Annex C: Uncertainty budget terms

1. Statistical uncertainty

The statistical uncertainty u_A(A-B) of a single code comparison between two stations A and B is evaluated by taking the upper limit of the error bar of the TDEV at 1 d when available, or otherwise the upper limit of the closest error bar available.

The statistical uncertainty of P1 – P2 or E1 – E5a is computed from a quadratic sum of each individual code uncertainty. But the statistical uncertainty of P3 or E3 is either computed from a quadratic sum linked to the ionosphere-free linear combination, or from a similar TDEV analysis as for each individual code. We provide both results in the uncertainty budgets. When there is a significant difference between both results, it means that there are other noise modulations than the expected white phase noise in the data.

The total statistical uncertainty is similarly obtained either from a quadratic sum linked to the ionosphere-free linear combination (which result should be similar within a few ps to the quadratic sum of both results above obtained from a similar computation), or from a quadratic sum between u_A(traveling – reference) and u_A(traveling – visited) obtained from the TDEV analysis. The highest of both values is then used for the total combined uncertainty computation leading to a conservative estimate.

2. Type B uncertainties

- $u_{B,1}$ observed maximum misclosure. This uncertainty component is an estimation of the stability of equipment during the campaign. When a single receiver is traveling the only possible estimation is the classical misclosure. With two traveling receivers it is also possible to estimate the stability of the ensemble during the trip by computing the offset between these receivers when implemented in all sites. The misclosure $u_{B,1}$ we use is the maximum value between the actual misclosure between the start and the end of the campaign and the offset between both traveling equipment when implemented in remote sites. [This part is for information only, not applicable here due to OPM7 failure.]

- $u_{B,11}$ position uncertainty at reference site. The position of the GPS centre of phase of traveling antenna is estimated by using the NRCAN PPP software on RINEX 2.11 files obtained during the campaign, while for the reference antenna the coordinates of the last G1 calibration are used. According to the BIPM guidelines, we choose a conventional value of 50 ps for the position error at the reference site, which corresponds to a potential error of about ± 4.5 cm. Note that we assume the same phase centre for both P1 and E1 carriers, and a negligible offset between P2 and E5a carriers for Galileo delay uncertainty computations.

- $u_{B,12}$ position uncertainty at visited site. Same as above.

- $u_{B,13}$ uncertainty due to multipath at reference site. We assume in all cases a conventional value of 200 ps. It is slightly smaller than the value proposed by the CCTF WG on GNSS, but this conventional value is in line with some experiment achieved at OP and ORB.

- $u_{B,14}$ uncertainty due to multipath at visited site. Same as above, but this part might be underestimated if the visited location is not optimal with respect to such issues.

- $u_{B,21}$ REFDLY uncertainty (traveling receiver at reference lab). Uncertainty of the measure of the time difference between the reference point of the traveling receiver and the local UTC(k). The used value is the quadratic sum of a conventional value (200 ps) with the standard deviation of the actual measurement. When the REFDLY is obtained by summing several individual measurement the uncertainty is increased by quadratic sum as required.

- $u_{B,22}$ REFDLY uncertainty (traveling receiver at visited lab). Same as above.

- $u_{B,TOT}$: Quadratic sum of all previous u_B.

- $u_{B,31}$ REFDLY uncertainty of the reference system to its local UTC(k). Computed in a similar way as $u_{B,21}$. This term can be set to 0 when the calibration is a G1/G2 type, the uncertainty of REFDLY being already included in the calibration of the reference receiver.

- $u_{B,32}$ REFDLY uncertainty (at visited lab) of the link of the visited system to its local UTC(k). Computed as $u_{B,21}$. When this delay is measured and the $u_{B,32}$ is taken into account, the local distribution system can be modified afterwards without loosing the calibration, provided an uncertainty is given for the new delay.

- $u_{B,41}$ uncertainty of antenna cable delay at reference station. This term can be set to 0 when the calibration is a G1/G2 type, the uncertainty of antenna cable delay being already included in the calibration of the reference receiver.

- $u_{B,42}$ uncertainty of antenna cable delay of traveling station, when such a cable delay is provided. When this delay is measured and the $u_{B,42}$ is taken into account, the antenna cable can be modified afterwards without loosing the calibration, provided an uncertainty is given for the new antenna cable delay.

- $u_{B,SYS}$: Quadratic sum of all type B uncertainty.

- u_{CAL0}: Quadratic sum of u_A and $u_{B,SYS}$. This uncertainty is for the link between the calibrated receiver and the reference receiver, without taking into account the uncertainty of this reference receiver as obtained from a G1 station calibration.