Project: IEEE P802.15 Working Group for Wireless Speciality Networks (WSN)

Submission Title: Inter-Carrier Interference for IEEE Std 802.15.3d Multiband Transmission

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Abstract: This document describes a simulation study on potential intercarrier interference when aggregating up to four channels in IEEE Std 802.15.3d

Purpose: Information of SC THz

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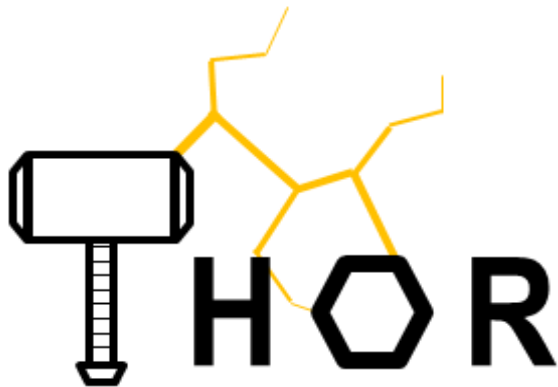
Inter-Carrier Interference for IEEE 802.15.3d Multiband Transmission

Influence of the transmit pulse on the bit error rate

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Multiband Transmission with IEEE 802.15.3d

H2020 ThoR project demonstrates a multiband transmission for wireless backhaul links [1]

IEEE 802.15.3d defines channels with a bandwidth from 2.16 GHz to 69.12 GHz

Transmit power spectrak density (PSD) mask prevents inter-carrier interferecen (ICI)

Which transmit pulses comply with the defined transmit spectral mask of IEEE 802.15.3d?

IEEE 802.15.3d channel plan [2]
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Link Level Simulations with SiMoNe

- Link level simulator in SiMoNe [3] was extended by a multi-carrier mode
- Independently configurable subcarriers can be transmitted in parallel
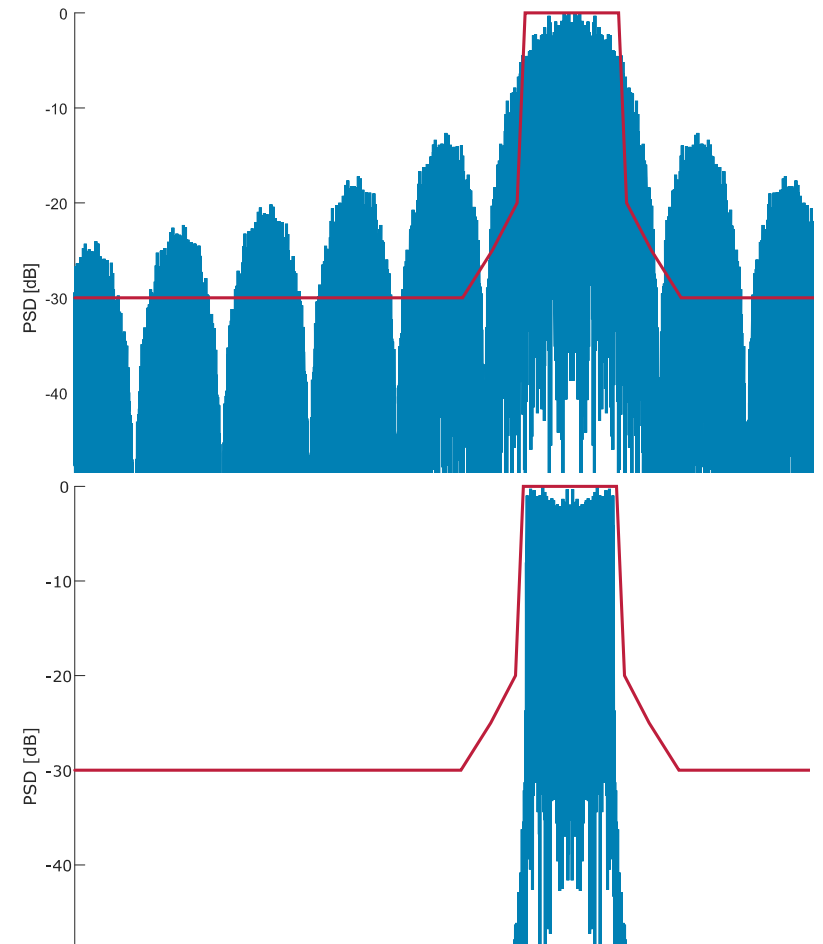
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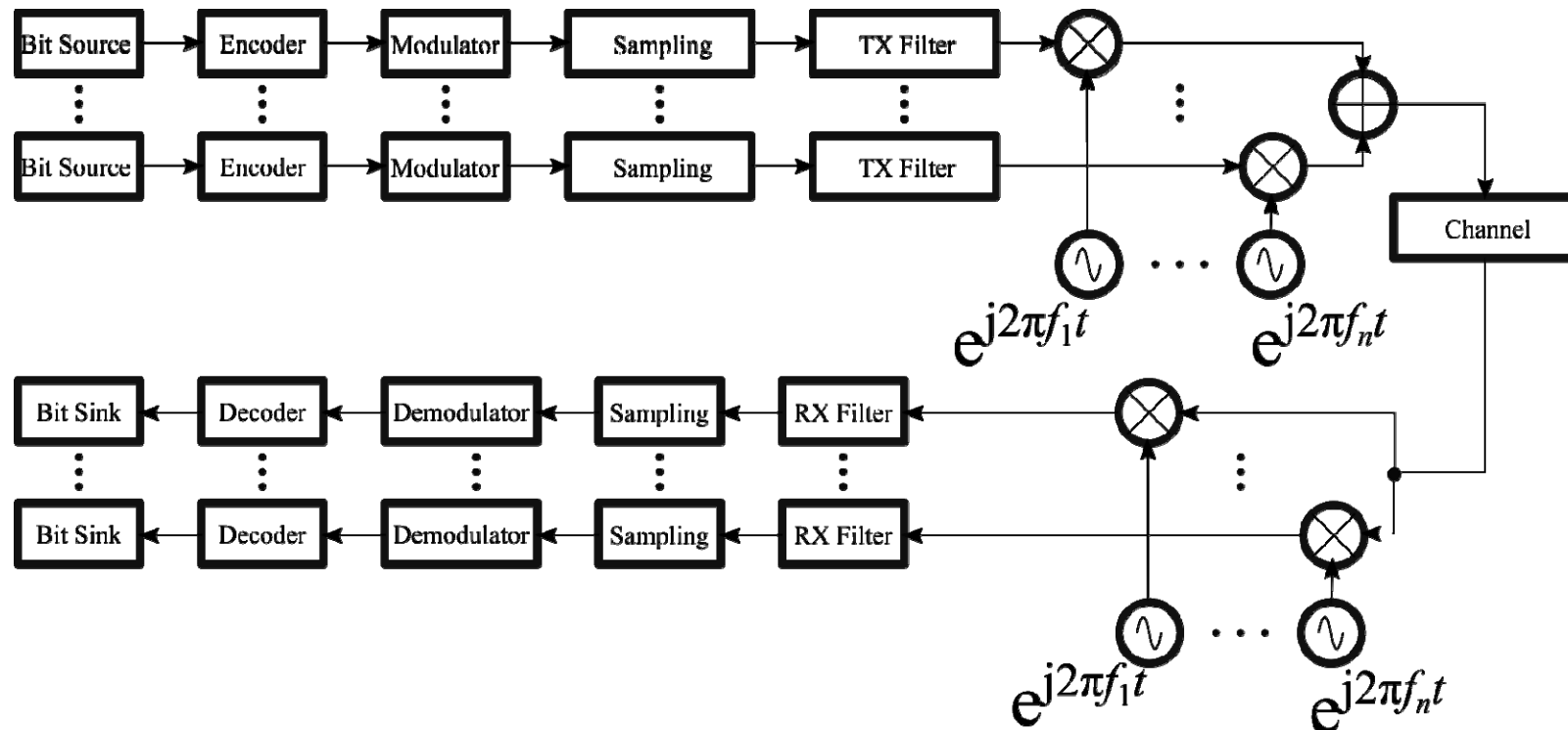
Spectrum of RECT and SINC pulse
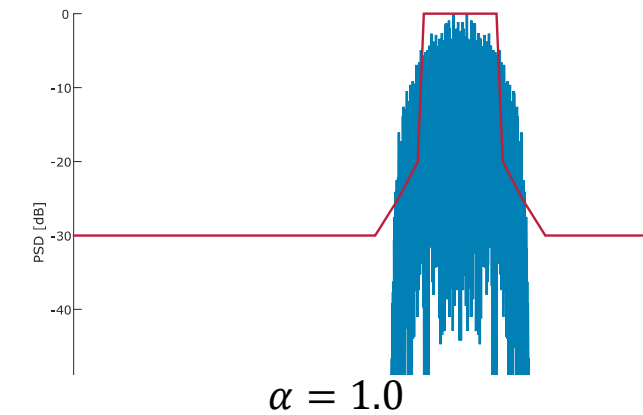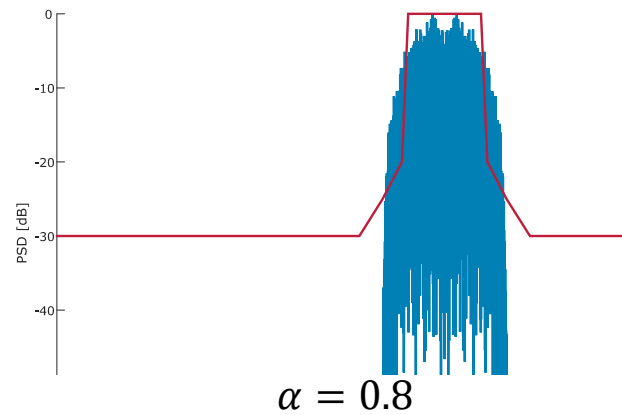
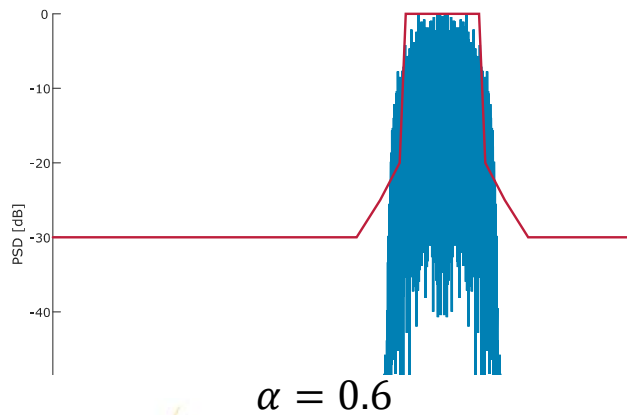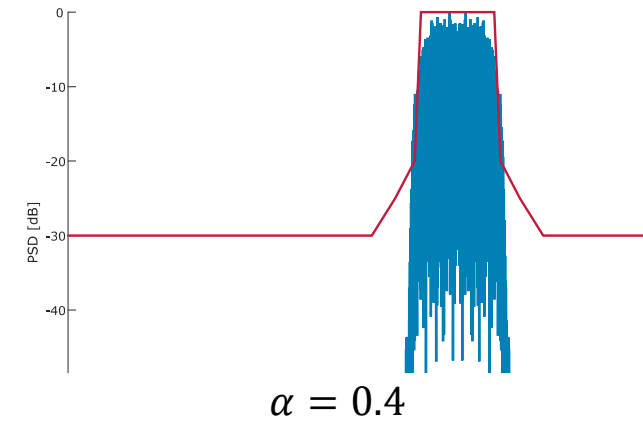2.16 GHz channel, 1.76 GBd symbol rate
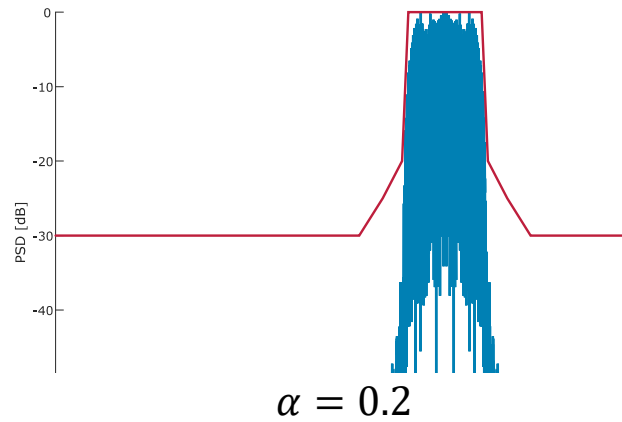
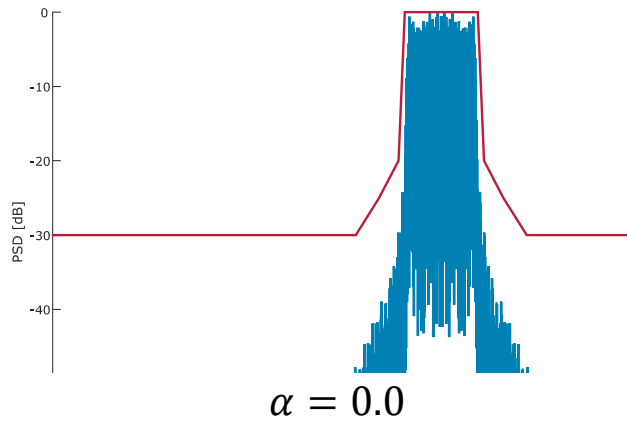rectangular pulse shaping

- High inter-carrier interference
- IEEE 802.15.3d transmit spectral mask in red

sinc pulse shaping

- Pulse duration corresponds to 128 times of the symbol duration
- No practical use

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Spectrum of RRC pulse with different roll-off factor α

$\alpha = 0.0$

$\alpha = 0.2$

$\alpha = 0.4$

$\alpha = 0.6$

$\alpha = 0.8$

$\alpha = 1.0$

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$\alpha > 0.3$ does not comply with the power spectrum masks anymore

How does the transmit pulse affect the bit error rate?

$$\alpha = 0.3$$

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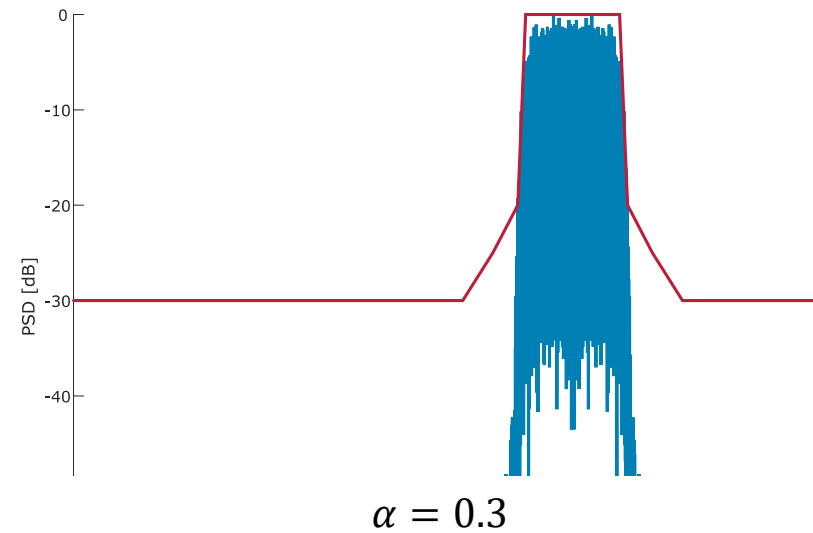
Multiband configuration

- Channel IDs 1-24, 33-44, 49-54, 62-64, 68
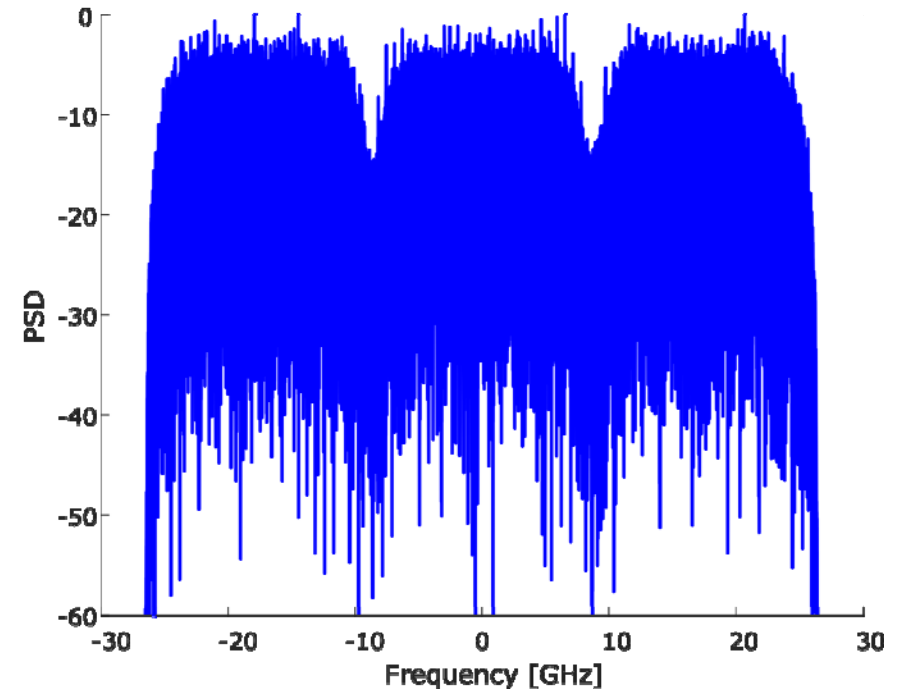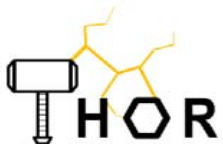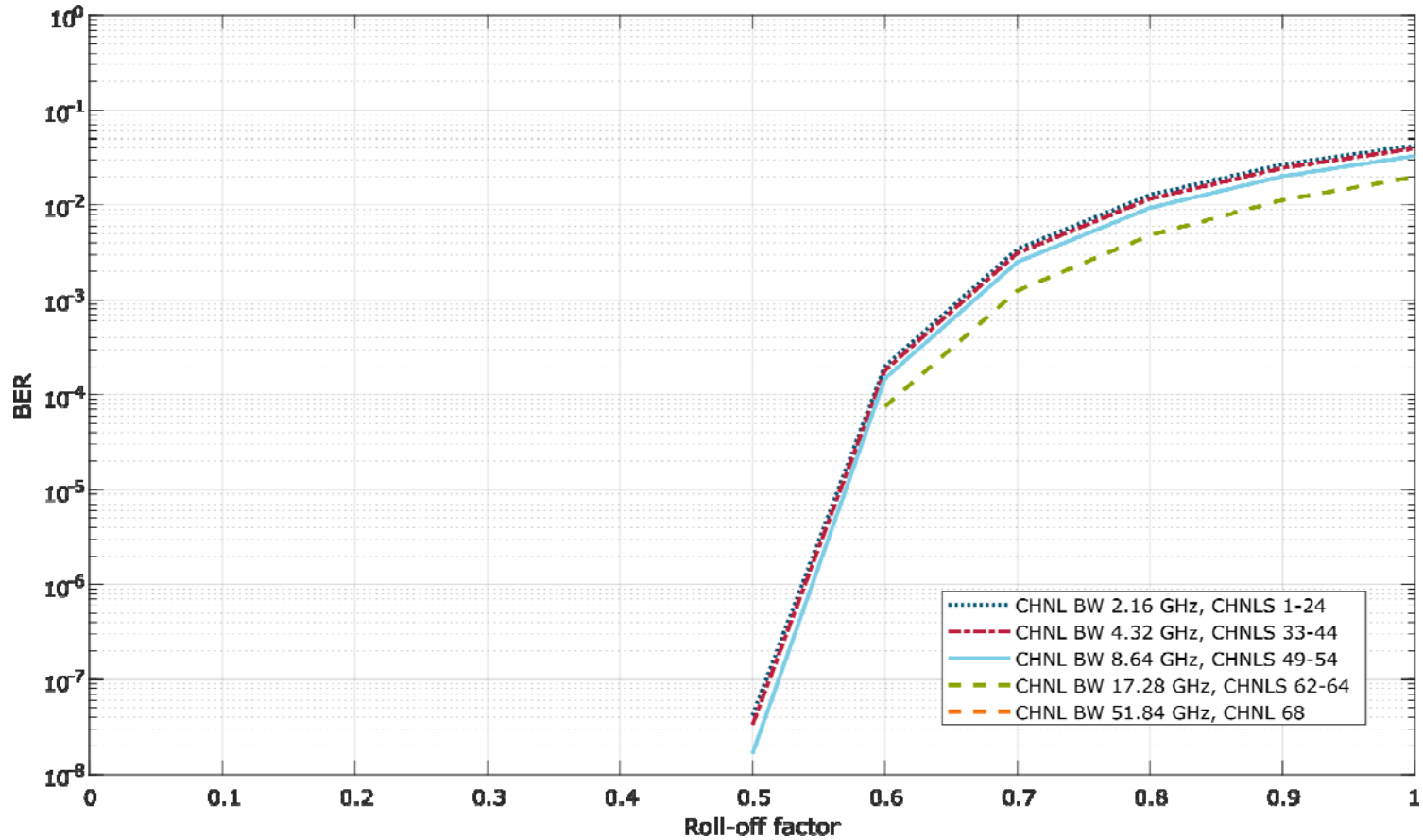- Subcarrier symbol rates 1.76 GBd, 3.52 GBd, 7.04 GBd, 14.08 GBd, 42.24 GBd
- 16-QAM modulation
- No channel coding
- Perfect channel without AWGN
- RRC pulse with different roll-off factors
- 10 Mbit transmitted

Exemplary PSD of CHNL IDs 62-64

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Bit error rate from inter-carrier interference

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Bit error rate

ROF / CHNL BW	2.16 GHz	4.32 GHz	8.64 GHz	17.28 GHz	51.84 GHz
0	0	0	0	0	0
0.1	0	0	0	0	0
0.2	0	0	0	0	0
0.3	0	0	0	0	0
0.4	0	0	0	0	0
0.5	$4.15 \cdot 10^{-8}$	$3.31 \cdot 10^{-8}$	$1.64 \cdot 10^{-8}$	0	0
0.6	$2.01 \cdot 10^{-4}$	$1.81 \cdot 10^{-4}$	$1.49 \cdot 10^{-4}$	$7.55 \cdot 10^{-5}$	0
0.7	$3.5 \cdot 10^{-3}$	$3.1 \cdot 10^{-3}$	$2.5 \cdot 10^{-3}$	$1.3 \cdot 10^{-3}$	0
0.8	$1.3 \cdot 10^{-2}$	$1.2 \cdot 10^{-2}$	$9.3 \cdot 10^{-3}$	$4.8 \cdot 10^{-3}$	0
0.9	$2.7 \cdot 10^{-2}$	$2.5 \cdot 10^{-2}$	$2.0 \cdot 10^{-2}$	$1.1 \cdot 10^{-2}$	0
1.0	$4.3 \cdot 10^{-2}$	$4.0 \cdot 10^{-2}$	$3.3 \cdot 10^{-2}$	$2.0 \cdot 10^{-2}$	0

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Conclusion

- Transmit spectral mask prevents inter-carrier interference
- Root-raised cosine with roll-off factor < 0.3 agrees with the transmit spectral mask
- Roll-off-factors > 0.4 lead to inter-carrier interference

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References

[1] https://thorproject.eu/
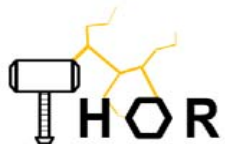
[2] V. Petrov, T. Kürner and I. Hosako, "IEEE 802.15.3d: First Standardization Efforts for Sub-Terahertz Band Communications toward 6G," in IEEE Communications Magazine, vol. 58, no. 11, pp. 28-33, 2020.

[3] J. M. Eckhardt, C. Herold, B. K. Jung, N. Dreyer and T. Kürner, ``Modular link level simulator for the physical layer of beyond 5G wireless communication systems," Radio Science, vol. 57, no. 2, e2021RS007395, 2022.

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Thank you for your attention!

ご清聴ありがとうございました

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