Real-time Integrated 2.04 centimeters Range Resolution and 16.14-Gbps Bidirectional Wireless Communication in Photonic-assisted Millimeter wave Band System over 100 meters

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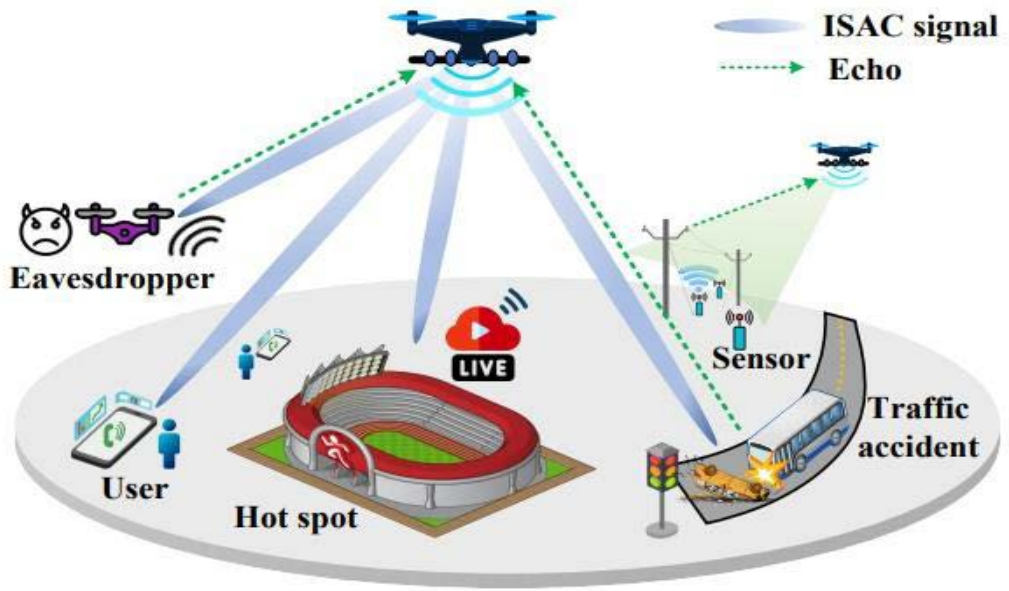
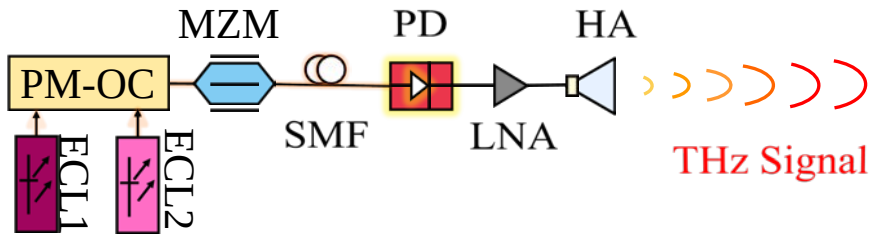
Background



Millimeter wave Integration of Sensing and Communication

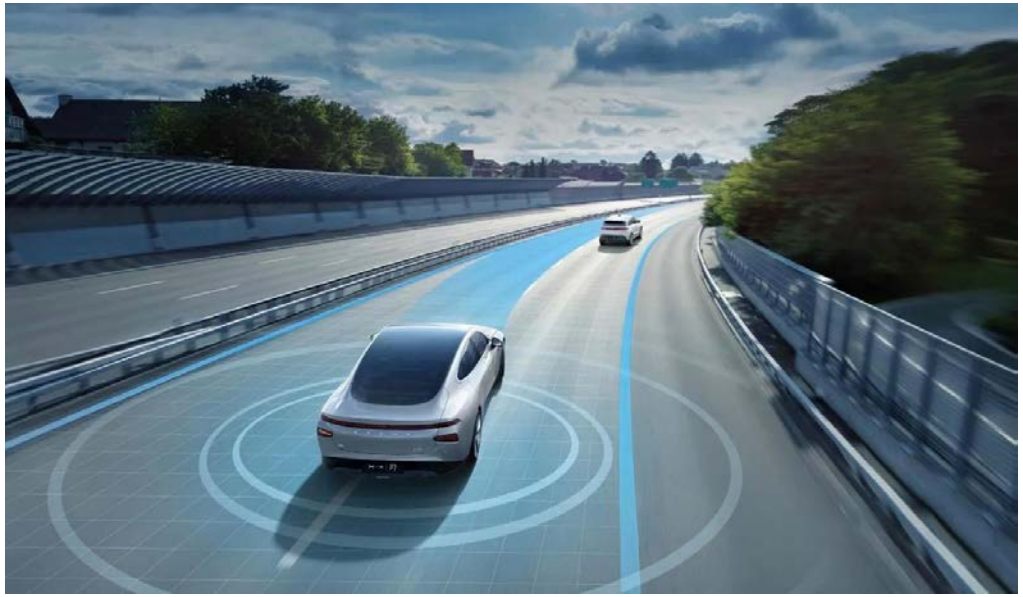


photonic-assisted up-conversion schemes

Ref	Band	Wireless distance (m)	Data Rate (Gbps)	Range Resolution (cm)	OL/RT
[3]	Ka	5	14.5	5	OL
[4]	W	1	78	3	OL
[5]	W	10.8	92	1.5	OL
[6]	W	10	47.06	1.02	OL
[7]	THz	1.57	32	1.875	OL
[8]	THz	0.5	120	0.25	OL

State-of-the-art photonic-assisted ISAC works

Motivation



Autonomous driving

UAV cooperation

BiDi ISAC over long ranges is a prerequisite for the reliable deployment of 6G ISAC applications !

Our Work

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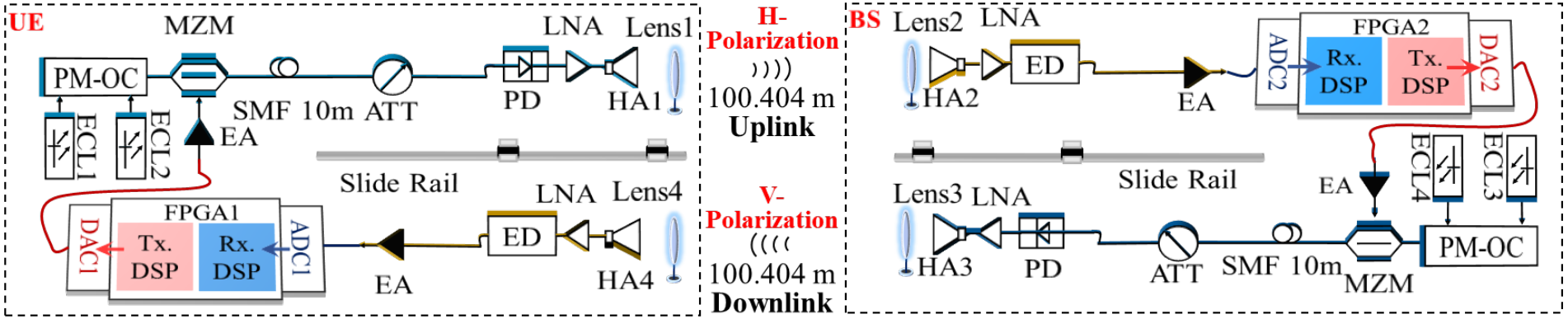
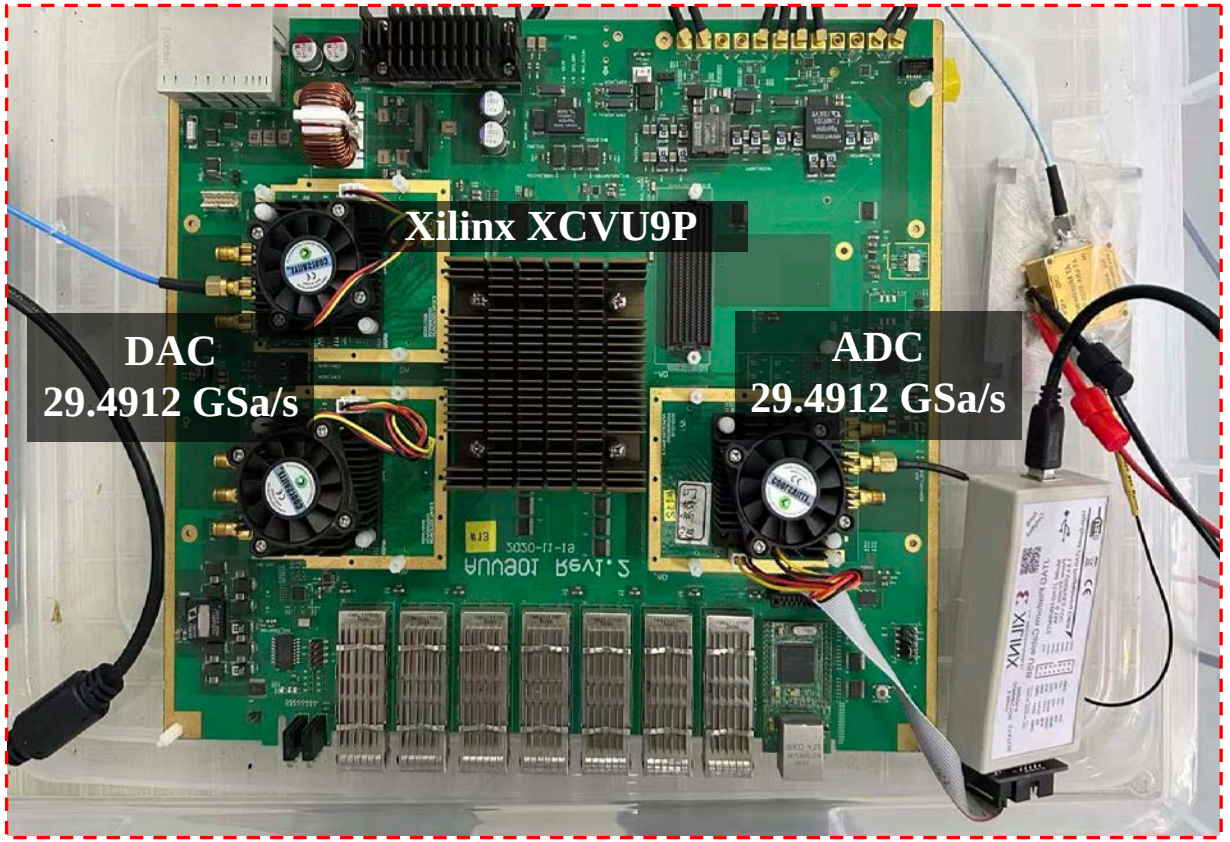
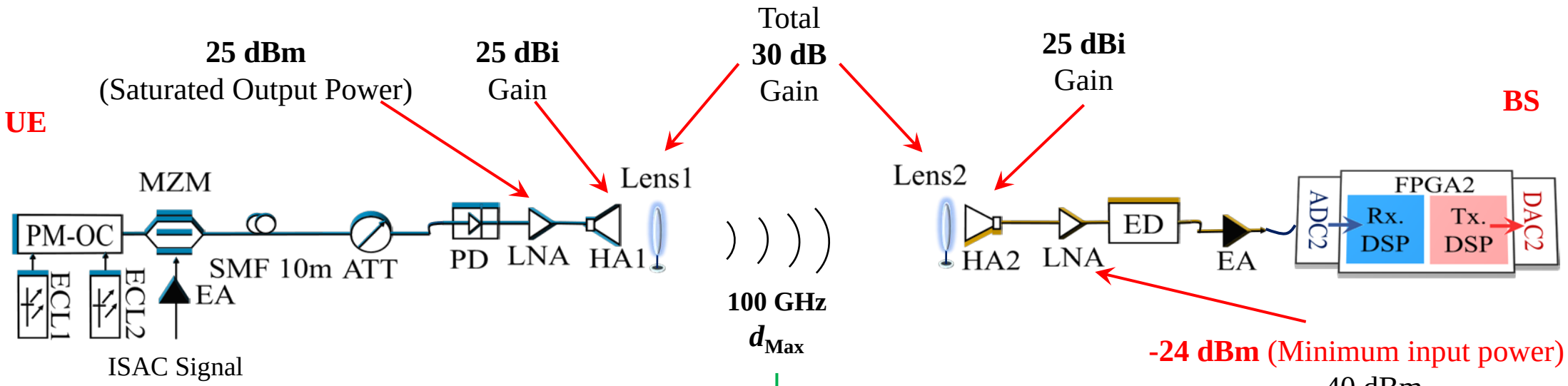


Performance limitation analysis: Theoretical Range Resolution



- **Theoretical range resolution:**
- ADC Sampling rate: 29.4912 GHz
- =>Timing accuracy: 1/29.4912 GHz = 0.0339 ns
- =>Theoretical ranging resolution: ΔREsti.=0.0339/2×c= 0.508 cm.

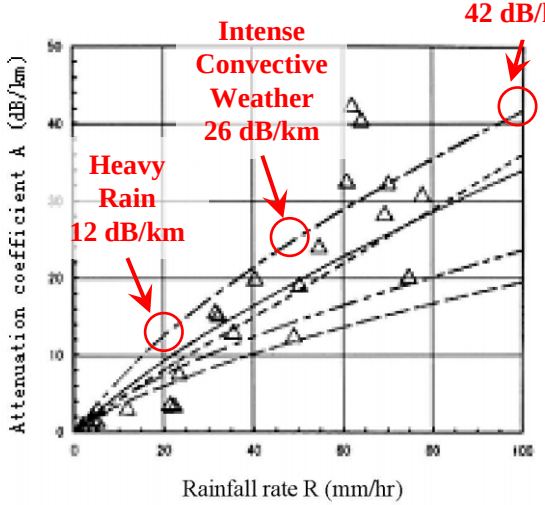
Performance limitation analysis: Maximum Range



$$25+80-(20\times\log10(d_{Max})+132.44+0.39\times d_{Max})=-24 \Rightarrow d_{Max}=0.65 \text{ (km)}$$

Performance limitation analysis: Influence of weather

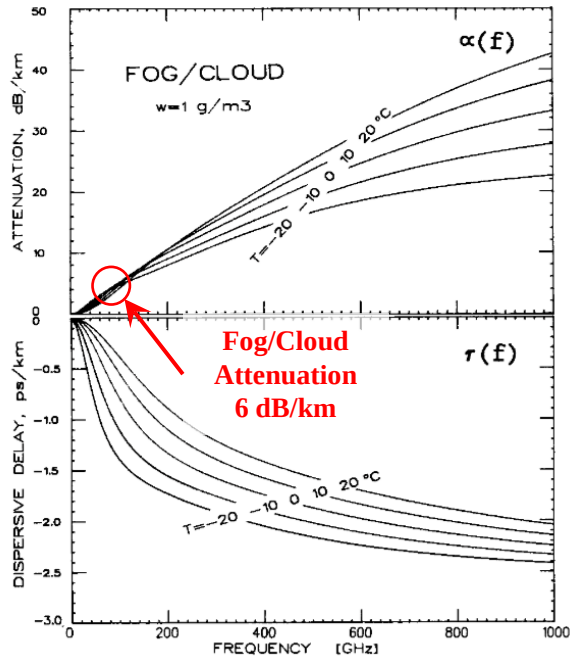
(a) Rain Attenuation



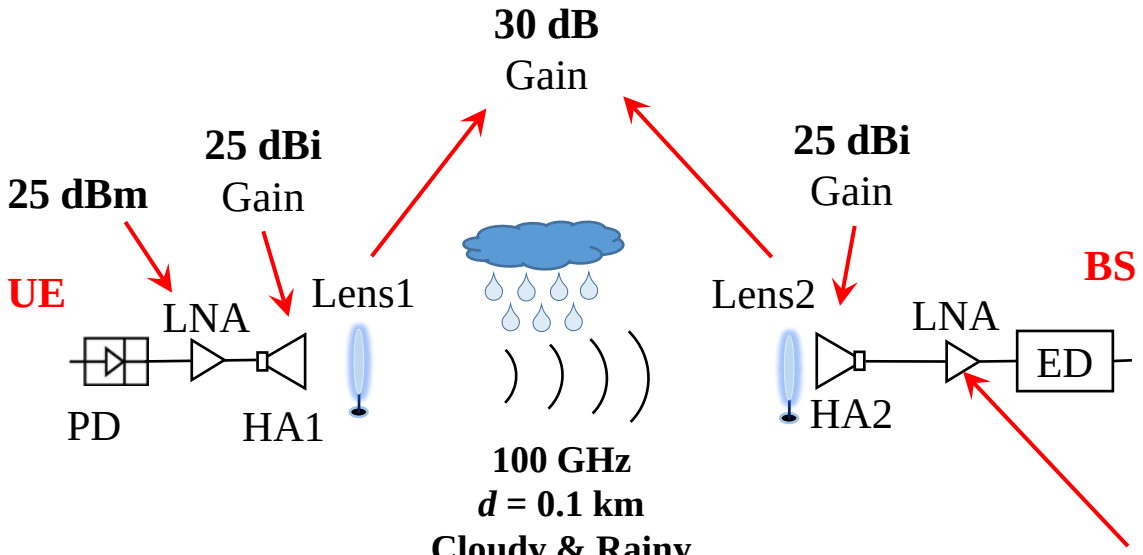
—— Weibul, — · — · Marshall and palmer, — · · — Best, — — — Joss, Thams and Waldvogel dropsize distributions, and ····· experimental fit, and furthermore, △ experimental raw data.

Comparison between calculations and measurements at 103 GHz, for a l minute integration time [1]

(b) Fog/Cloud Attenuation



SWD model predictions of attenuation α(f) and delay γ(f) for frequencies up to 1000 GHz assuming a water content, w= l g/m³, and temperatures from -20 to + 20° C [2]



20×log10(0.1)+132.44+0.39× 0.1
+ Rain Attenuation (<4.2 dB)
+ Fog/Cloud Attenuation (<0.6 dB)

[1] Qingling, Zhao, and Jin Li. "Rain attenuation in millimeter wave ranges." 2006 7th international symposium on antennas, propagation & EM theory. IEEE, 2006.

[2] Liebe, Hans J., Takeshi Manabe, and George A. Hufford. "Millimeter-wave attenuation and delay rates due to fog/cloud conditions." IEEE transactions on antennas and propagation 37.12 (1989): 1617-1612.

Thank you!