

Simultaneous transmissions of PN ranging with filtered high-order modulations

CCSDS Fall Meeting 2022

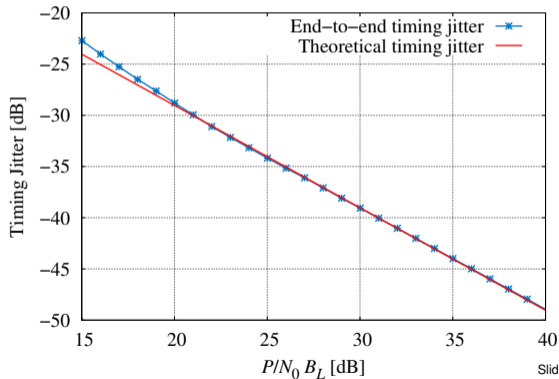
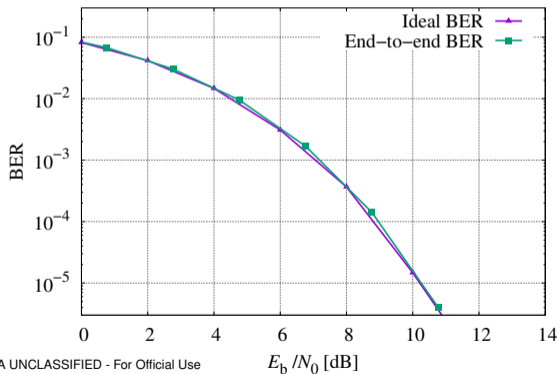
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- 1 State-of-the-art
- 2 Novel Communication System
- 3 Simulation Campaign and Applications
- 4 Conclusions

GMSK and PN Ranging

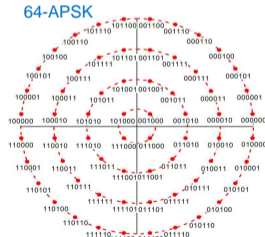
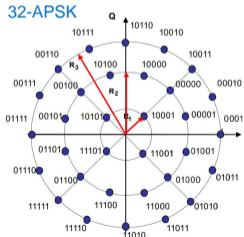
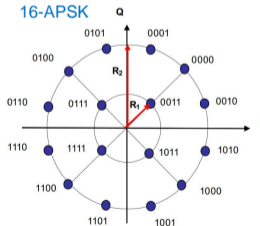
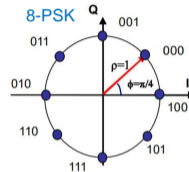
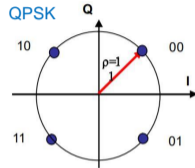
- Currently, space research missions employ GMSK (Gaussian Minimum Shift Keying)-modulated telemetry coupled with PN Ranging
- Reciprocal interference of ranging and telemetry signals
- Receiver based on a closed-loop interference cancellation approach



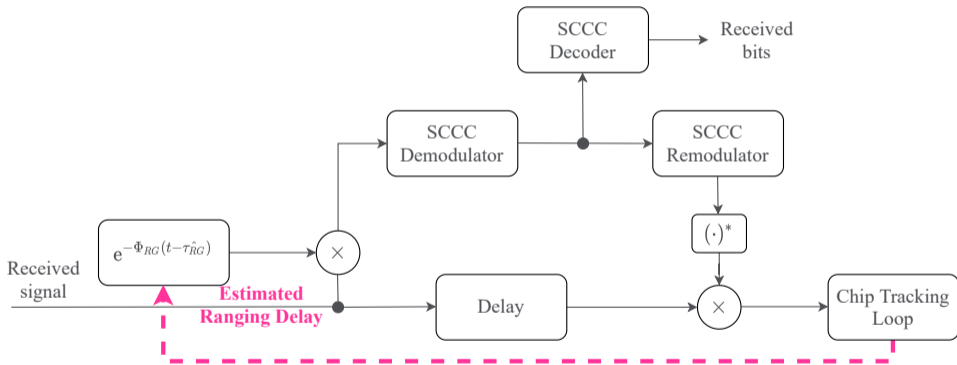
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SCCC and PN Ranging - Modulations

- High-order modulations for SCCC (Serially Concatenated Convolutional Codes) coupled with PN Ranging

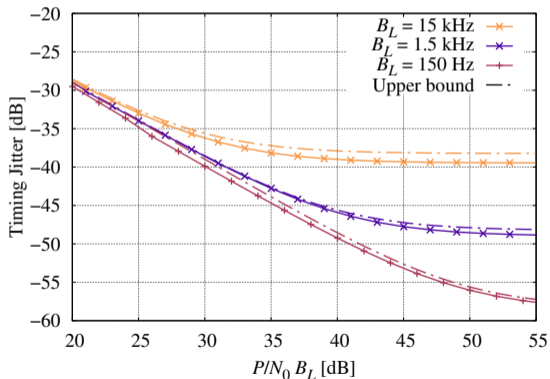


SCCC and PN Ranging - Closed-loop Receiver

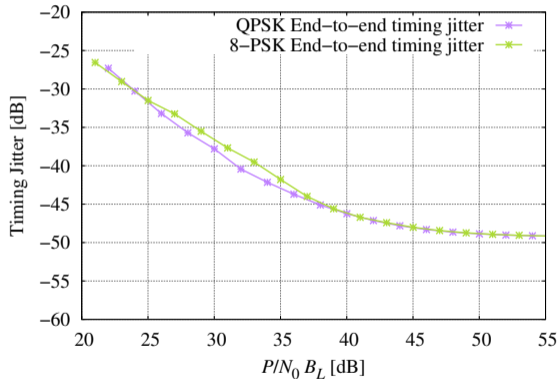
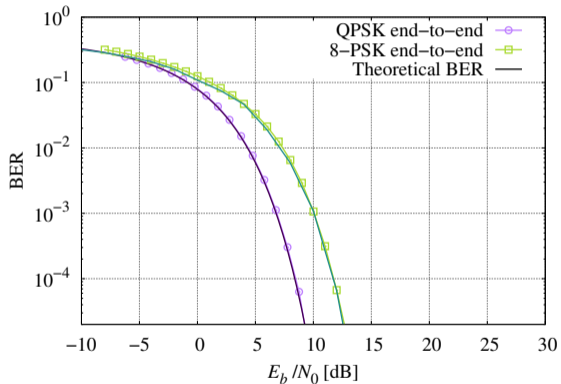


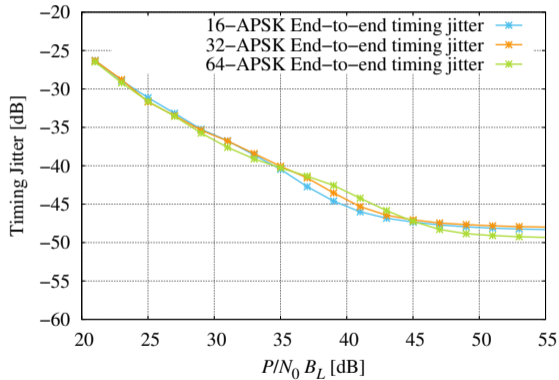
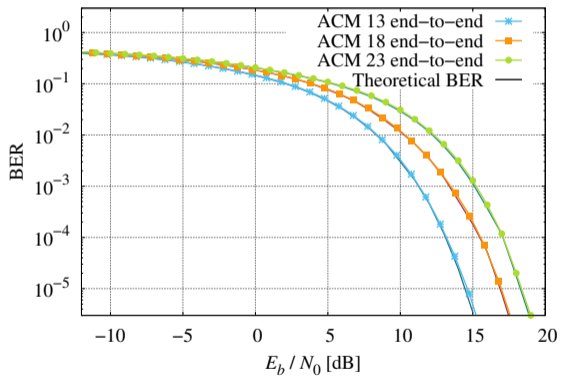
SCCC and PN Ranging - Ranging performance

- Genie-aided receiver scheme fed with the transmitted telemetry symbols
- Upper-bound characterizing the noise floor: $\sigma_{\tau}^2 \leq \frac{B_L}{4(P/N_0)} T_c^2 + \frac{(\sigma_p^2 B_L T_c)}{4} T_c^2$



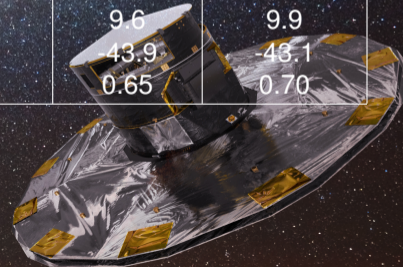
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GAIA/GAIA-NIR Link Budget

	GAIA		GAIA-NIR	
	Best-case	Worst-case	Best-case	Worst-case
ACM	11	5	21	16
E_b/N_0 [dB]	5.46	2.39	8.49	6.5
R_b [Mbps]	14.5	8.9	26.5	21.1
B [MHz]	9.2	9.6	9.6	9.9
Timing Jitter $\tilde{\sigma}_\tau^2$ [dB]	-46.9	-41.7	-43.9	-43.1
Jitter [m]	0.45	0.83	0.65	0.70



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- Communication architecture that combines spectrally-efficient modulations with PN Ranging
- Receiver scheme that iteratively performs closed-loop ranging and telemetry cancellation
- Ranging accuracy comparable to that of the state-of-the-art approach
- Data rate two/three times higher than the current limit, paving the way to a new generation of Space Research missions with more ambitious scientific objectives
- The work led to the publication of the paper “On the use of Pseudo-Noise Ranging with high-rate spectrally-efficient modulations in satellite payload telemetry links” in IEEE Transactions on Aerospace and Electronic Systems.

Thank you for your attention!

