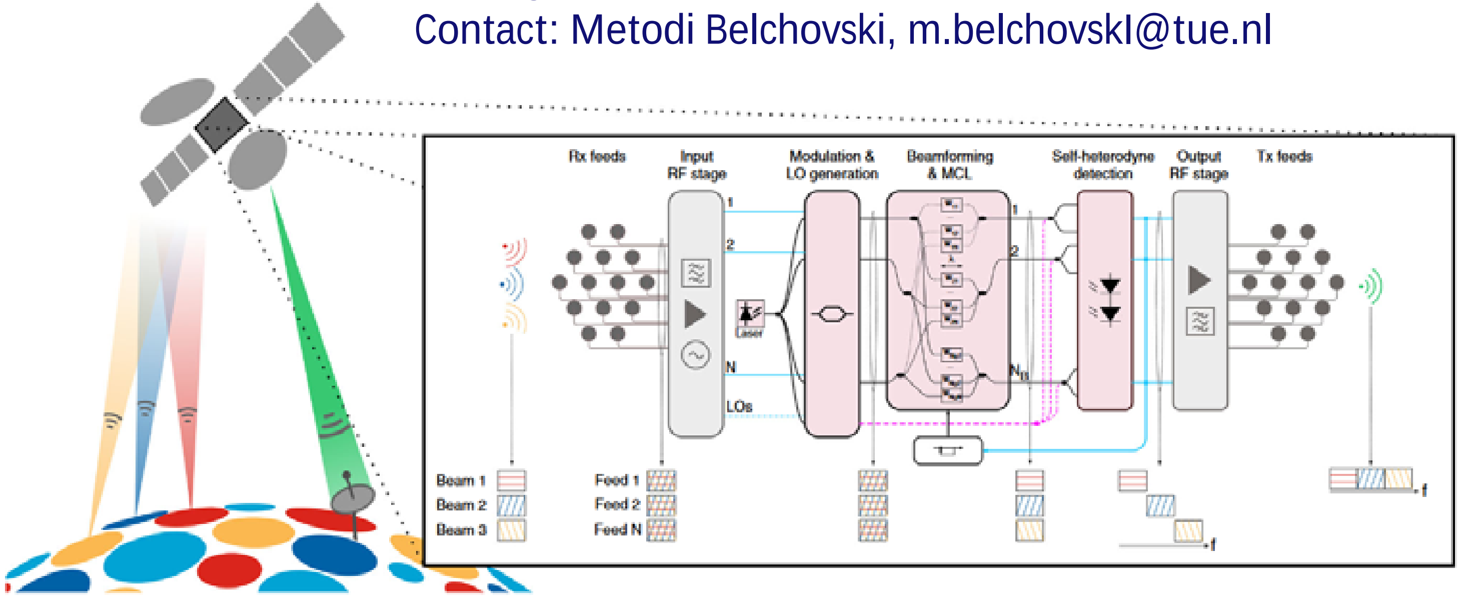
Integrated Photonics for RF front-end in satellite communication

Contact: Metodi Belchovski, m.belchovskI@tue.nl



RELEVANCE

- 6G = Unified 5G terrestrial + satellite network
- Solution for signal routing/ switching/ beam forming networks (BFN) at satellite nodes

PROBLEM

- Increase data throughput
- Reduce Size, Weight and Power (SWaP)

SOLUTION

Integrated photonics because:

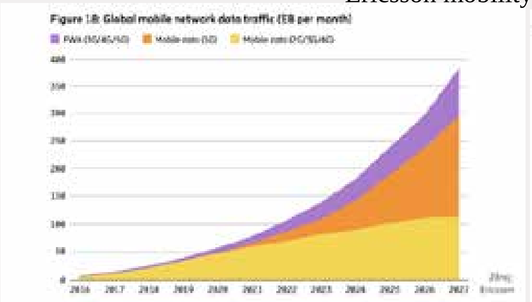
- Large transport/processing optical BW
- Small, Lightweight, Compact, Power efficient

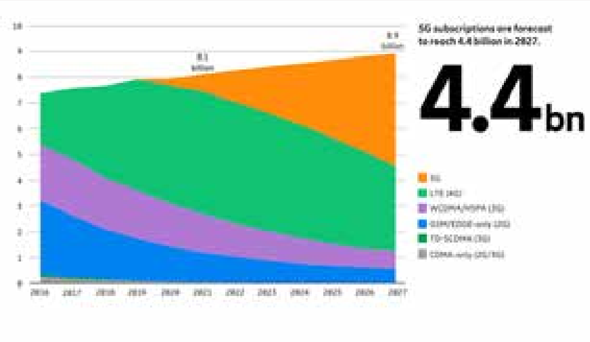
Assessing 5G mm-Wave Indoor RF Exposure: Insights from Channel Sounding

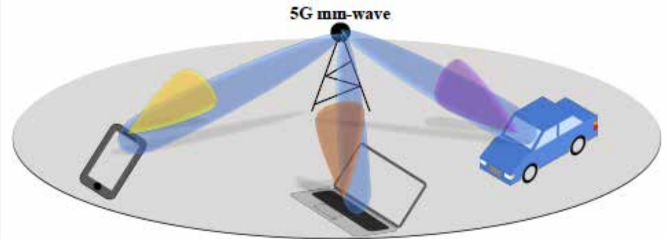
Sudha Malik, s.malik@tue.nl

Motivation

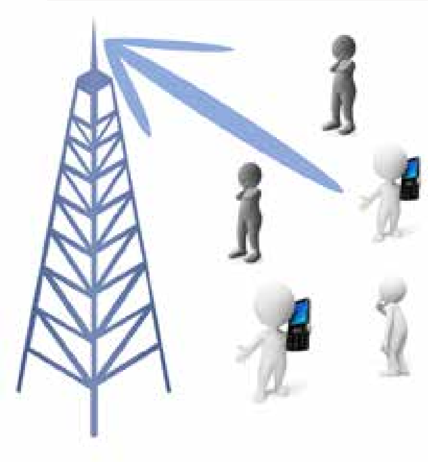
Ericsson mobility report, 2021







5G mmWave beamforming

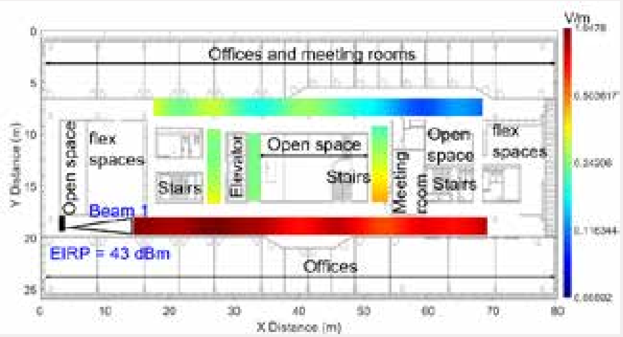


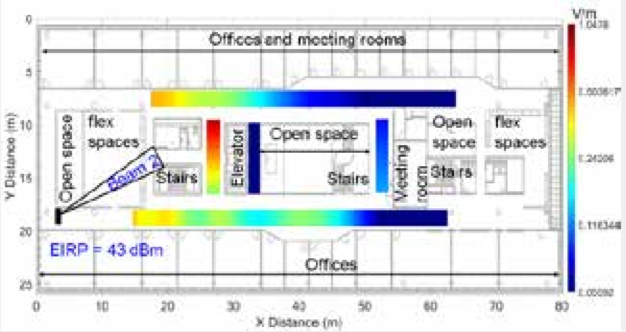
5G mmWave antenna direct signal to the user

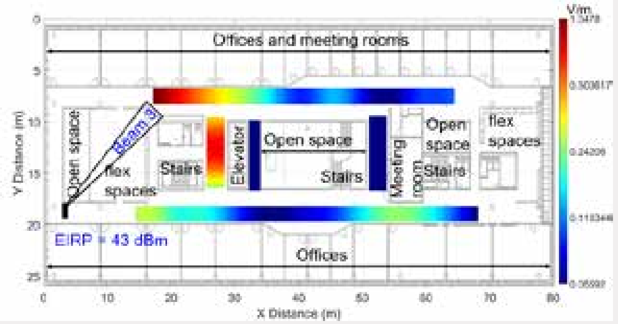
In-situ measurement

*S. Aerts et al., IEEE Access, vol. 7, pp. 184658-184667, 2019.

Methodology for Indoor RF exposure assessment and measurement results





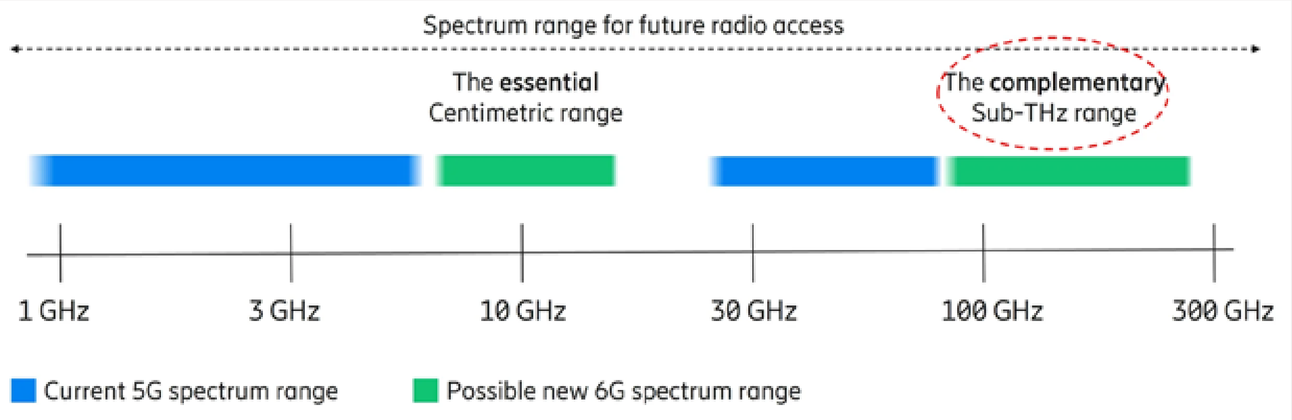


Conclusion

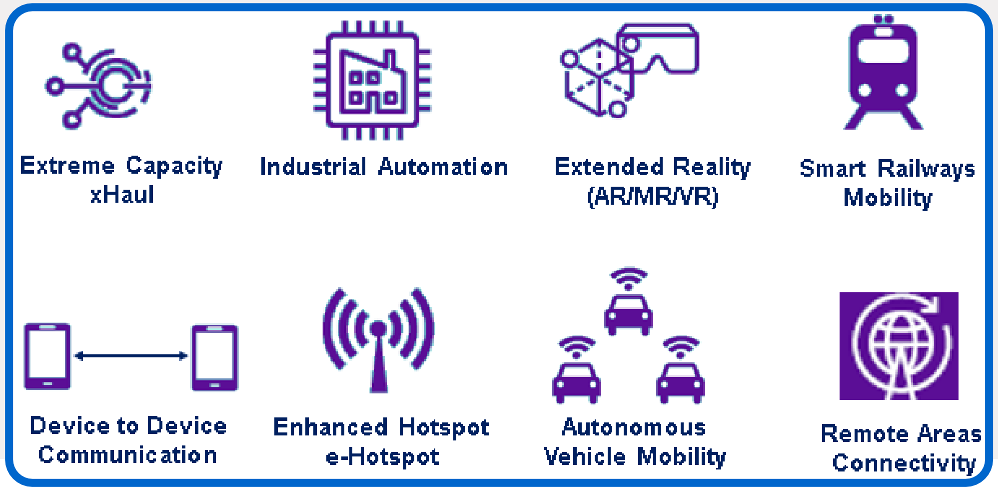
- **This work has presented an experimental assessment of RF-EMF exposure at 27 GHz from a channel sounder within a real-world indoor environment.**
- **The maximum recorded exposure is found for the beam transmitting in a direct LOS path.**
- **The maximum recorded exposure is 1 .05 V/m, which corresponds to about 1.7 % of the ICNIRP/IEEE reference level of 61 V/m.**

Material Characterization techniques for 6G applications in the Sub-THz bands

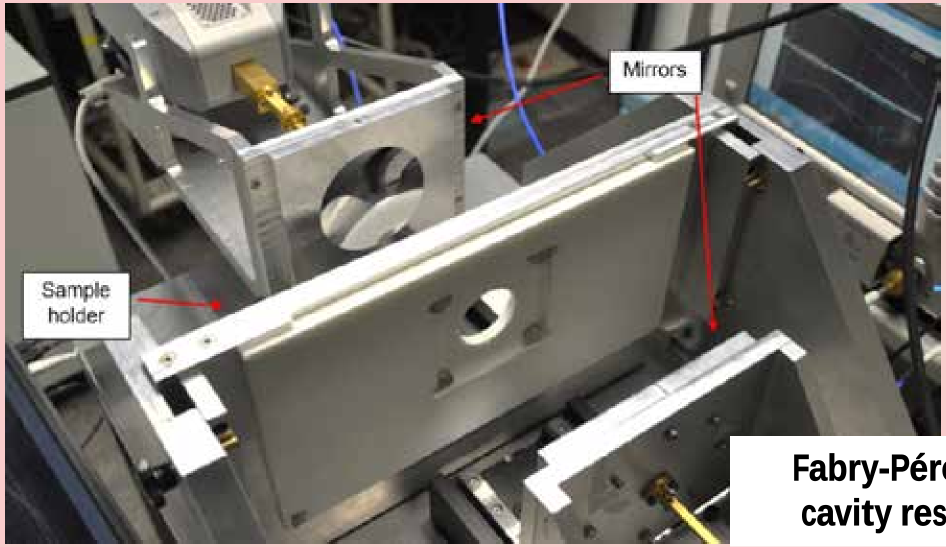
Contact: Paola Escobari. *p.a.escobari.vargas@tue.nl*



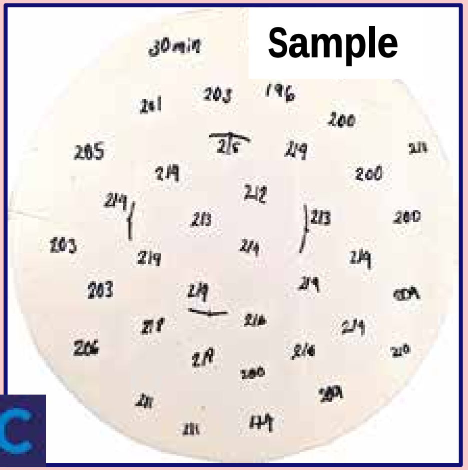
Source: www.ericsson.com/en/6g/sub-terahertz-communication



Source: www.techplayon.com/6g-wireless-access-use-cases/



Fabry-Pérot open cavity resonator



Come to see the results in the poster!

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Power Efficient 140GHz Transmitter Architectures for Next-Gen Automotive Radar

Contact: Remco Schalk, r.schalk@tue.nl/remco.schalk@nxp.com

Next generation automotive radar requires

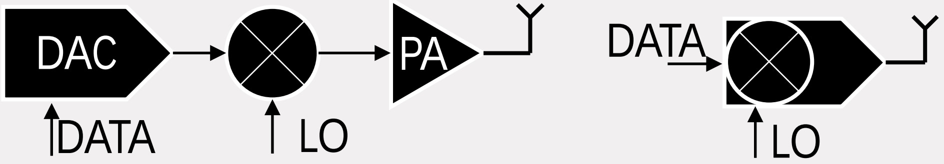
- **Increased** range, angular and velocity resolution
- **Increased** robustness
- **Increased** interference mitigation

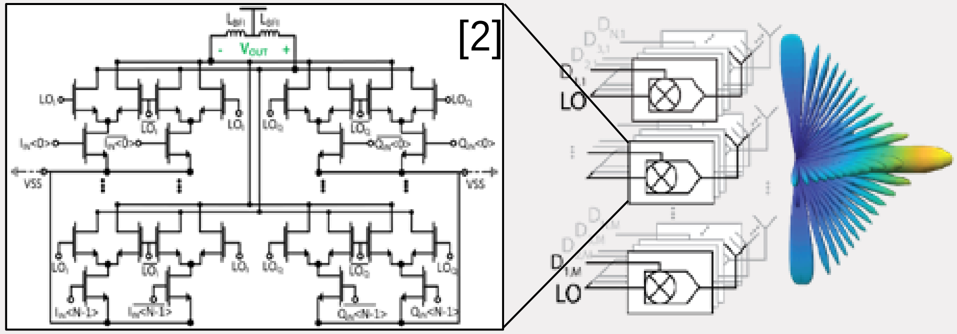
140GHz automotive radar potential solution

J **Increased** available BW

J **Reduced** antenna size

L **Reduced** efficiency





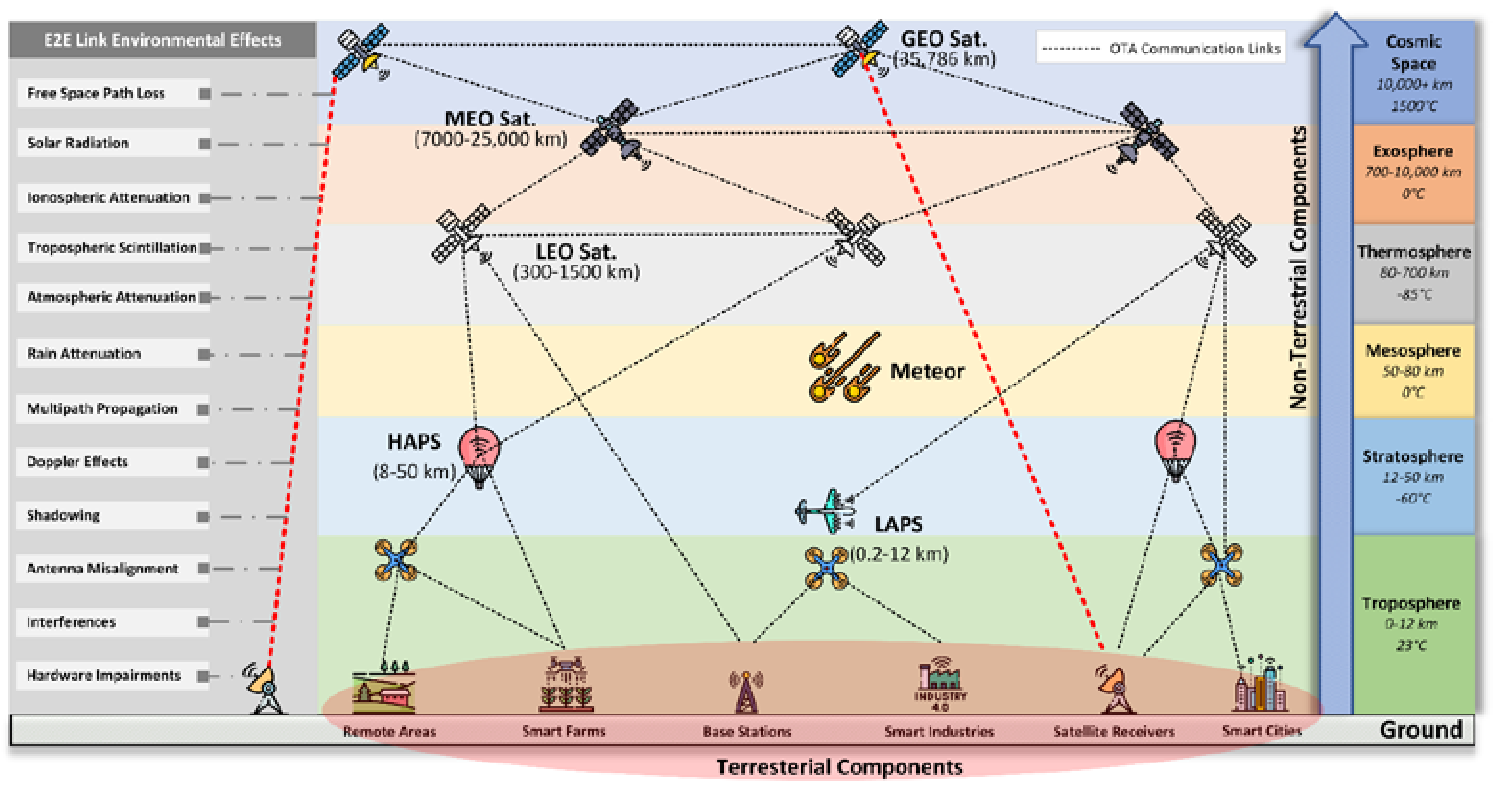
Explore potential of digital transmitters for 140GHz radar

[1] NXP Semiconductors, Automotive
[2] M. Neofytou, ISCAS 2021

<Dynamic High-Pathloss Doppler-Enabled OTA Emulator>

Contact: <Naila Rubab>, <n.rubab@tue.nl>

To design and implement a dynamic high-pathloss doppler-enabled over-the-air emulator for wireless communication systems for non-terrestrial (NTN) scenarios



Run-time Bit-wise Data Gating for Dynamic Neural Networks in Wireless Receivers

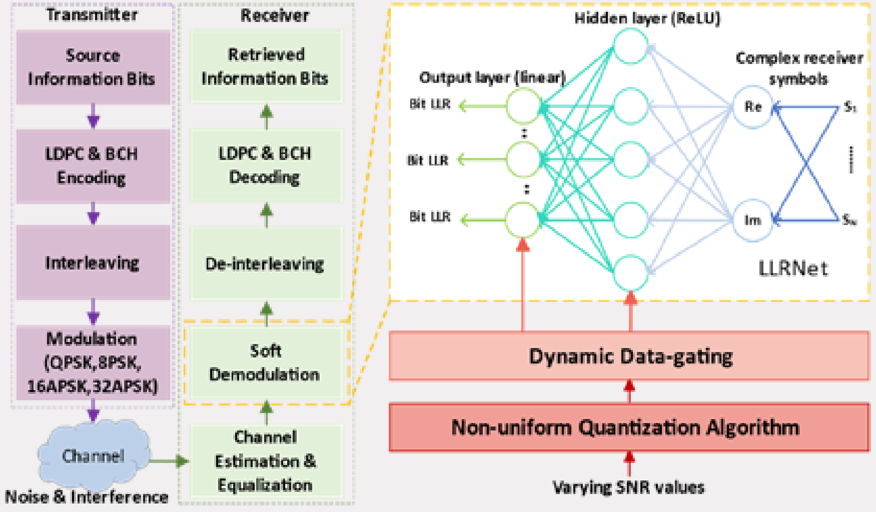
Contact: Priscilla Sharon Allwin, p.s.allwin@tue.nl

Problem statement:

Dynamic Neural Networks (DyNN) have the capability to adjust their structure, parameters, and precision on the fly.

This adaptability makes DyNNs well-suited for systems operating in rapidly changing environmental conditions, like wireless communication.

Traditional uniform quantization, if applied in DyNNs, can lead to unnecessary power consumption due to varying precision needs in different environmental conditions.



Contributions:

An offline non-uniform quantization algorithm enabling run-time quantization adaptation while preserving system performance.

A low overhead dynamic data-gating architecture facilitating run-time non-uniform quantization.

Results:

By using an LLRNet with dynamic data-gating :

- Up to 43 % total power reduction
- 3% minimal area overhead
- Improved EDAP as constellations get denser

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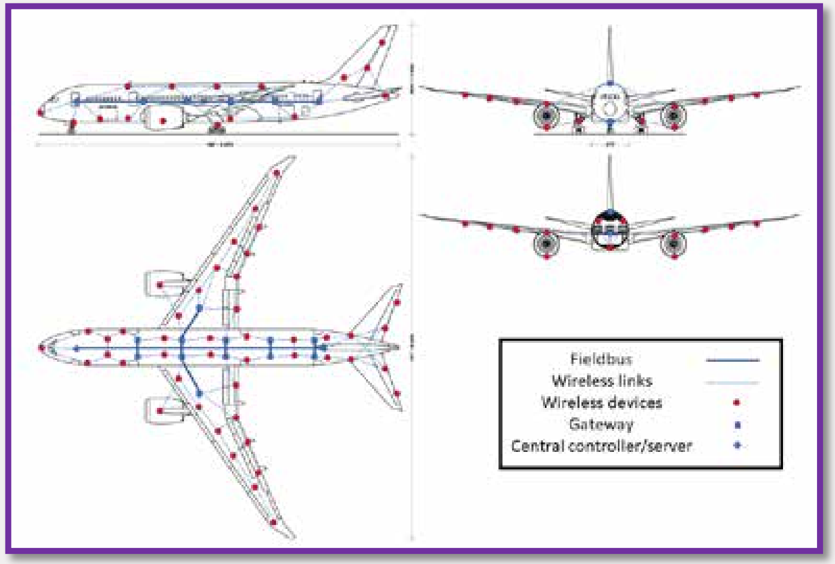
Techniques for Ultra-Reliable Intra-Aircraft Wireless Communications

Contact: Jobish John / Smolders, Youri, (j.john@tuel.nl / y.smolders@student.tue.nl)

Source: Roberto Magni by Foto ReD Media Airbus

Current → Future

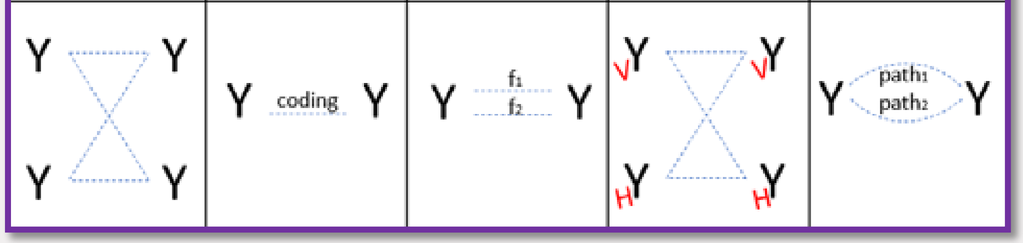
Hybrid Wired-Wireless Architecture



- Airbus A380 aircraft roughly contains a total wiring length of **470 km** and total wire weight is **5700 kgs**
- **30%** of cables are potential candidates for a wireless substitute
- WAIC is estimated to reduce fuel consumption by **12%**

Reliability through Diversity Techniques

Spatial	Time	Frequency	Polarization	Channel



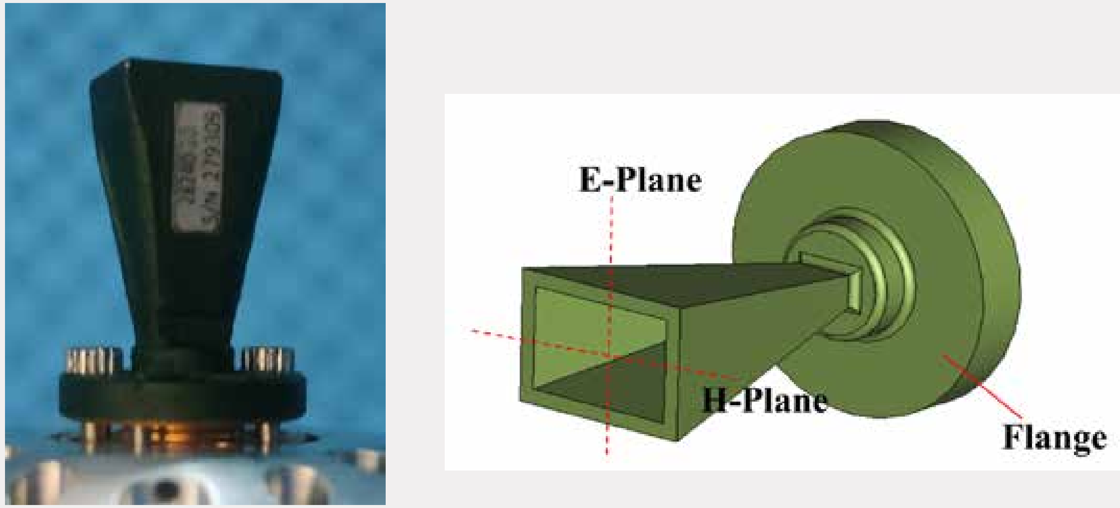
Joint work with

CWTe CENTER FOR WIRELESS TECHNOLOGY EINDHOVEN

TU/e

Standard Gain Horn Antenna: A Reliable Reference for Antenna Gain Measurements?

Purnima Yadav, p.purnima@tue.nl



(a) (b)

Fig. 1. (a) Simulation Model and, (b) Actual Standard Gain Horn Antenna

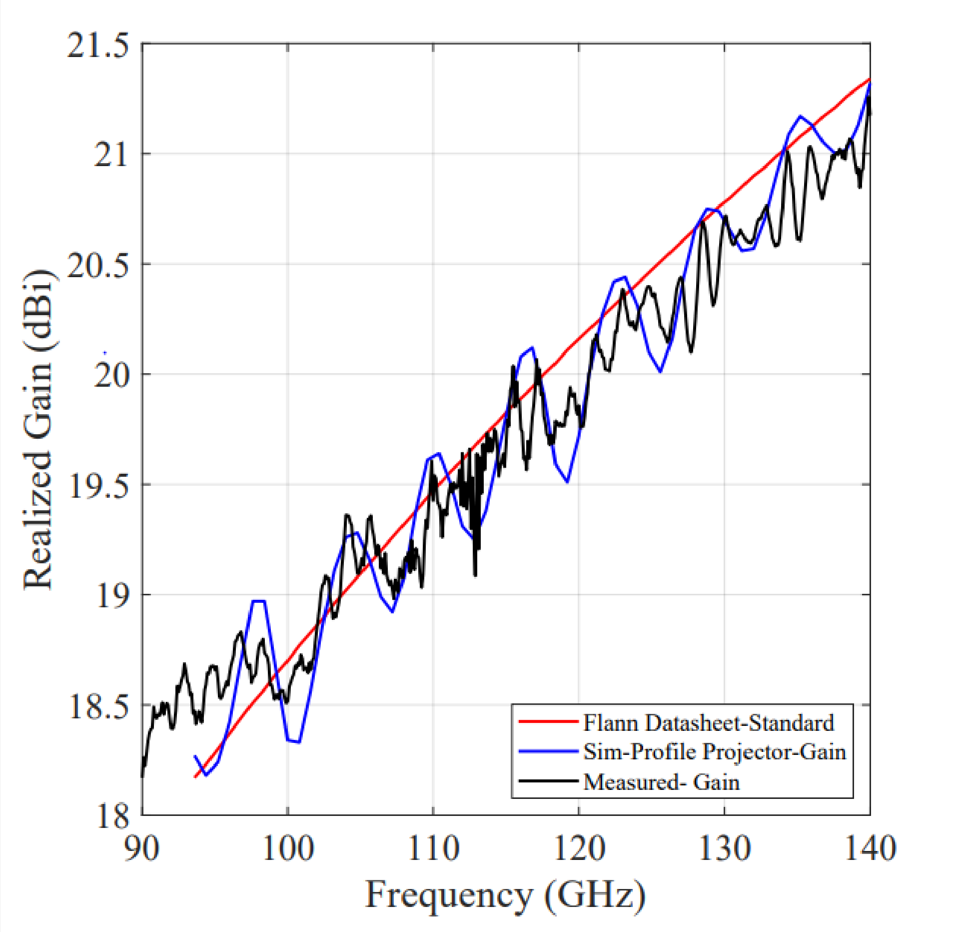


Fig. 2. Comparison of the simulated and measured gain with frequency of Flann microwave SGH.

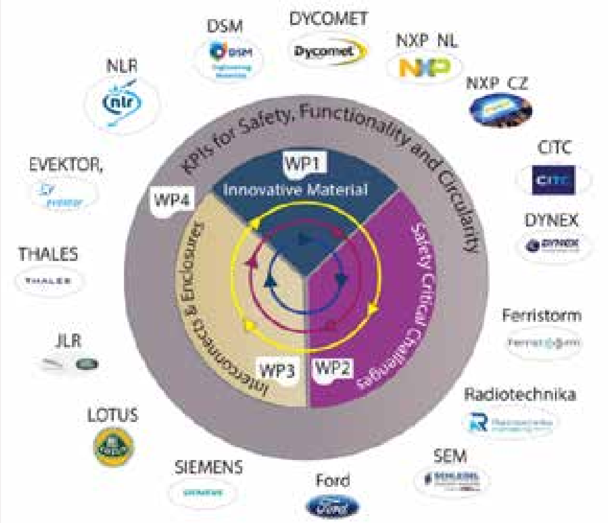
Safe and Sustainable Electromagnetic Shielding Solutions for Mobility

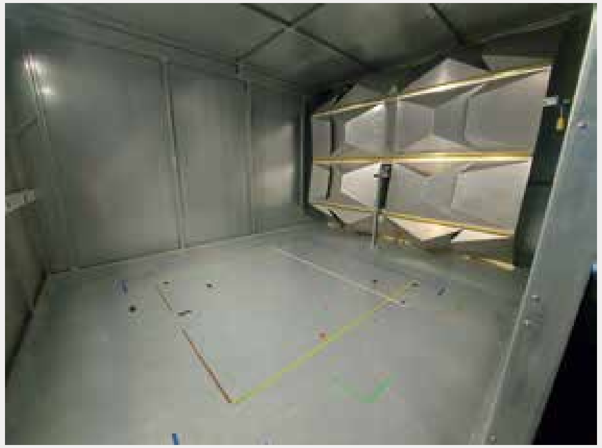
Contact: Sadegh Barzegar, m.s.barzegar.klishomi@tue.nl; Furkan Sahin, f.sahin@tue.nl

PARASOL is a European funded Marie Skłodowska-Curie project, with partners from 6 countries and 12 Doctoral Researchers (DRs) will be involved.

With a new mindset towards Safe-and-Sustainable-by-Design approach, each DR will develop missing tools and techniques for electromagnetic shielding solutions for vehicles.

TU/e has 2 DRs who will focus on Shielding Effectiveness of Cables (DR8), and Novel In-situ Material Characterization Methods (DR2).





DR8 will develop an accurate measurement procedure for Shielding Effectiveness by finding “radiation efficiency” of cable shielding using Reverberation Chamber.

DR2 will develop In-Situ, Non-destructive and broad-band material characterization method to retrieve electrical parameters.

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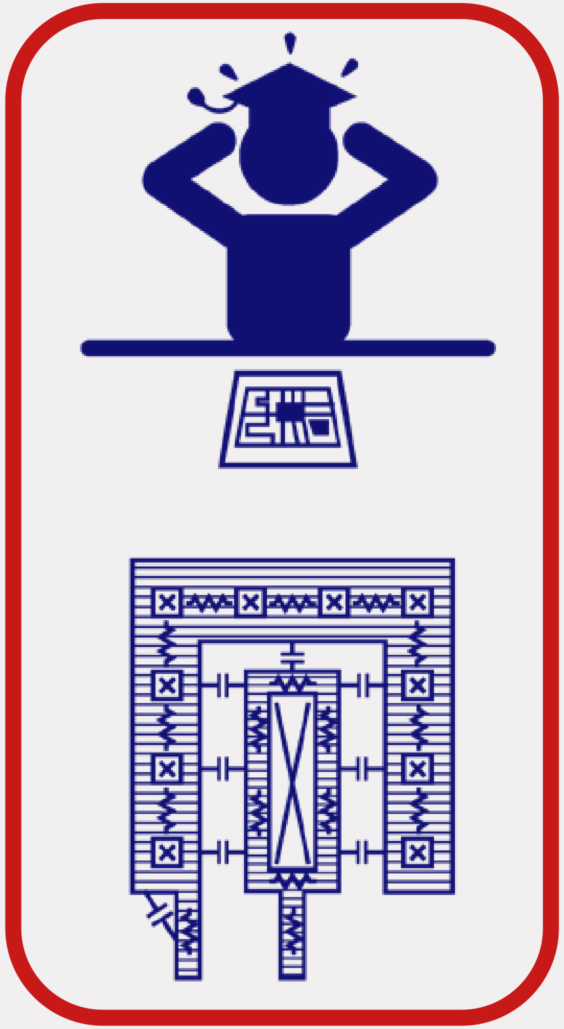
Integrated Circuits – Designed by the Public

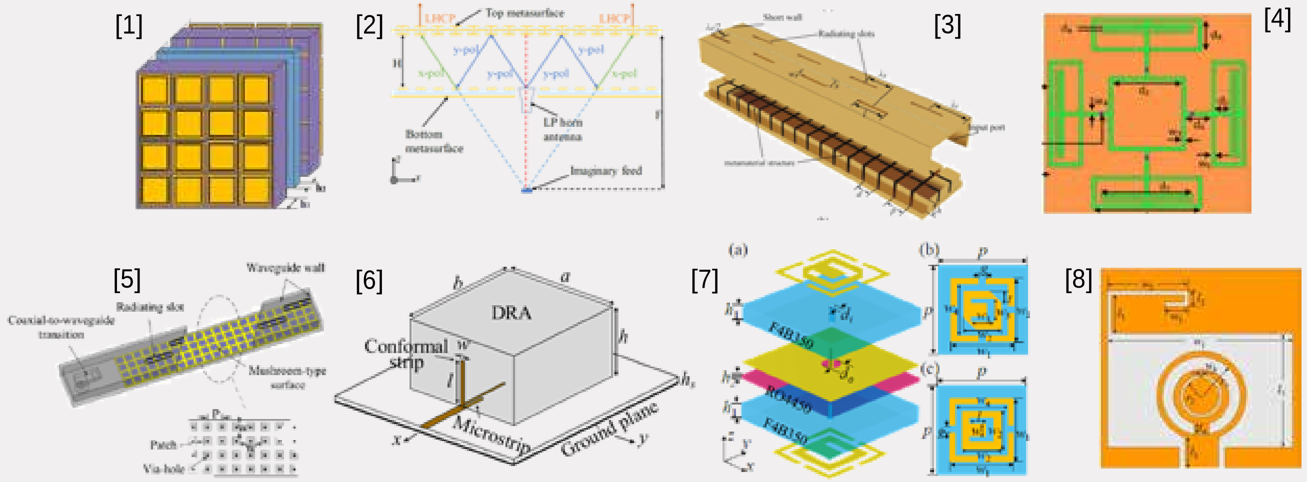
Contact: Elles Raaijmakers, e.a.l.Raaijmakers@tue.nl

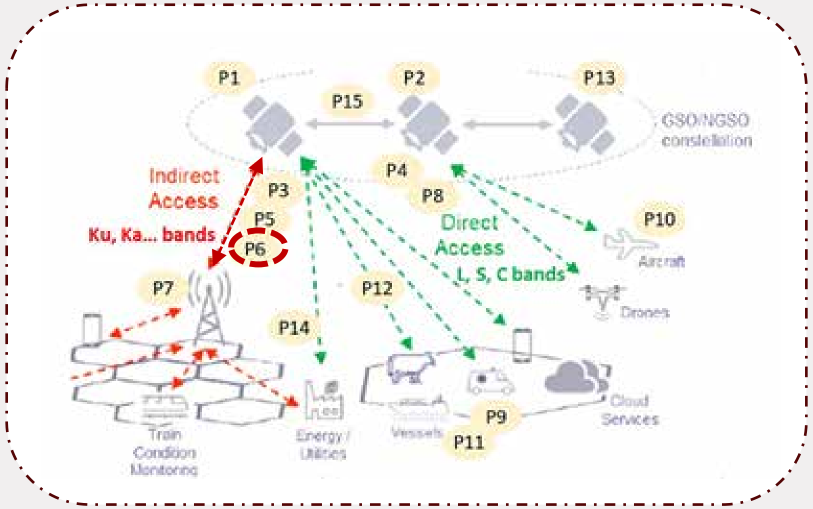


Integrated Filtering Antenna Solutions for Satellite Communications

Ashifa. M. Musthafa, a.mohammed.musthafa@tue.nl

The project is focused on the design of integrated filtering antenna arrays for beyond 5G or 6G satellite communications. Emphasis is put on the development of innovative solutions with various synthesis methods to optimize frequency selectivity, roll-off factor, in-band gain stability, insertion loss, and total efficiency.





[1] S. -Y. Lou, R. Li and H. -T. Gao, "Design of a Low Profile Flexible Tri-Band Frequency Surface Applied in X-Band, K-Band and Millimeter-Band," in IEEE Access, vol. 7, 2019.
[2] Q. -S. Jia et al., "A Broadband Filtering Circularly Polarized Folded Transmitarray Antenna Based on Metasurface," in IEEE Antennas and Wireless Propagation Letters, vol. 22, no. 10, Oct. 2023.
[3] Y. -D. Wang, X. -L. Liang, W. Wang, Y. -H. Tan and P. -K. Liu, "Ku-band Waveguide Slot Filtering Antenna Based on Metallic-Nail Metamaterial," 2020 International Conference on Microwave and Millimeter Wave Technology (ICMMT), Shanghai, China, 2020.
[4] P. Bajaj, D. Kundu and D. Singh, "A Dual-Polarized L-S-Band Frequency-Selective Rasorber With Highly Selective Transmission Response," 2022 IEEE Microwaves, Antennas, and Propagation Conference (MAPCON), Bangalore, India, 2022.
[5] Z. Zheng, X. Fang, W. Wang, G. Huang, H. Zhang and X. Liang, "A Compact Waveguide Slot Filtering Antenna Based on Mushroom-Type Surface," in IEEE Antennas and Wireless Propagation Letters, vol. 19, no. 10, Oct. 2020.
[6] Y. M. Pan, P. F. Hu, K. W. Leung and X. Y. Zhang, "Compact Single-/Dual-Polarized Filtering Dielectric Resonator Antennas," in IEEE Transactions on Antennas and Propagation, vol. 66, no. 9, Sept. 2018.
[7] Q. -S. Jia et al., "A Broadband Filtering Circularly Polarized Folded Transmitarray Antenna Based on Metasurface," in IEEE Antennas and Wireless Propagation Letters, vol. 22, no. 10, Oct. 2023.
[8] C. Lai, Z. Deng and Z. Yan, "A Novel Compact UWB Antenna with Triple Band-Notched Characteristics," 2022 IEEE MTT-S International Microwave Workshop Series on Advanced Materials and Processes for RF and THz Applications (IMWS-AMP), Guangzhou, China, 2022.

Funded by the European Union

Multi-Path Connectivity for Next-Generation XR Applications

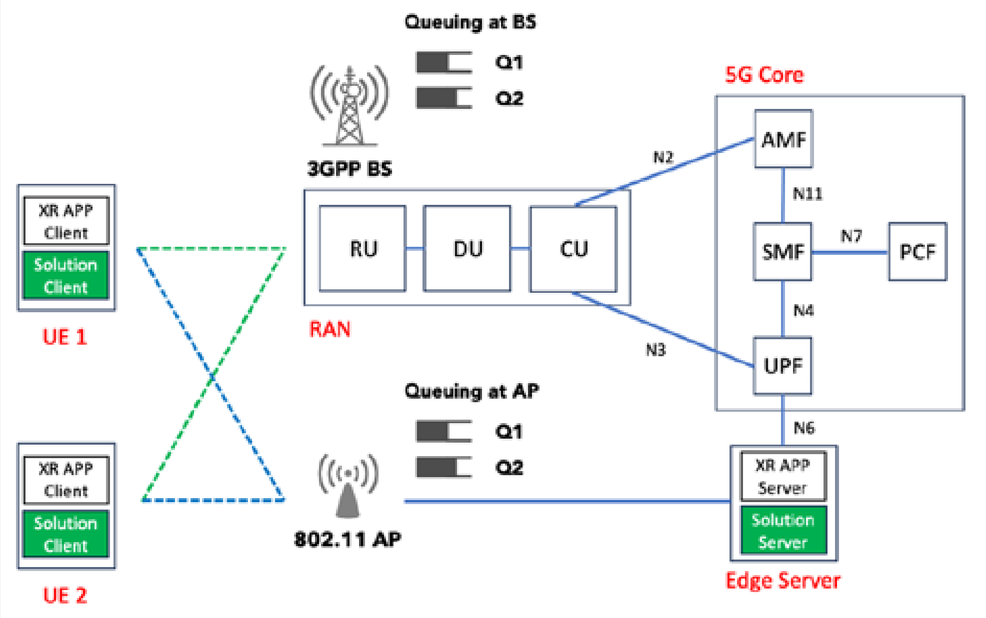
Contact: Hamid Hassani, h.hassani@tue.nl

XR is set to revolutionize the coming decade.

Challenge: Fulfilling XR stringent requirements

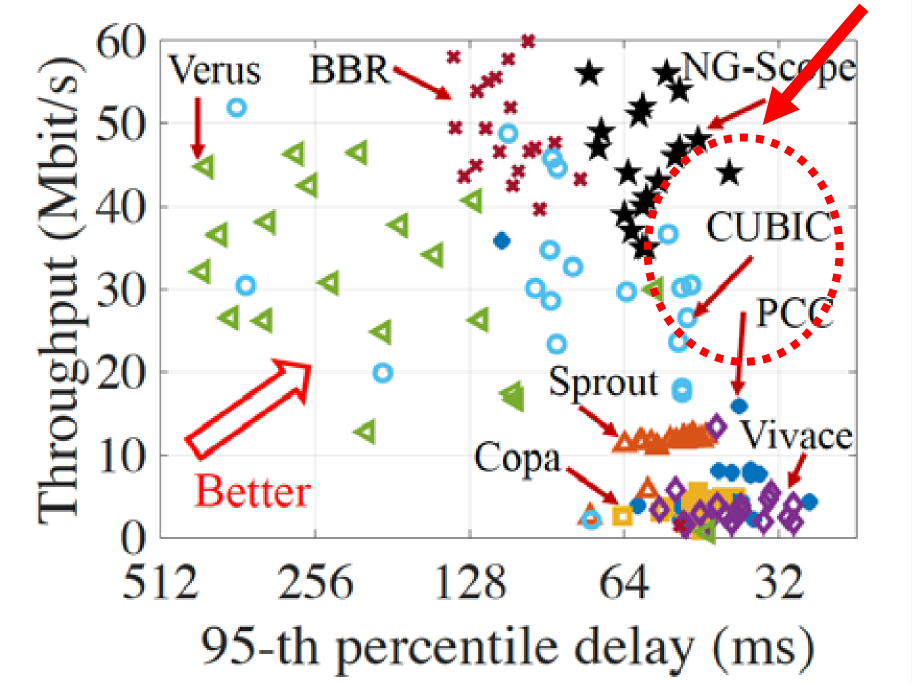
Approach: Cross-layer Multi-path at the Transport layer

- Simultaneous transmission over 802.11 and 3GPP



System Architecture

Targeting Area



Y. Xie and Kyle Jamieson, Proc. of the ACM on Measurement Analysis of Computing Systems, 2022.

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