Session 4

Optimization of the current SLR tracking network: potential for SLR-derived reference frames

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Operational Satellite Laser Ranging now has a history of over 40 years. The current SLR tracking network evolved over this long period of time and now comprises stations from different epochs on different technological levels. In the upcoming years, the upgrading and even the automatization of the systems will be an issue, bearing a great potential for enhancing the overall performance of SLR and the quality of the geodetic parameters derived.

Within a simulation study, we have been investigating the current deficiencies of the SLR tracking network and how the impact of a technical improvement of certain existing stations would be. We have performed a comparison of different scenarios in order to be able to determine the impact of the performance of different SLR stations on the estimated geodetic parameters. The outcomes of the study are intended to contribute to establishing the basis for a concerted upgrading of the existing station network.

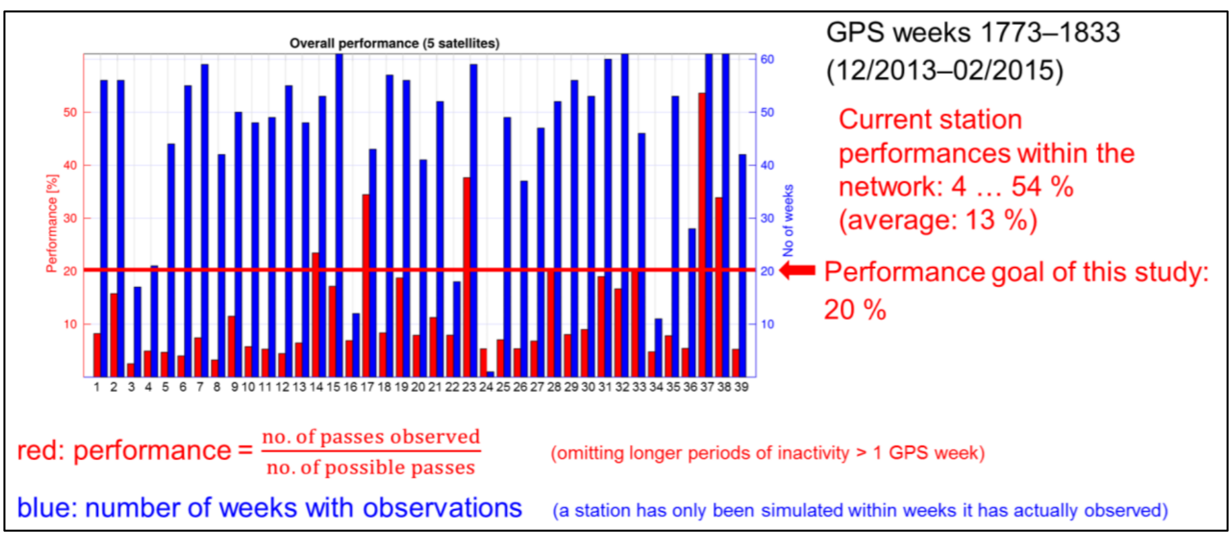

Figure 1: Current performances in the existing SLR station network.

Figure 1 gives an overview over the current performances within the SLR station network. The performances are an average over the five satellites LAGEOS-1, LAGEOS-2, Etalon-1, Etalon-2 and LARES. The performance values have been calculated as the number of passes observed w.r.t. the number of possible passes ("possible" in the sense of a satellite elevation ≥ 10°), omitting longer periods of inactivity (> 1 GPS week). As can be seen, most of the stations measure less than 10% of the passes theoretically possible. The blue bars reflect the number of weeks within which the station has been active, the basis for the calculation of the performance value (red bar).

Within this simulation study, we have defined a performance goal of 20% for each station. The simulations have been performed as described in the presentation by Kehm et al. in Session 1, assuming the real network with real station performances, only one station of them “improved” to a performance of 20%.

The results for three exemplary stations in different geographical locations (Figure 2) are shown in Table 1 and compared to a scenario assuming the whole SLR network operating at a minimum performance of 20%. As can be seen, already the upgrade of a single station within the network can lead to a significant reduction of the WRMS of the time series of a parameter w.r.t. the a-priori TRF and EOP. Thus, the “full” improvement can also be approached even if it might not be possible for all stations in the network to reach the goal of 20% performance. This can be due to external conditions like the cloud coverage which has not been taken into account within the present simulation study.

Table 1: Exemplary results for a single improved station in the network (performance of Arequipa, Haleakala, Badary, resp., improved to 20%) as well as for a fully upgraded station network assuming a minimum performance of 20% for all stations.

$-\Delta$***WRMS*** **[%]**	t_x	t_y	t_z	*scale*	x_{pole}	y_{pole}	*LoD*
Arequipa 20 %	**3**	**4**	**6**	**3**	0	**3**	0
Haleakala 20 %	**3**	1	**5**	**4**	**2**	**2**	1
Badary 20 %	**3**	**3**	– 1	**3**	**2**	**2**	0
all 20 % (Kehm et al., 2017)	**10**	**27**	**14**	**49**	**10**	**10**	**4**

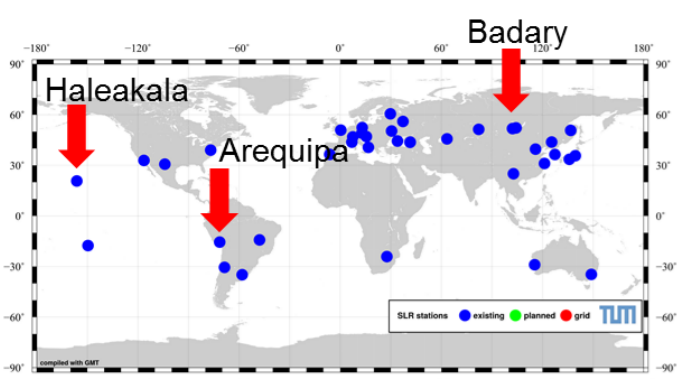

Figure 2: Geographical locations of the exemplary stations.

Table 2 summarizes the results of the studies presented here (performance enhancement) as well as in Session 1 (eight additional stations added) and additionally shows the effect of a hypothetical SLR network with eight additional stations operating at a minimum performance of 20%.

Table 2: Effect of technical improvement (improved performances), network geometry (additional stations, cf. talk in Session 1) and combined effect on the estimated parameters.

Effect of	Helmert parameters (reference: SLRF)					EOP (ref.: IERS C04)		
	WRMS				RMS of residuals	WRMS		
	t_x	t_y	t_z	M		x_{Pol}	y_{Pol}	LoD
Performance (real Network)	10 %	27 %	14 %	49 %	44 %	10 %	10 %	4 %
Geometry (+ 8 Stations)	18 %	20 %	24 %	20 %	6 %	4 %	5 %	2 %
combined	**26 %**	**41 %**	**35 %**	**59 %**	**48 %**	**13 %**	**15 %**	**6 %**

From the results of the studies presented here as well as in Session 1, we can draw the following conclusions:

- It is strongly recommended to invest into the **improvement of existing stations** alongside **establishing new stations** (Kehm et al., 2017; also refer to presentation by Kehm et al. from Session 1).
- Even the upgrade of a single existing station can lead to a significant improvement of the estimated geodetic parameters, thus one can profit immediately even if the enhancement of the full network is going step-wise or if the real operating conditions (e.g., cloud coverage) of some stations do not allow for a higher performance.