Intermediate Report Nr. 5 - PRELIMINARY

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1 Ranging with Ternary Preamble Sequences (TPS)

In this short IR, I tried to evaluate the performance of each ranging algorithm (direct, parallel, sinc, sliding) for bot LOS and NLOS scenarios over a wide range of SNR. The methods and the ranging parameters are listed below:

- **Direct:** The ED output values are used directly for ranging purposes. Uncertainty is characterized by $\frac{T_i}{4}$, as also seen in IR 10
- **Parallel:** Analyzed in IR 8. For fair comparison I doubled the integration interval, getting a resolution of T_i. Uncertainty is also characterized in IR 10.
- **sinc:** To be analyzed (IR 12). I used a resolution of 0.25 ns for interpolation, but I did not correct any systematical errors in terms of leading edge detection due to the usage of sinc-curves. Instead of sinc-interpolation, I used a LS interpolation reducing the oscillations prior to the leading edge. The same technique was used for IR 10.
- **Sliding:** As introduced in IR 9. Integration times of 1.25, 2.25 and 4.25 ns were chosen, yielding a resolution of 0.25 ns each. Each of these intervals can only exploit a certain number of symbols, and this was corrected by shifting the E_p/N_0 accordingly (half of the energy difference in dB was shifted due to non-coherent combining loss). Since the long integration time of 4.25 ns requires at least 17 symbols, for all algos with $T_i = 4$ ns the symbol count was set to 64 (which was corrected by shifting the energy vector by 3 dB).

I performed simulations over 500 channel realizations for K=0 (NLOS) and K=1 (LOS). The following figures show the results in terms of ranging performance and robustness, while taking the integration period into account as well. For each SNR value, the optimal threshold was chosen.

Fig. 1 shows the performance of different algorithms for a set of integration periods and for both LOS and NLOS cases. All plots have in common, that the sliding algorithm performs much less robust, but also more accurate at higher SNR values (which is also verified by Tab. 1). Increased accuracy is more emphasized for LOS. The interpolation algorithms seems to benefit from large integration values, whereas the parallel algorithm seems to loose performance in LOS environments. Generally, the difference between algorithms is more and more observable with increasing integration periods and/or increasing strength of the LOS component.

	$T_i = 1$ ns		$T_i = 2$ ns		$T_i = 4$ ns	
	SB (adapt.)	SB (norm.)	SB (adapt.)	SB (norm.)	SB (adapt.)	SB (norm.)
K=0						
direct	0.635	0.64	0.715	0.73	1.111	1.15
parallel	0.721	0.72	0.903	0.90	1.406	1.41
sinc	0.755	0.75	0.968	0.97	1.193	1.19
sliding	0.710	0.71	0.828	0.83	1.032	1.03
K=1						
direct	0.421	0.42	0.605	0.60	1.028	1.03
parallel	0.647	0.67	0.973	1.01	1.702	1.77
sinc	0.468	0.56	0.586	0.76	0.887	1.15
sliding	0.381	0.45	0.453	0.59	0.746	1.03

Table 1: Preliminary Results for Ranging with TPS (noise-free case)

Fig. 2 shows the influence of the integration period T_i on ranging performance and accuracy. As expected, for all algorithms accuracy increases with decreasing integration periods. It is interesting, though, that also robustness seems to benefit from shorter integration intervals[1].

Finally, Tab. 1 compares the accuracy of different algorithms also for normalized thresholds. For these simulations, the noise vector was set to zero.

[1] So far, I don't have an explanation for this effect, but I will try to find out.

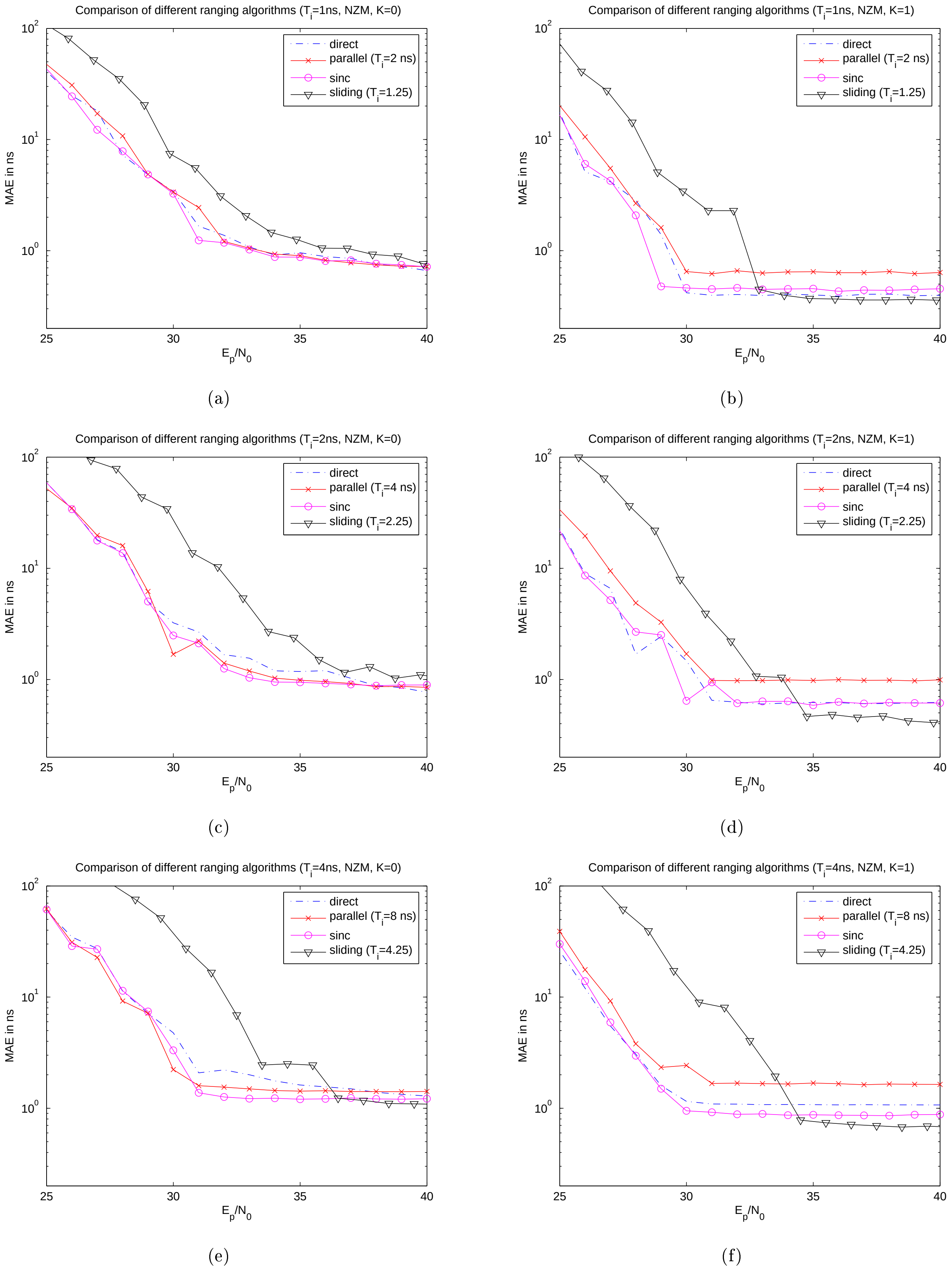

Figure 1: Comparison of different ranging algorithms

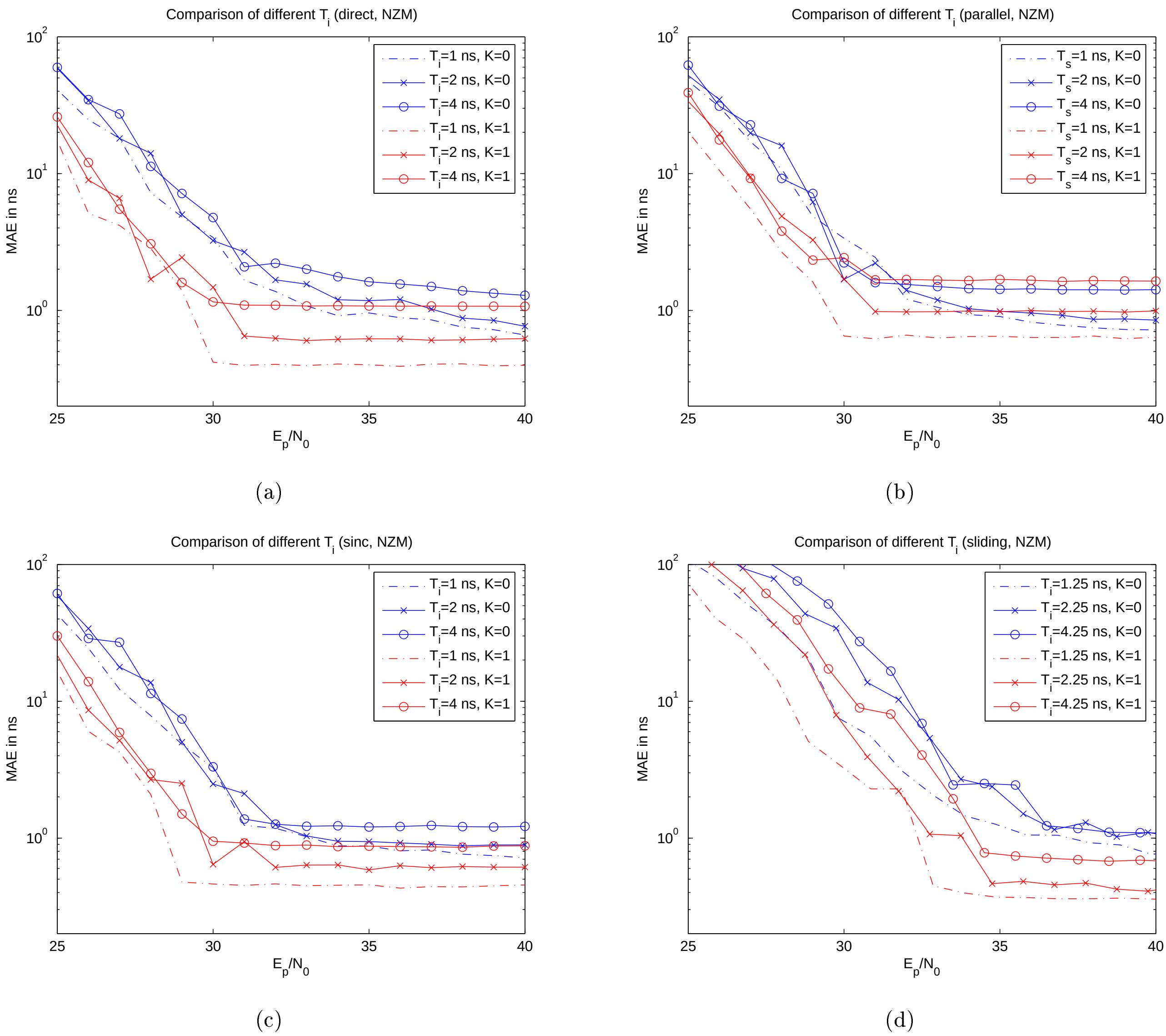

Figure 2: Influence of the integration interval on the performance of different ranging algorithms