3.6.1.3 Natural Resources, Canada (NRCan)

NRCan is an ITRS Combination Centre for the International Earth Rotation Service (IERS). The IERS objective for the TRF combination project is to have independent combinations of the TRF realizations thus providing some quality control. Since the late 1980's, IGN has been the sole agency responsible for determining the ITRF realizations. At NRCan, the capability to combine GPS solutions has been developed. Extending this capability to combine solutions containing station coordinates and velocity determined with the DORIS, GPS, SLR and VLBI techniques, was a natural step forward.

The recent work related to the ITRF combination was mainly dedicated to solution analysis and software upgrades. In principle, all contributing solutions are combined simultaneously to generate the final solution. The data combination is currently done using a two-step procedure. In the first step, the solutions within each technique are combined. In the second step, all the intra-technique solutions obtained in the first step are combined to generate the final solution. This approach has been chosen because it is less demanding on the available resources, namely, existing software is usable with minimal upgrade requirements. Splitting the combination activities, however, introduces some approximations.

In the intra-technique combination, the following activities are performed: 1) standardization of the solutions to a consistent "flavour" of SINEX; 2) removal of the constraints and rescaling of the covariance (iterative); 3) removal of the outliers (also iterative); 4) alignment of all solutions to a reference using 14 or less transformation parameters (rotation, translation, scale & rates) as appropriate; 5) combination (addition of normals); 6) analysis of the results. For a few solutions, the removal of the constraints caused a significant degradation of the relative station coordinates/velocities. In some cases it is not possible to remove the a-priori constraints, suggesting some incompatibilities between a-priori and estimated matrices for some solutions. Numerical problems are also not ruled out. Some intra-technique combinations are almost ready.

During the second step, the results from the first step are combined along with the local ties. The ties at each site are allowed 3 degrees of freedom in translation (TX, TY, TZ) during the adjustment. The combined solution currently includes the DORIS, GPS, SLR and VLBI. The 3-D RMS of the residuals vary from 8 mm to 29 mm in position, and from 2 to 9 mm/y in velocity. The realization of the origin (SLR), scale and rate (VLBI & SLR), orientation and rates (ITRF97 & NNR) needs further investigation and should be further resolved as the intra- and inter-technique combinations are integrated. Table 1 summarizes the 3-D RMS statistics for each

technique after the intra- and inter-technique combinations. In the intra-technique columns, the RMS residuals are between each solution and the combined intra-technique solution. Similarly, the inter-technique RMS are between the technique combination and the inter-technique combination. Position RMS are determined from the position residuals at the minimal position variance. In the table, the GPS-D technique refers to the GPS densification solutions. Since in this case there is little or often no overlap between the solutions, they were compared to the IGS combined solutions to extract meaningful statistics; those solutions haven't yet been included in the inter-technique combination. There were also two (GRIM5, CSR) multi-techniques solutions. Those haven't been included yet.

Table 1: 3-D RMS position and velocity statistics for the intra-technique and inter-technique combinations.

	Intra-technique		Inter-technique	
Techniques	Position 3-D RMS (mm)	Velocity 3-D RMS (mm/y)	Position 3-D RMS (mm)	Velocity 3-D RMS (mm/y)
DORIS	35	11	33	10
GPS-D	8	6	-	-
GPS	13	6	4	2
Multi	-	-	-	-
SLR	26	10	24	5
VLBI	16	2	6	3

A few more iterations of the combination process are needed to produce the final solution. Analysis of the quality and consistency of the origin and scale determinations also remain to be done. Comparisons with the official ITRF 2000 will also be performed.

Remi Ferland