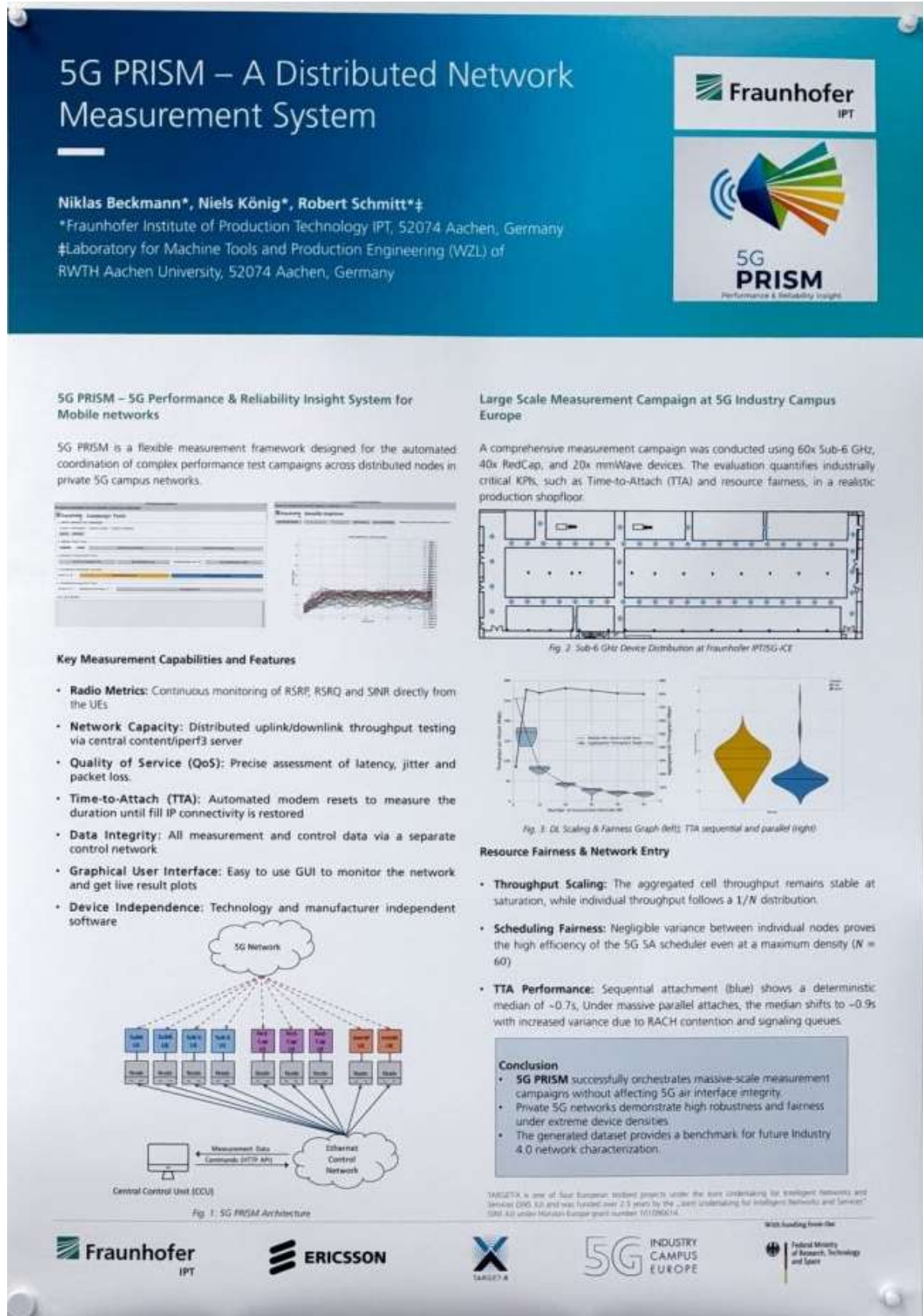


5G PRISM: A Distributed Network Measurement System

Niklas Beckmann, Niels König, Robert Schmitt

5G PRISM is a distributed network monitoring and measurement system. It can do distributed load testing, stress tests, baseline monitoring and more. The system itself is device independent. We will present the system itself, as well as some results of a large scale measurement campaign conducted at Fraunhofer IPT (more than 100 devices in total).



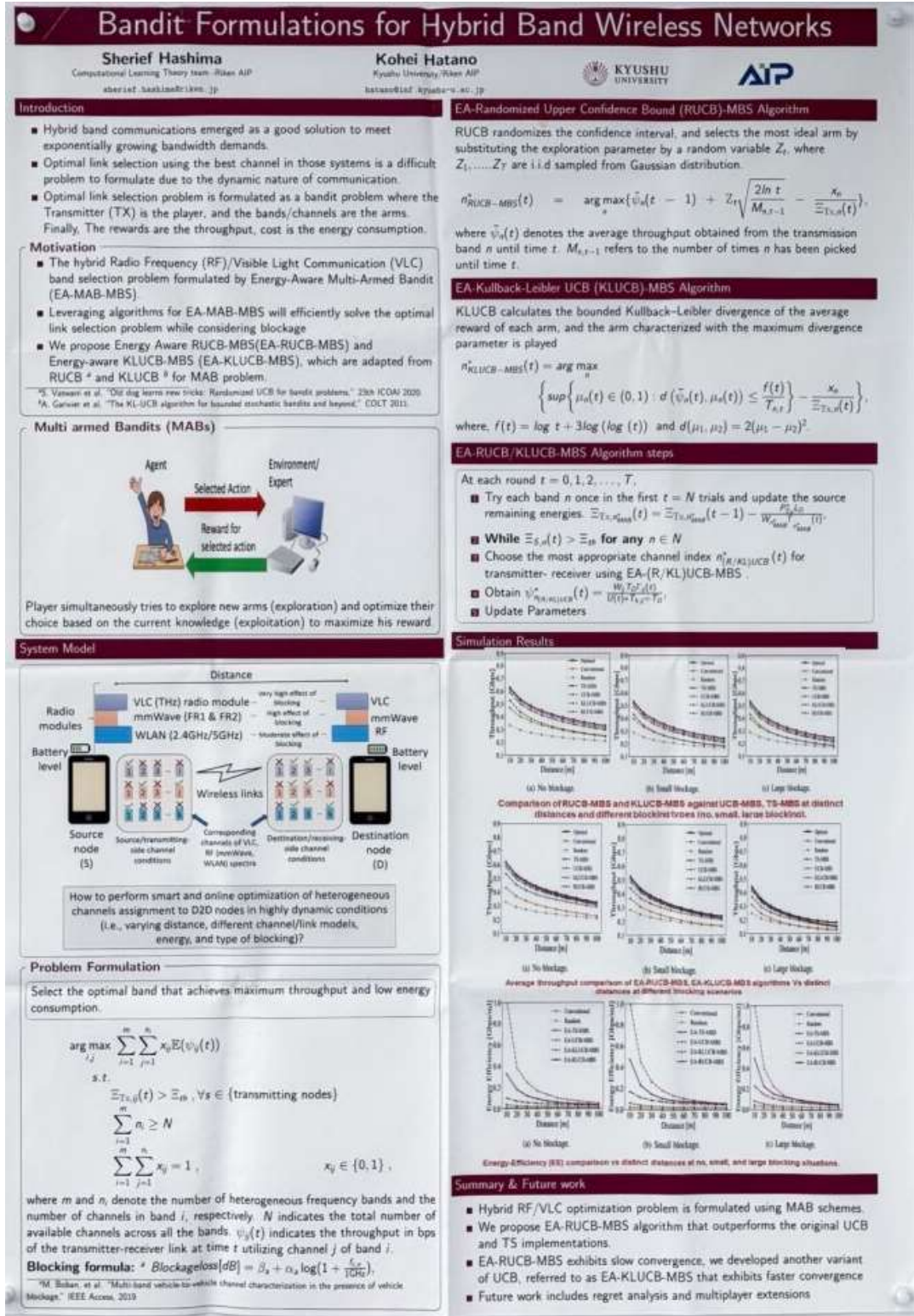
Bandit Formulations for Hybrid Band Wireless Networks

Sherief Hashima, Kohei Hatano RIKEN/AIP

Hybrid band communications emerged as a good solution to meet exponentially growing bandwidth demands. Optimal link selection using the best channel in those systems is a difficult

problem to formulate due to the dynamic nature of communication. This problem is formulated as a bandit problem where the Transmitter (TX) is the player, and the bands/channels are the arms.

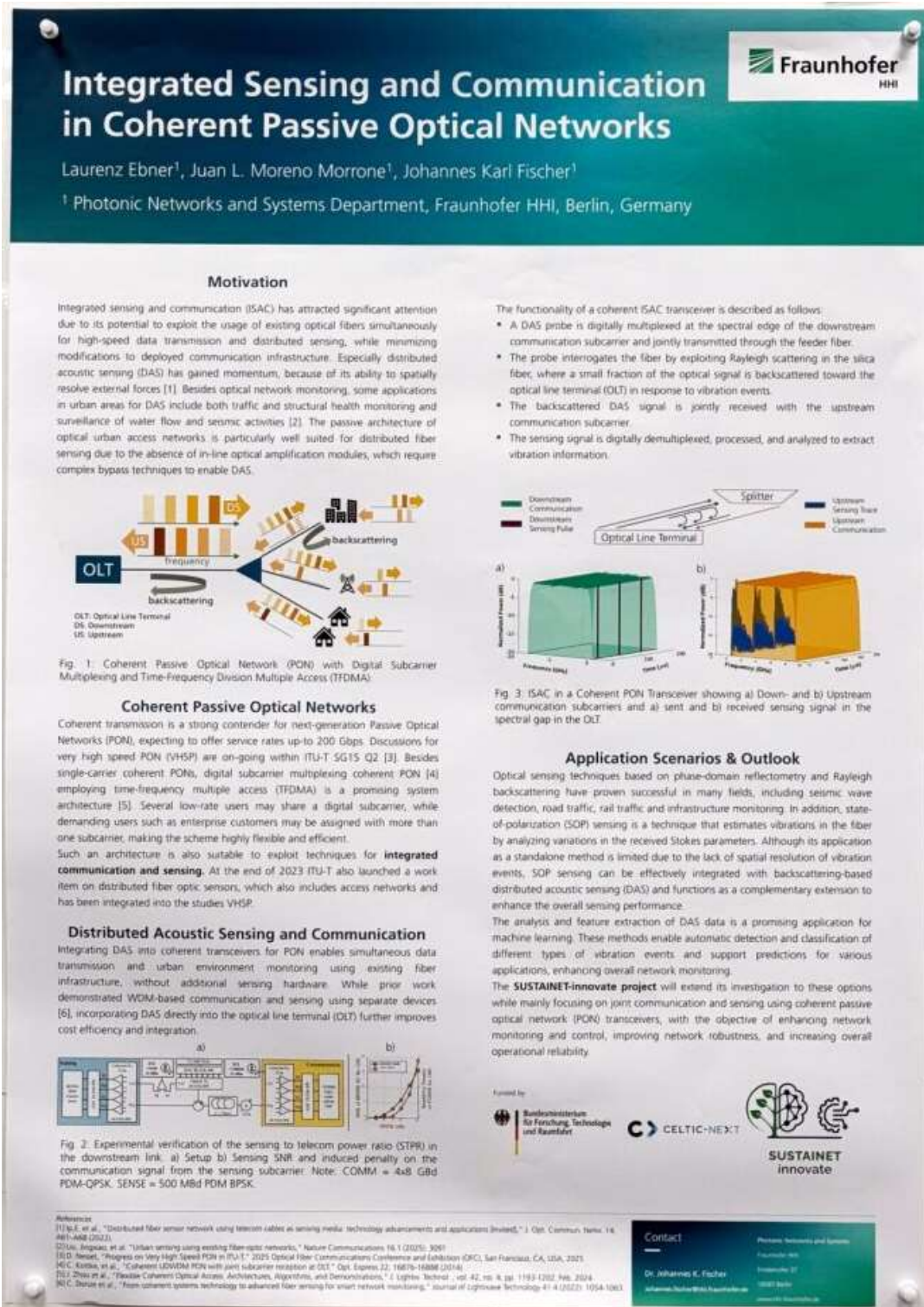
Finally, the rewards are the throughput, cost is the energy consumption.



Integrated Sensing and Communication in Coherent Passive Optical Networks

Laurenz Ebner (Fraunhofer HHI), Juan L. Moreno Morrone (Fraunhofer HHI), Johannes K. Fischer (Fraunhofer HHI)

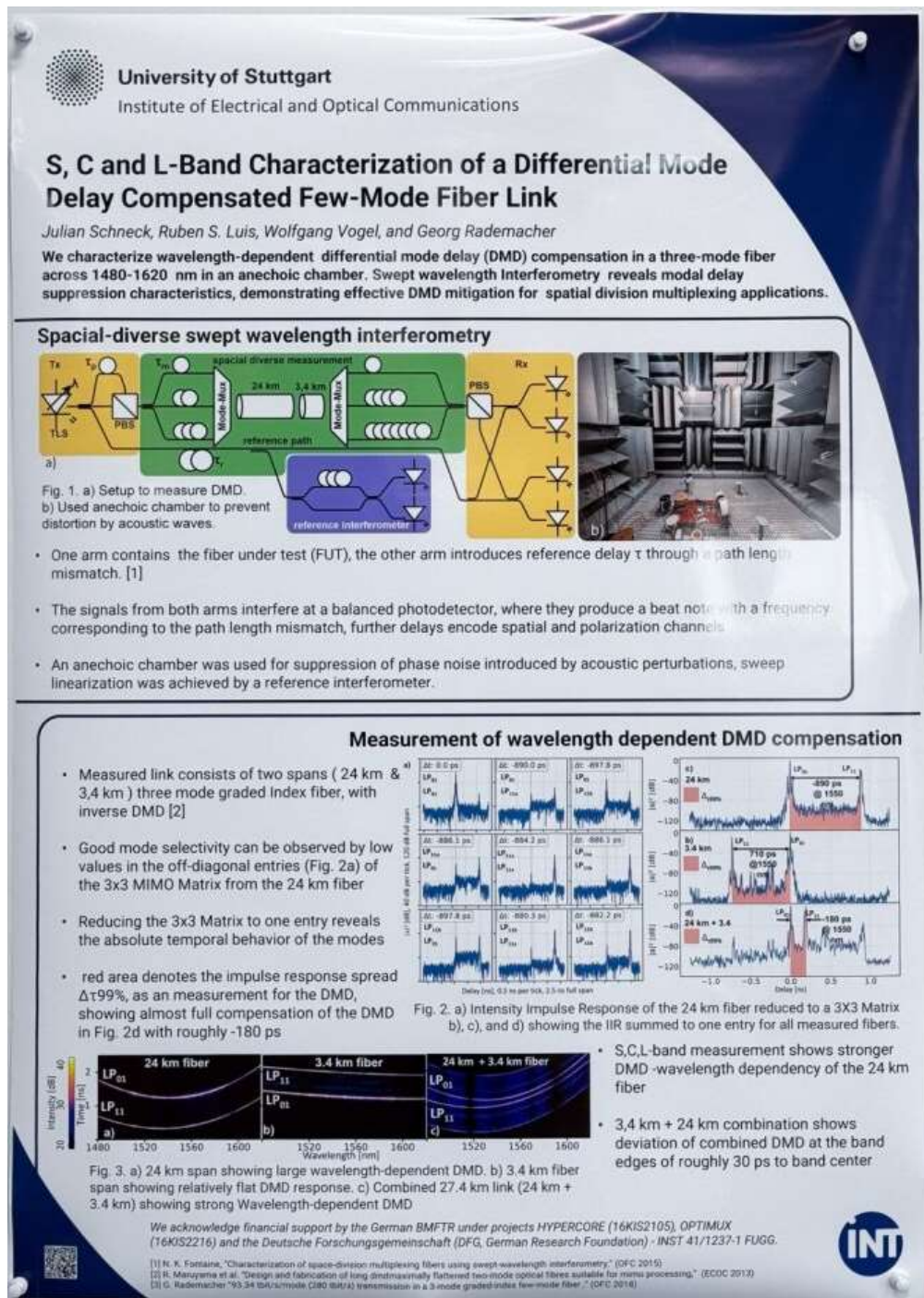
Integrated sensing and communication (ISAC) has attracted significant attention due to its potential to exploit the usage of existing optical fibers simultaneously for high-speed data transmission and distributed sensing, while minimizing modifications to deployed communication infrastructure. Especially distributed acoustic sensing (DAS) has gained momentum, because of its ability to spatially resolve external forces. Besides optical network monitoring, applications in urban areas for DAS include both traffic and structural health monitoring and surveillance of water flow and seismic activities. This work investigates distributed fiber sensing for passive optical networks in urban areas.



S, C and L-Band Characterization of a Differential Mode Delay Compensated Few-Mode Fiber Link

Julian Schneck (University of Stuttgart), Wolfgang Vogel (University of Stuttgart), and Georg Rademacher (University of Stuttgart)

Spatial division multiplexing (SDM) in few-mode fibers offers a promising pathway to overcome the capacity limits of single-mode transmission systems. However, differential mode delay (DMD)—the temporal separation between propagating modes—poses a significant challenge, causing inter-modal interference and limiting transmission reach. Effective DMD compensation is therefore critical for realizing practical SDM links. In this work, we characterize wavelength-dependent DMD compensation in a three-mode fiber across the extended wavelength range of 1480–1620 nm. Measurements were conducted in an anechoic chamber to minimize environmental perturbations. Using swept wavelength interferometry, we quantify modal delay suppression characteristics and demonstrate effective DMD mitigation strategies applicable to next-generation SDM systems.



Towards AFDM-ISAC for Next-Generation Communications

Naoya Kumakura (Keio Univ.), Ryoya Saito (UEC), Koichi Adachi (Keio Univ.), Haris Gacanin (RWTH Aachen Univ.)

We evaluate the impact of peak-to-average power ratio (PAPR) reduction technique on the ambiguity function (AF) of affine-frequency division multiplexing (AFDM)-integrated sensing and communication (ISAC), which is a promising candidate for the future wireless communication systems.

Towards AFDM-ISAC for Next-Generation Communications

Naoya KUMAKURA¹ Ryoya SAITO¹ Koichi ADACHI¹ Haris GACANIN^{*}¹ Department of Information and Computer Science, The Faculty of Science and Technology, Keio University, Japan[‡] Advanced Wireless and Communication research Center (AWCC), The University of Electro-Communications, Japan^{*} Institute for Communication Technologies and Embedded Systems, The Faculty of Electrical Engineering and Information Technology, RWTH Aachen University, Germany

Background

- 5G/6G systems operate under high mobility, high carrier frequencies, and wide bandwidths, leading to linear time-variant (LTV) channels.
- Conventional multicarrier waveforms (e.g., OFDM) lose subcarrier orthogonality in high-Doppler scenarios, resulting in severe inter-carrier interference (ICI).
- Affine Frequency Division Multiplexing (AFDM) leverages delay-Doppler domain sparsity to ensure reliable transmission over LTV channels.



Figure 1: Concept of the LTV channel

Waveform Comparison Between AFDM, OCDM, and OFDM

Waveform Characteristics

- OFDM assumes a time-invariant channel; however, Doppler spread breaks subcarrier orthogonality, leading to ICI.
- OCDM employs fixed chirp-based spreading, which provides limited diversity gain over LTV channels.
- AFDM utilizes the affine Fourier transform with tunable chirp parameters to control delay-Doppler coupling.

Chirp Parameter Design

- Chirp parameters determine the symbol mapping in the delay-Doppler domain.
- Proper parameter selection aligns the transmitted signal with the LTV channel characteristics.

Diversity Properties

- AFDM can achieve full diversity over LTV channels with appropriate chirp parameters.
- OFDM and OCDM generally fail to guarantee full diversity in high-Doppler scenarios.

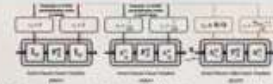


Figure 2: Modulation diagram (Left: OFDM, Center: OCDM, Right: AFDM) [5]

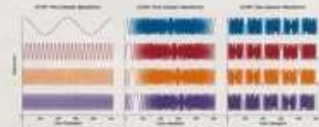


Figure 3: Waveform comparison (Left: OFDM, Center: OCDM, Right: AFDM)

Performance Evaluation

BER vs. SNR

- **AWGN channel:** AFDM, OCDM, and OFDM exhibit identical BER performance.
- **LTI channel:** AFDM and OCDM exhibit identical performance, while OFDM achieves only linear diversity gain.
- **LTV channel:** AFDM outperforms OCDM due to the chirp parameter design, whereas OFDM fails to maintain reliable communication.

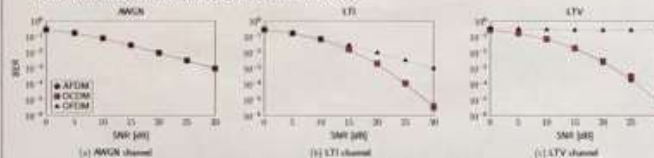


Figure 4: BER vs. SNR for AFDM, OCDM, and OFDM

PAPR Reduction

- Typical PAPR reduction methods, such as selected mapping (SLM) [2] and grouped pre-chirp selection (GPS) [3], are applied to AFDM.

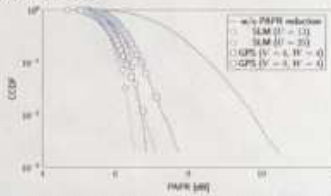


Figure 5: Comparison of PAPR performance between GPS and SLM

AFDM-ISAC Waveform Design

Auto-Ambiguity Function (AAF) Analysis

- The AAFs of OFDM, OCDM, and AFDM are compared to evaluate their sensing performance.
- OFDM exhibits a dominant correlation along the Doppler axis, limiting the Doppler resolution.
- OCDM shows a strong delay-Doppler correlation.
- AFDM achieves a highly concentrated AAF around the origin, enabling superior delay-Doppler resolution [4].

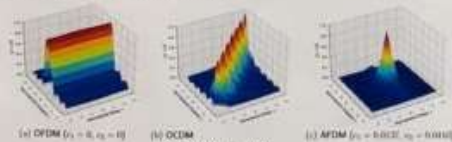


Figure 6: Comparison of AAFs for OFDM, OCDM, and AFDM

Impact on AAF-based Sensing Metrics

PSR (Peak to Sidelobe Ratio) / ISLR (Integral Sidelobe Ratio)

- Due to fundamentally different mechanisms, a strictly fair comparison of PAPR reduction capabilities between SLM and GPS is non-trivial.
- SLM introduces random phase rotations, which results in a significant degradation of sensing metrics.
- In contrast, GPS adjusts chirp parameters without significantly altering the waveform structure, thereby preserving the AAF characteristics.

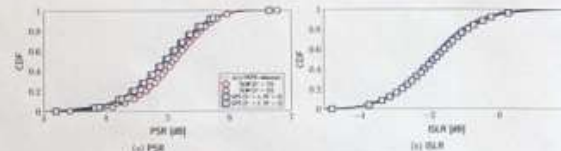


Figure 7: Comparison of PSR and ISLR

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Acknowledgement

This work was supported by JSPS KAKENHI Grant Number 25K01278.

Identifying Non-Controlled Vehicles via MPC Trajectory Tracking for Outdoor Channel Modeling of 6G Integrated Sensing and Communication


Nopphon Keerativoranan and Jun-ichi Takada from Institute of Science Tokyo, Ainur Ziganshin and Christian Schneider from Technische Universität Ilmenau

Accurate channel characterization for 6G Integrated Sensing and Communication (ISAC) requires high-fidelity digital twins that account for dynamic outdoor environments. A major challenge in this domain is the presence of "non-controlled" traffic—vehicles lacking ground-truth positioning data—which complicates the validation of ray-tracing simulations against measurement data. This poster presents a methodology to detect, track, and geo-locate these non-controlled vehicles using only Multipath Components (MPCs) extracted from channel sounder measurements. We employ a two-stage Recursive-RANSAC algorithm that first detects consistent linear trajectories within processing windows and subsequently stitches them over time using Hungarian-based pairing. Experimental validation compares the tracked MPCs extracted from channel measurements at 2.53 GHz (using both SAGE and RIMAX estimators) with reference trajectories extracted from video footage, demonstrating that the reconstructed trajectories align with physical road geometries.

Identifying Non-Controlled Vehicles via MPC Trajectory Tracking for Outdoor Channel Modeling of 6G Integrated Sensing and Communication

Nopphon Keerativoranan¹, Ainur Ziganshin², Marc Miranda², Christian Schneider² and Jun-ichi Takada¹

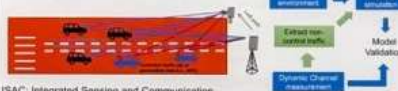
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TAKADA Lab.
6G-ICAS4Mobility
Federal Ministry of Research, Technology and Innovation
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1. Introduction

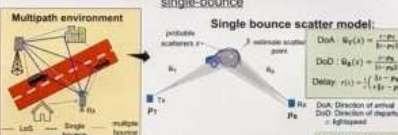
- 6G ISAC demands accurate digital twins for deterministic and dynamic modeling, e.g., ray tracing (RT), evaluated via channel meas.
- The Challenge:** MPCs include reflections from moving objects; validating them traditionally requires matching to visual 3D data.
- The Gap:** Obtaining ground truth for "non-controlled" traffic is difficult, especially in video Non-Point-of-View (NPoV) zones.
- The Objective:** Investigate capability of tracking and geo-locating these vehicles using only measured MPCs.



ISAC: Integrated Sensing and Communication

2. Estimation of Dynamic Single-bounce Scatterers

Goal: Estimate scatterer for each multipath component assuming single-bounce



Single bounce scatterer model:

Initiator scatterers \vec{r}_i estimate scatterer points \vec{r}_s

DoA: $\vec{u}_s(x) = \frac{1}{\sqrt{1+x^2}} \begin{bmatrix} -x \\ 1 \end{bmatrix}$

DoD: $\vec{u}_d(x) = \frac{1}{\sqrt{1+x^2}} \begin{bmatrix} x \\ 1 \end{bmatrix}$

Delay: $\tau(x) = \frac{1}{c} \left(\sqrt{1+x^2} + 1 \right)$

DoA: Direction of arrival
DoD: Direction of departure
DoD: Direction of departure

Input from meas.:
 • Tx and Rx position
 • Estimated MPCs
 • DoA $\rightarrow \vec{u}_{d,m}$
 • DoD $\rightarrow \vec{u}_{a,m}$
 • Delay $\rightarrow \tau_m$

1. Find estimate \hat{x} using least square method:

$$\hat{x} = \arg \min_x \left\{ \frac{(\tau(x) - \tau_m)^2}{\sigma_\tau^2} + \frac{\|\vec{u}_d(x) - \vec{u}_{d,m}\|^2}{\sigma_{\vec{u}_d}^2} + \frac{\|\vec{u}_a(x) - \vec{u}_{a,m}\|^2}{\sigma_{\vec{u}_a}^2} \right\}$$

measurement delay (seconds) τ
 Direction cosine (DoA)
 Direction cosine (DoD)

2. Filtering a single bounce and dynamic scatterer:

- A path is classified as single bounce if difference in delay $\Delta\tau$, angles ($\Delta\theta_{DoA}$, $\Delta\theta_{DoD}$) and Doppler Δf_d are less than acceptable threshold

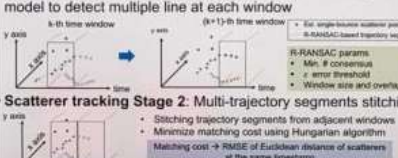
Conditions:
 $\Delta\tau < \tau_{thres}$
 $\Delta\theta_{DoA} < \theta_{thres}$
 $\Delta\theta_{DoD} < \theta_{thres}$
 $\Delta f_d < f_{thres}$

Pass single-bounce conditions Fail single-bounce condition

3. Two-stage Recursive-RANSAC Dynamic Scatterer Tracking

- Assumption:** local linearity and sparseness of dynamic single-bounce scatterers
- parameters for tracking:** scatterer position vs time window
- Scatterer tracking Stage 1: R-RANSAC [1] w/ linear trajectory model to detect multiple line at each window**

b-th time window (b+1)-th time window



R-RANSAC recursive random sample consensus


- Scatterer tracking Stage 2: Multi-trajectory segments stitching**

- Stitching trajectory segments from adjacent windows
- Minimize matching cost using Hungarian algorithm
- Matching cost \rightarrow RMSE of Euclidean distance of scatterers at the same timestamp
- No stitching if matching cost is greater than threshold

4. Measurement Scenario and Extracted MPCs

- MIMO channel response**
 - obtained from ILMSoundG3 channel sounder [2]
- MPC estimation**
 - RIMAX parameters estimation [3]
 - Process every 40 ms
 - Delay, AoA, AoD, Doppler complex path weight

32 x 32 MIMO configuration



Rx (roadside unit) stationary Tx (mounted on vehicle) stationary Scenario: Dynamic outdoor, near roundabout

Channel sounder setting

parameter	value
Center Freq	2.53 GHz
Bandwidth	20 MHz
# array elements (dual polarized)	8 horizontal / 2 vertical
Sampling time	4 ms
Measurement time	80 s

5. Results and Discussion

Estimated dynamic single-bounce scatterers (top left subfigure)


- Most likely vehicles: trajectories along the road behind Rx and half of roundabout

Estimated trajectories

- Only partial trajectories of vehicle were tracked
- 12 vehicular trajectories were partially detected out of 23 retrieved from video footage
- Common detected segments are right side of Rx and a roundabout corner (near LoS)
- Segment of Truck1 beyond reference were seen

Single-bounce and tracking setting

parameter	value
Window size	1 s
Overlapping size	0.89 s
ϵ error threshold	3 m
Min. # consensus	13 samples (~0.5 sec)
Segment stitching threshold	3 meters
Standard deviation of meas. parameters	$\sigma_\tau = 10$ ns $\sigma_{\theta_{DoA}} = 5^\circ$ $\sigma_{\theta_{DoD}} = 10^\circ$ $\sigma_{f_{dmax}} = 30^\circ$ $f_{dmax} = 5$ Hz



Overall estimated single-bounce scatterer estimate (top left), and 3 samples of estimated vehicle trajectories from MPCs in comparison with visual-based geolocation references

Conclusion

- Proposed framework can estimate single-bounce scatterer of vehicle motion
- Due to rich multipath and estimation technique, not all MPCs of entire trajectory was estimated, resulting in the partially reconstructed of vehicle trajectories
- Partial trajectories can be used to reconstruct/exclude MPCs of non-control traffic at certain time window

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 [2] H. Takada, M. L. L. Lima, and A. Kishino, "RIMAX: A maximum likelihood framework for parameter estimation in multipath channel sounding," in IEEE Trans. Wireless Commun., vol. 19, no. 1, pp. 1-14, Jan. 2020.

The 7th Germany-Japan Beyond 5G/6G Research Workshop, Tokyo, Japan This work is partially supported by the project BMBF 6G-ICAS4Mobility with Project No. 18K03241 21 Jan 2026

Simplified Vehicular Scattering Models for Integrated Sensing And Communication: A Bistatic Radar Cross Section based Study

Karthik Subhash Jayasree (Institute of Science Tokyo), Nopphon Keerativoranan (Institute of Science Tokyo), Junichi Takada (Institute of Science Tokyo)

This work investigates the suitability of simplified vehicular models for Integrated Sensing and Communication (ISAC) systems. Multiple simplified geometric models based on cuboids and curved cuboids are generated using the physical dimensions of a real vehicle, namely the VW Sharan. The bistatic radar cross sections of these models are computed using full wave electromagnetic simulations using the multilevel fast multipole method. To evaluate the scattering behavior, both radar cross section and received power responses of the simplified models are compared against those of the full scale VW Sharan model at an operating frequency of 2.1 GHz. The comparative analysis shows that the modified two curved cuboid model provides the closest approximation to the scattering characteristics of the VW Sharan car.



Simplified Vehicular Scattering Models for Integrated Sensing And Communication : A Bistatic Radar Cross Section based Study.

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² Electronic Measurements and Signal Processing Group EMS, Technische Universität ilmenau, Germany.

1. Introduction

Integrated Sensing and Communication (ISAC):


- Combines the concept of communication and sensing into a single system [1].
- Enables object detection using existing communication infrastructure.

ISAC Channel model:

- Hybrid channel model [1]:


Deterministic Multi Scattering Centre Target model [1]:

- Each target is represented by several multiple scattering centres.
- Need for MSC model in ISAC:**
 - Conventional methods rely on complex EM simulations to compute the scattering fields.
 - MSC models are suitable for large scale ISAC applications.
- Research Gap:** MSC based models for typical sensing targets (Vehicles, Humans etc.) is underdeveloped and insufficiently validated.
- Research Goal:** To model a vehicle using deterministic MSC model for ISAC applications.
- Challenge:**
 - Identification of MSCs directly from a real car is challenging.
 - Scarcity of accurate car models.
- Objectives of this work:**
 - Model a car using simplified geometric structures.
 - Evaluate modeling accuracy and assess error due to simplification.

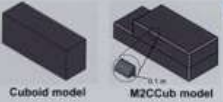


2. Simplified Vehicular Modelling

- Simplifying the car into basic geometric shapes makes it easier to identify key scattering features like stationary phase points (SPP) and scattering centers (SCs)[2].
- These models can be easily constructed using only the basic dimensions (length, width, and height) of a real car.
- Trade-off:** Simplification comes at the cost of **reduced accuracy**.
- Evaluation approach:** Compare Bistatic RCS (Radar Cross Section) of simplified models with an actual car model (VW Sharan car).
- Reference model:** A more realistic geometric approximation of VW Sharan (Consistent with the measurement campaign).



Simplified car models




Where L, W and H is the length, width and height of VW Sharan.

The simplified models are created using FreeCAD, with dimensions set to match those of a real car (VW Sharan car).

Model Dimensions	
Car Model	Dimensions
Cuboid (Cub)	L x W x H
	Upper
	Lower
M2C-Cub	L x W x H/2
Edge Curvature	0.1 m

3. Simulation

- Bistatic RCS of simplified models are generated using the multilevel fast multipole method (MLFMM) in Ansys HFSS.
- The Bistatic RCS (σ) of Simplified models are compared to that of VW Sharan.



Parameter	Value
Frequency	2.1 GHz
Material	Perfect conductor
Excitation	Plane wave
Incident wave	-z direction
Polarization	x-polarized

Power Gain (PG):

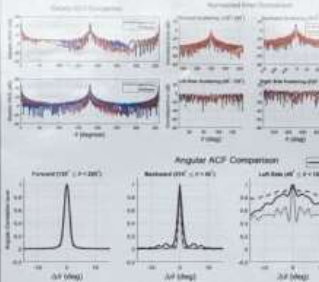
$$PG(\theta) = \frac{\lambda^2 \cdot \sigma(\theta)}{4\pi \cdot R^4} \cdot R = \frac{\lambda^2 \cdot \sigma(\theta)}{4\pi \cdot R^3}$$

where D is the largest dimension of VW Sharan

$$\text{Normalized error}(\theta) = 10 \cdot \log_{10} \left(\frac{|PG_{\text{model}}(\theta) - PG_{\text{VW Sharan}}(\theta)|}{PG_{\text{VW Sharan}}(\theta)} \right)$$

4. Results and Discussions

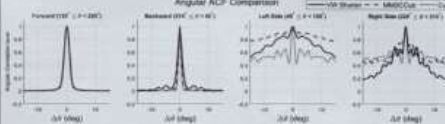
The Bistatic RCS of simplified car models and the error in PG are compared with the actual car model.



Normalized Error Comparison

MM2CCub and Cuboid models show similar normalized error in the forward and backward regions. MM2CCub has relatively lower and stable values of error for the Left side and right side.

Angular ACF Comparison



- The Autocorrelation function (ACF) of the bistatic RCS in the angular domain was compared for the three models.
- Both the Cub and MM2CCub capture the VW Sharan angular ACF characteristics very well in the forward and backward scattering scenarios.
- However in the right and left side scattering scenarios MM2CCub captures angular correlation envelope significantly better.

5. Conclusion

- Simplified Cuboid models are adequate for forward and backward scattering scenarios.
- Proposed MM2CCub model accurately captures the scattering behavior of VW Sharan across all the regions.
- These simplified models can serve as a basis for applying MSC-based approaches in future research.

6. References

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The 7th Germany-Japan Beyond 5G/6G Research Workshop

Acknowledgment: This work is partially supported by the project B6W 6G-ECASIMobility with Project No. 19B03241.

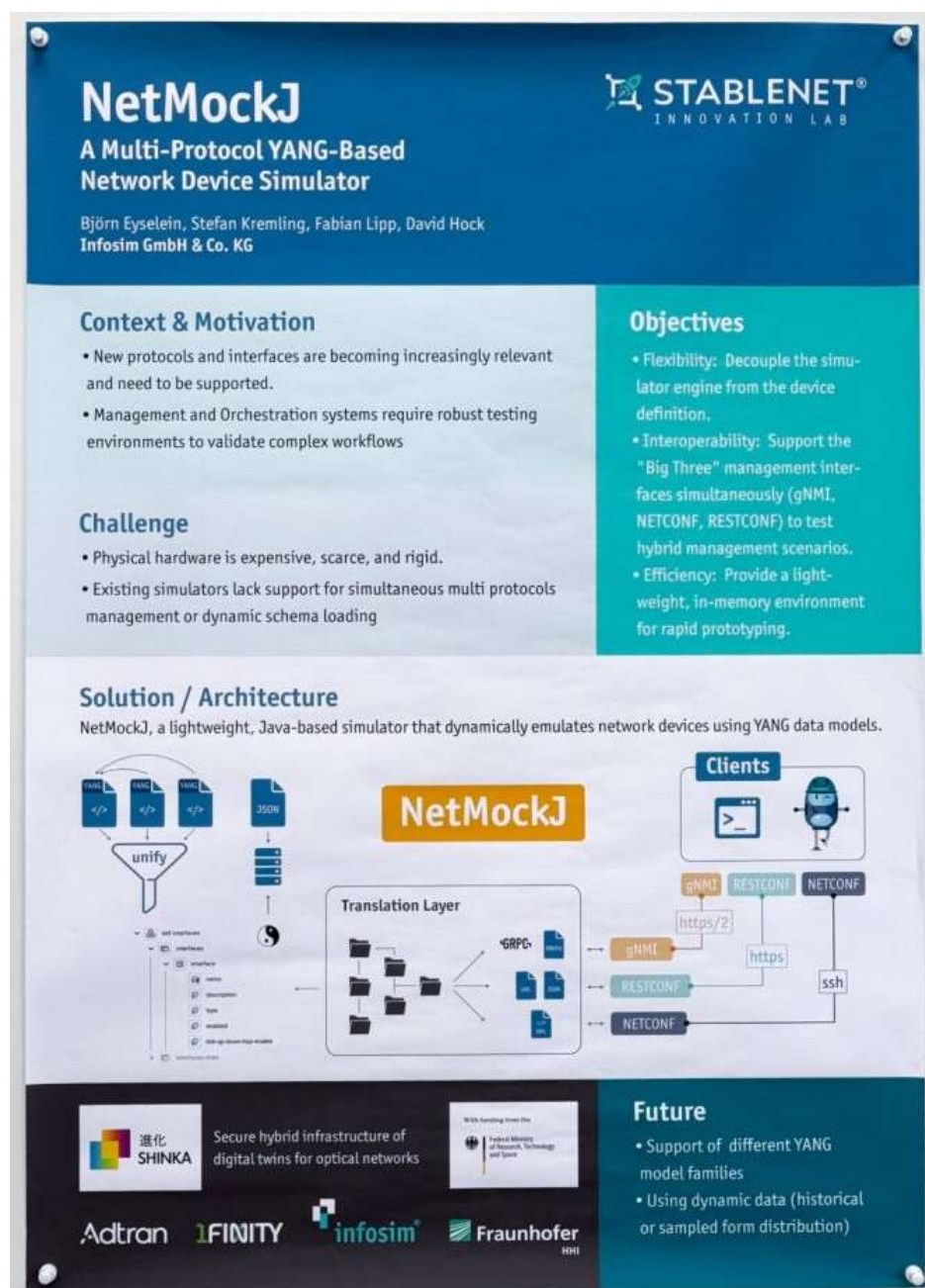
21-22 January 2026

NetMockJ: A Multi-Protocol YANG-Based Network Device Simulator

On site presenters: David Hock, Infosim & Fabian Lipp, Infosim - Additional authors: Björn Eyselein, Infosim & Stefan Kremling, Infosim

We present NetMockJ, a network device simulator developed as a Proof of Concept (PoC) within the SHINKA project, funded by the BMFTR. In the context of Beyond 5G and 6G, where network functions are increasingly softwarized, flexible testing environments for Management and Orchestration (MANO) systems are essential. NetMockJ enables the simulation of network devices by dynamically loading YANG data models to define their structure and state.


The simulator maintains a unified internal data store, exposed simultaneously via three industry-standard interfaces: gNMI, NETCONF, and RESTCONF. This multi-protocol approach allows researchers to validate orchestration workflows across different management paradigms within a single, lightweight environment, bypassing the need for physical hardware. As a functional prototype, NetMockJ serves as a tool for accelerating research and prototyping in next-generation network management and experimental automation scenarios.



Channel Modeling for ICAS vehicular applications

Maximilian L bke (FAU Erlangen-N rnberg)


Integrated sensing and communication (ISAC) for vehicular applications has attracted significant attention due to its potential to improve traffic safety and enhance spectral efficiency. To enable reliable system design and performance evaluation for vehicular applications, an accurate understanding and modeling of the time-varying characteristics of vehicular ISAC channels are essential. A dynamic sensing channel model is proposed for vehicular ISAC scenarios, based on 3D Ray tracing simulations conducted at mmWave frequencies in intersection scenarios. An improved multipath-component-distance (MCD) threshold-based cluster identification and tracking algorithm for sensing channel is proposed, which groups the multipath components (MPCs) contributed from the same target vehicles or surrounding buildings into clusters and subsequently tracks their evolution over time. To model the dynamic evolution process of channel, parameters characterizing the birth-to-death behavior of clusters are investigated. These include the cluster survival duration, initial (birth) point, number of born clusters and cluster evolution in the delay, azimuth and Doppler domains, which constitute a dynamic model for the outdoor vehicular ISAC channel.




6G-ICAS4Mobility

Channel modeling for ICAS vehicular applications

Guojin Zhang, Norman Franchi and Maximilian L bke
Institute for Smart Electronics and Systems, Friedrich-Alexander-Universit t Erlangen-N rnberg (FAU)



CLITES



FAU

Motivation and Goals


The integrated communications and sensing (ICAS) system is expected to be implemented in intelligent transportation systems (ITSs), significantly enhancing safety while reducing traffic congestion and accident rates.

- Waveform design for ICAS systems in various dynamic scenarios.
- Development of concepts for the ICAS-related extension of the 3GPP channel model, as well as the implementation and validation of the extended 3GPP channel model.
- Develop a Geometry-Based Channel Model based on simulations in highway scenarios.
- Analyze the correlation and different properties of time-varying ICAS channels, i.e. Sharing degree (SD).
- Validate Dual-Link MIMO channel measurements using Ray-tracing tools.
- Propose a dynamic statistical channel model to capture the time-varying properties of high-mobility ICAS channels, based on simulations in intersection scenarios.

Intersection & Highway Scenarios

Parameter settings	
Frequency	2.53 & 77 GHz
Tool	Altair WinProp
Velocity	Vehicle A: 110 km/h Vehicle B: 80 km/h Vehicle C: 115 km/h Vehicle D: 120 km/h
Antenna	Tx: Radar antenna $G_{max} = 17.37$ dBi Beamwidth: 20° (V), 30° (H) Sx & Rx: Omnidirectional antennas
Time	12s

Sensing channel



Communication channel




Fig. 1. Simulation results of sensing and communication channel at time $t = 0$ s.

Geometry-Based Channel Model

- Multipath-components distance (MCD)-threshold clustering method for both sensing and communication channel.
- Group the multipath components from the same interaction points or objects.
- For sensing channel, MCD between paths i and j :

$$MCD_{i,j} = \sqrt{\|MCD_{i,j}\|^2 + \|MCD_{i,j}\|^2 + \|MCD_{i,j}\|^2}$$
- For communication channel:

$$MCD_{i,j} = \sqrt{\|MCD_{i,j}\|^2 + \|MCD_{i,j}\|^2 + \|MCD_{i,j}\|^2}$$

where $MCD_{i,j}$ is delay domain, $MCD_{i,j}$ is angular domain, and $MCD_{i,j}$ is Doppler frequency domain.

- Cluster level parameter: intra-cluster delay, angular, and Doppler spread.
- Sharing degree (SD)—power ratio of the sharing clusters in communication and sensing channel.

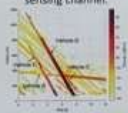
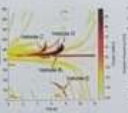
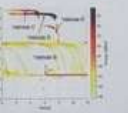




Fig. 104: Delay-time power profile. Fig. 105: Angular-time power profile. Fig. 106: Doppler-time power profile.

- Cluster evolution within their lifetimes in delay, angular and Doppler domains.
- Survival duration t_s .
- Initial (birth) point: $\mathbf{r}_b, \phi_b, \nu_b$.
- Number of born clusters at each snapshot N .

Dual-Link MIMO Channel

Validation—Dual-Link MIMO Channel Measurements

- Measurements conducted by TU Ilmenau, in roundabout scenarios, at the frequency bands of 2.53 GHz and 20 MHz bandwidth.
- Simulation: Varying antenna configs. (characteristics, mounting positions)
- Compare statistical parameters between measured and simulated data, including path loss, large-scale parameters (delay spread, angle spread, Doppler spread), shadow fading.

- Tracking algorithm: track the trajectory of the paths contributed from the same scatterer points at different time.
- Channel characteristics:
- Lifetimes (Birth to death process of the target and clutter in time-varying channel).
- Initial power and delay positions of the tracking trajectory;
- Dynamic variations within their lifetimes, i.e. power decay.





Fig. 3. Simulation results at time $t = 0$ s.

(1) G. Zhang, N. Franchi and M. L bke, "Dynamic Channel Characterization for Vehicular ISAC in Intersection Scenarios at 77 GHz," 2025 28th International Workshop on Smart Antennas (WSA), Erlangen, Germany, 2025, pp. 189–194, doi: 10.1109/WSA65299.2025.11202826.

(2) G. Zhang, X. Cai, N. Franchi and M. L bke, "A Geometry-Based ISAC Channel Model for Vehicle-to-Vehicle Scenarios," 2025 29th European Conference on Antennas and Propagation (EuCAP), Stockholm, Sweden, 2025, pp. 1–5, doi: 10.23919/EuCAP63536.2025.10995559.



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The 7th Germany-Japan Beyond 5G/6G Research Workshop, 21–22.01.2026

  6G-ICAS4Mobility 2025

Radio Channel Characterization for ICAS (Channel4ICAS)

Christian Schneider

This work presents a joint German-Japanese research effort focused on radio channel characterization for Integrated Communications and Sensing (ICAS). Serving as an extension to the BMBF-funded 6G-ICAS4Mobility project, the effort aims to study the aspects of sensing and security in automotive communications. Key objectives include acquiring and analyzing high-resolution multi-link MIMO channel measurements in various frequency bands, validating state-of-the-art ray-tracing tools, and developing concepts for the extension of 3GPP channel models for use in simulations. Furthermore, channel analysis and modeling results are used to study optimal waveform design, to evaluate ICAS resource allocation as well as parameter estimation algorithms. The project aims for a holistic understanding of radio channels for ICAS, supporting demands in next-generation vehicular networks and strengthening German-Japanese research activities.



Radio Channel Characterisation for ICAS

Joint German-Japanese Research Project

Work funding from the Federal Ministry of Research, Technology and Innovation
Förderkennzeichen 18K02226

Project Overview

The Radio Channel Characterisation for Integrated Communications and Sensing (Channel4ICAS) project serves as an extension to the ongoing BMBF-funded 6G-ICAS4Mobility project. The German and Japanese research partners within the project extension aim for:

- ▶ Perform & share novel multi-link MIMO ICAS channel measurements
- ▶ Evaluate ray-tracing tools for ICAS applications
- ▶ Characterize automotive ICAS channels in multiple frequency bands
- ▶ Develop concepts for extending existing 3GPP channel models
- ▶ German-Japanese co-operation in ICAS standardisation and research.



Illustration of side-link based sensing in urban automotive scenarios
Credit: DENSO

Focus and Collaboration

ICAS Modelling and Characterisation	ICAS Channel Measurements	Ray Tracing Simulations	PHY Coding and Encryption	Waveform Design	High-resolution Path Estimation
Partners: FAU, TU Ilmenau, SciTokyo	Partners: TU Ilmenau, Tottori Uni.	Partners: DENSO, FAU, SciTokyo TU Ilmenau, BOSCH	Partners: DENSO	Partners: FAU	Partners: TU Ilmenau, Tottori Uni.

WP 1: Channel Measurements in FR1

Objectives

- ▶ Planning and execution of dual-link MIMO automotive channel measurements
- ▶ Post-processing, provisioning and dissemination of measurements
- ▶ High-resolution multipath parameter estimation



Measured scenario: urban roundabout with canopy TXs

WP 2: Channel Analysis & Modelling

- ▶ Characterisation of multi-path behavior in urban automotive ICAS
- ▶ Validation of existing channel simulation (ray-tracing) tools for ICAS applications
- ▶ Integration of channel data into a 3D simulation environment
- ▶ Concepts and implementation for GBSCM or hybrid extension of 3GPP channel models
- ▶ Investigations into the effect of antenna characteristics and positions on sensing



Ray-tracing output for the measured ICAS scenarios

WP 3: Data-based Evaluation

Objectives

- ▶ Optimized sensing wave-form design considering realistic channel and environment behavior (with results from WP1 and WP2)
- ▶ Development of physical layer (PHY) coding and encryption using CSI or sensing results

Collaborating Partners








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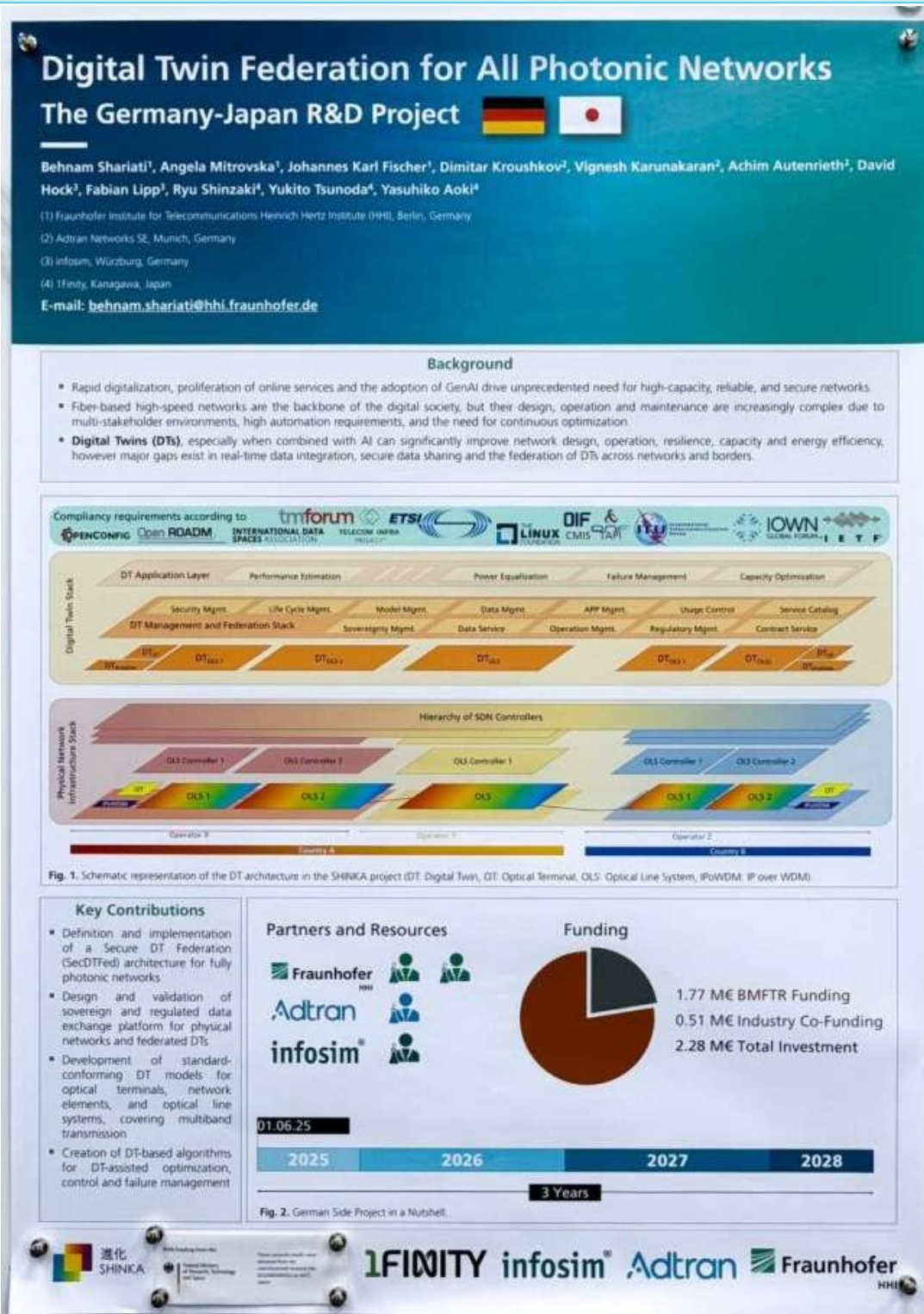
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Digital Twin Federation for All Photonic Networks

Fraunhofer HHI


The German–Japanese project SHINKA investigates a secure platform for the cross-border and cross-network integration of digital twins. The project aims to establish an ecosystem for the design, control, and optimization of high-speed photonic networks. To this end, SHINKA develops an architecture in which multiple digital twins map the physical network infrastructure and are interconnected via a common management and federation layer. Standardized interfaces ensure compatibility with diverse applications. The project plans to experimentally demonstrate a secure data exchange platform and validate the ecosystem across interconnected testbeds in Germany and Japan.



Measurement and Analysis of Static and Dynamic ISAC Channels

Christian Schneider

Integrated sensing and communication (ISAC) is set to become a key technology for beyond-5G and 6G networks. In this poster, we present our work on characterising multi-link radio channels for sensing in vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) environments. Our work is based on relevant channel sounding measurement campaigns. Our objectives are to present ISAC datasets that are useful for multi-path propagation analysis, and to study the channel contributions related to static and dynamic objects within the ISAC propagation channel. This is a joint German-Japanese research project involving the Institute of Science in Tokyo, Tottori University, and Technische Universität Ilmenau.




Measurement and Analysis of Static and Dynamic ISAC Channels

Contribution


Contribution

- Measurement of multi-link radio channels in FR1 for Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) for ICAS
- Multipath characterisation for static and dynamic channel contributions (buildings/trees vs. vehicles)
- Extension and parameterisation of Geometry-Based Stochastic Channel Models (GBSCM) for ICAS




Vehicle measured TX


Measured Scenarios of the FR1 ISAC Channel Sounding




(a)



(b)




(c)



(d)

Illustration of scenarios for


- parking lot,
- stationary TXs,
- dynamic TXs: convoy and
- dynamic TXs: opposite.



Assessing Targets

- Multi-link bi-static measurements involving 2 (mobile) transmitters, single stationary receiver and 2 targets
- Stacked Polarimetric Uniform Circular Arrays (SPUCA) sounding arrays with 32 elements (8 elements per ring for each polarization)
- 20 MHz measured bandwidth / channel at 2.53 GHz
- Parallel receive architecture and time-multiplexed transmitters, synchronized via GNSSDOs
- RTK-recorded position and orientation for all participating nodes

The datasets are publicly available! Contact: christian.schneider@tu-ilmenau.de



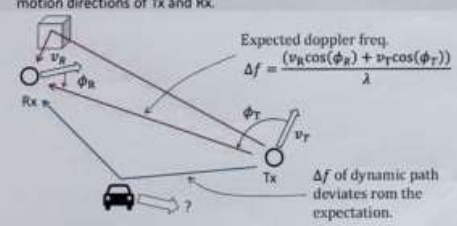
Estimation of Static and Dynamic Channel Contributions

► Key for accurate ISAC modelling:

- Characterisation of static and dynamic channel contributions
- Adaptation of estimation and analysis strategy

► Solution:

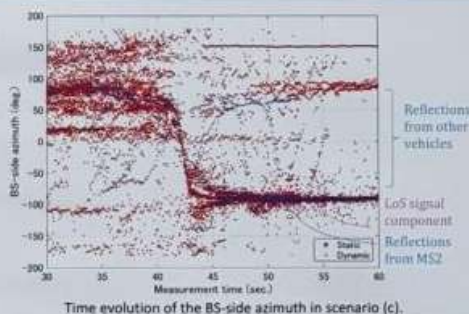
- Classify dynamic and static multipath components (MPCs) based on their expected Doppler frequencies,
- Determined from the MPCs' arrival and departure angles and the motion directions of Tx and Rx.



Expected doppler freq.
 $\Delta f = \frac{(v_R \cos(\phi_R) + v_T \cos(\phi_T))}{\lambda}$

Δf of dynamic path deviates from the expectation.

Static/Dynamic MPC classification based on the expected Doppler frequency.



Time evolution of the BS-side azimuth in scenario (c).

Analysis Results

- Static MPCs (from static objects such as buildings) and dynamic MPCs (from moving objects such as vehicles) were separately estimated.
- Power ratio of dynamic to static ranged from -35 to -15 dB.

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Reduction of absorption losses originated from NH bonds in high-Q SiN microring resonators based on low-temperature hot-wire deposition method

Kentaro Furusawa, Tomohiro Tetsumoto, and Norihiko Sekine (NICT)

Microcomb-based signal sources are anticipated to serve as important building blocks in various applications, ranging from telecommunication to sensing in the sub-terahertz frequency range. We have been developing microring resonators in the SiN platform using low-temperature deposition technique, key components in the microcombs. This approach not only eases the device fabrication thanks to the low-stress characteristics, but also paves a way to realize advanced photonic integrated circuits by employing various components available in the other platforms such as photo diodes via hybrid or heterogeneous integration. Recent progress in our device fabrication is presented, including the loaded Q-factors beyond 10^6 achieved by reducing the hydrogen content within the SiN films.

