ACCURATE measurement of track geometry is critical in the assessment of railway safety. Major rail-ways and infrastructure owners measure track geometry systematically to monitor track deterioration and identify defects. This data allows them to estimate the rate of track deterioration, optimise track maintenance schedules, and establish maximum line speed limits.

Determining track geometry involves measuring an individual rail’s geometric properties, as well as the relative displacement of one rail with respect to the other. To quantify the rail geometry, the rails are modelled as lines in three-dimensional space, and these lines are then projected onto two-dimensional planes. Once track geometry is measured, each measurement’s geographic location must be identified.

A variety of railcar-based geometry measurement systems has been developed over the past century, and many of these designs are still in operation today. The most common use mechanical sensors with movable feeler points that are in constant contact with the rails. The sensors’ movement is an indication of the track geometry. For example, the outputs of three horizontal feelers, mounted on three telescopic axles continuously touching the rails, can be used to measure rail alignment.

Although these systems represent a significant improvement over manual on-ground geometry measurement, geometry systems that use contacting sensors cannot be used on high-speed track, as the sensors will not maintain constant contact with the rails.

Many newer systems use non-contact optical laser sensors in conjunction with accelerometers and a vertical gyroscope to derive the desired track geometry measurements. This approach overcomes the speed restrictions of mechanical sensors. However, the use of accelerometers and a vertical gyro creates its own problems.

When the accelerometer output is double-integrated to compute the railcar’s displacement, the inherent accelerometer bias error produces a displacement error that grows quadratically with time. This renders the accelerometer-derived displacement unusable for track geometry measurement at slow car speeds. In addition, vertical gyros are known to produce false orientation readings when subjected to centripetal force, which may result in inaccurate measurement of superelevation during curves.

Track Geometry Features

The location of measured track geometry features has traditionally been determined by measuring the distance travelled from a predetermined reference (zero) point. For geometry feature measurements to be meaningful, railways need to have the location of track geometry features referenced (or synchronised) to railway landmarks such as mileposts, crossings, and switches. This is done either manually by the track geometry operator, or automatically using automatic location detectors (ALDs). Both approaches are less than ideal, since manual synchronisation is error-prone, while ALDs are costly to install and can be easily damaged or dislocated by track maintenance machines.

Given the inherent deficiencies of existing track geometry and feature localisation systems, Plasser American Corporation was interested in developing a new contact-free system.

The solution came from Applanix Cor-
The ability of POS/TG to continuously compute and output at high frequency the geographic position of the track geometry railcar lends itself to an elegant implementation of LS. During a measurement run, LS minimises the distance between the current location of the car and the synchronisation locations stored in a GIS database. Once the minimum is reached, LS issues a synchronisation message and signal. This process is fully automatic, and it is being successfully employed by Austrian Federal Railways (ÖBB).

POS/TG includes a number of features never before available in a track geometry measurement system, while allowing concurrent use for railway surveying and GIS generation. Simple installation, configuration, and minimal maintenance requirements allow it to be incorporated into almost all conventional rail vehicles or locomotives, allowing track geometry measurements during revenue service at track speeds. IRJ