Mobile Survai – Safe Advisory Speed Methodology

Version: 2026-08-05 • Applies to: Mobile Survai

1. Purpose & Scope

This document formalises the Mobile Survai methodology for deriving curve advisory-speed screening values from a vehicle-mounted electronic inertial measurement unit and GNSS receiver. It documents the implemented sensor alignment, signal conditioning, peak selection, speed correlation, advisory-speed calculation, outputs, safeguards and interpretation requirements.

The method follows the electronic accelerometer approach described by Transport for NSW for network-level curve audits, in which measured lateral acceleration is correlated with GPS location, speed and distance. It is intended to support engineering review of curve advisory speeds; it does not replace practitioner judgement or statutory sign-setting procedures.

2. Glossary

Record: A single georeferenced Mobile Survai observation, normally associated with a photograph and a short road interval.

Lateral acceleration: Acceleration measured across the vehicle, expressed in gravitational units (g).

Raw lateral acceleration: The signed accelerometer value after sensor-to-vehicle axis mapping and before smoothing.

Filtered lateral acceleration: The signed lateral acceleration after Gaussian-weighted smoothing.

Peak lateral acceleration: The maximum absolute filtered lateral acceleration occurring within a Record.

Test speed: The GNSS vehicle speed captured at the same instant as the filtered lateral-acceleration peak.

Target lateral acceleration: The adopted lateral acceleration used in the advisory-speed calculation; currently 0.20 g.

Advisory speed: The calculated speed at which the same curve would produce the adopted target lateral acceleration, assuming lateral acceleration varies with speed squared.

3. Hardware & Data Sources

- Phidget Precision Spatial 3/3/3 inertial measurement unit operating through the Phidget firmware IMU/AHRS algorithm.
- IMU data interval configured to the fastest supported interval, nominally 4 ms (approximately 250 Hz).
- GNSS speed, position, heading and distance from either the supported Phidget GPS or u-blox ZED-F9P configuration.
- Mobile Survai Data table for storing the calculated advisory-speed value with the corresponding georeferenced survey record.

The IMU and GNSS data streams are processed continuously while the survey is active. The lateral filter history remains continuous across photographic Record boundaries so that the smoothing response is not artificially reset between adjacent observations.

4. Instrument Setup & Levelling

The IMU is rigidly mounted to the survey vehicle. The installation is calibrated using the Mobile Survai two-position calibration procedure, which averages readings taken in opposing vehicle orientations to reduce the influence of an imperfectly level calibration surface.

The sensor axes are mapped to the vehicle coordinate system. The configuration setting Switch_X_Y allows the same processing path to be used where the device has been installed at 90 degrees to the normal mounting direction.

The lateral axis is not quaternion-rotated into a world-level coordinate frame. This intentionally retains the effective lateral-force response experienced by the vehicle, including the combined influence of curve acceleration, road superelevation or crossfall, vehicle body roll and mounting alignment. This is consistent with the practical response measured by traditional ball-bank methods.

5. Vehicle-Axis Mapping

At every IMU sample, the raw accelerometer and gyroscope axes are remapped to the vehicle axes.

- Normal installation: the configured device X-axis is used as the vehicle lateral axis.
- Rotated installation: Switch_X_Y exchanges the applicable device X and Y axes.
- The signed lateral value is retained through the filtering stage.

The absolute value is not applied before filtering. Retaining the sign prevents alternating left-right vibration from being accumulated as false sustained cornering acceleration.

6. Gaussian-Weighted Signal Smoothing

A high-rate electronic accelerometer responds to potholes, surface texture, suspension vibration and other short-duration disturbances that would not represent sustained curve demand. Mobile Survai therefore applies a causal Gaussian-weighted smoothing filter to the signed vehicle lateral-acceleration signal.

Current filter settings:

- Gaussian standard deviation: 0.20 seconds.
- Filter extent: 3 standard deviations.
- At a 4 ms sample interval, the kernel contains approximately 151 historical samples, representing about 0.60 seconds of prior data.

The newest sample is assigned the highest Gaussian weight, with progressively smaller weights applied to older samples. Available weights are renormalised while the history buffer is initially filling.

Because the filter is causal and intended for live operation, it is correctly described as Gaussian-weighted smoothing rather than a centred zero-phase Gaussian filter.

7. Filtered Peak & Matching Speed

For each Record, Mobile Survai retains the maximum absolute value of the filtered lateral-acceleration signal. Whenever a new filtered peak is observed, the current GNSS speed is stored at the same instant.

This pairing is essential: the advisory-speed calculation uses the speed that generated the selected lateral-acceleration peak, rather than the GNSS speed at the later time when the database row is written.

When a Record closes, the peak filtered lateral acceleration and its matching test speed are finalised together. The per-Record peak is then reset, while the Gaussian history is retained for the next Record.

8. Advisory-Speed Calculation

For a vehicle following the same curve radius, lateral acceleration is approximately proportional to the square of vehicle speed. Mobile Survai therefore calculates advisory speed using:

Advisory speed = Test speed × √(Target lateral acceleration ÷ Measured lateral acceleration)

Current calculation parameters:

- Target lateral acceleration: 0.20 g.
- Minimum processed lateral acceleration: 0.03 g.
- Minimum test speed: greater than 10 km/h.
- Calculated values are constrained to a maximum of 200 km/h as a data-integrity safeguard.
- The calculated result is rounded to the nearest whole kilometre per hour.

Where the processed lateral acceleration is below 0.03 g, or the matching test speed is 10 km/h or less, the Record does not generate a meaningful advisory-speed result and a value of zero is stored.

9. Worked Example

Assume the following processed result for a curve:

- Peak Gaussian-filtered lateral acceleration: 0.32 g.
- GNSS speed at the same peak: 80 km/h.
- Target lateral acceleration: 0.20 g.

Advisory speed = 80 × √(0.20 ÷ 0.32)

Advisory speed = approximately 63 km/h

The software stores the calculated value to the nearest 1 km/h. Final sign selection remains subject to engineering review and the applicable sign-setting conventions.

10. Data Output

When lateral-acceleration recording is enabled, the advisory-speed result is written to Data.User10 for the corresponding Mobile Survai Record.

The same database row contains the supporting survey context, including:

- Record ID and survey ID
- road ID and road name
- photograph name
- chainage and supplied chainage
- latitude, longitude and altitude
- heading and timestamp
- recorded vehicle speed
- pitch and roll
- surface and road attributes

This enables the advisory-speed result to be mapped, reviewed against imagery and road geometry, compared between travel directions and interrogated with the broader Mobile Survai dataset.

11. Network-Level Survey Procedure

The following field procedure aligns with the Transport for NSW guidance supplied for electronic accelerometer curve audits:

- The survey should be undertaken by practitioners trained in test-vehicle setup, accelerometer operation and interpretation of the resulting data.
- Survey each road section at least once in both directions.
- Where directional passes produce different advisory-speed results, the lower result should be selected for engineering review.
- Additional passes should be undertaken where results are disturbed by traffic, hazards, inconsistent speed or an unrepresentative vehicle path.
- The test vehicle should negotiate the curve at a steady speed and follow the natural curve path.
- Where a nominal advisory speed already exists, the test speed should generally be between that speed and no more than approximately 10% above it, subject to safe driving conditions.
- Potholes and minor obstructions should normally be traversed rather than avoided, because evasive manoeuvres can distort the lateral-acceleration trace.
- Digital event markers or sign inventories may be used to reconcile calculated results with existing signs.

12. Compound, Reverse & Extended Curves

The continuous sensor and GNSS streams allow the dataset to represent long compound curves, reverse curves and changing-radius sections. Gaussian history is preserved across individual photographic Records, preventing artificial discontinuities in the measured response.

The current Mobile Survai database output provides an advisory-speed value at each Record. Curve-level consolidation, comparison of adjacent Records and selection of a final signed advisory speed are undertaken during engineering review or downstream analysis.

13. Safeguards & Edge Cases

- Raw accelerometer maxima are not used; peak selection occurs only after Gaussian-weighted smoothing.
- The signed lateral signal is smoothed before conversion to magnitude.
- The GNSS speed is captured at the same instant as the selected filtered peak.

- The filter history is not cleared at each photo boundary.
- Low-speed and very-low-lateral-acceleration results are excluded from meaningful calculation.
- NaN and infinite calculated values are rejected.
- The advisory-speed result is a screening and engineering-support output, not a rollover, skid-resistance or absolute safety limit.

14. Interpretation & Engineering Review

The calculated value represents a comfortable lateral-acceleration criterion applied to the measured vehicle response. It is not a guarantee that all vehicles, drivers, tyres, loads, weather conditions or pavement states can safely negotiate the curve at that speed.

Final advisory-speed selection should consider:

- repeatability between passes
- results from both travel directions
- curve length and consistency of radius
- compound and reverse curve geometry
- road surface condition and available friction
- sight distance and delineation
- intersections, accesses and roadside hazards
- existing warning signs and network consistency
- vehicle-path or traffic disturbances during testing

As noted in the Transport for NSW guidance, electronic analysis may produce results to the nearest 1 km/h, but engineering judgement is required when selecting the most appropriate advisory speed for signing.

15. Method Status, Configuration & Refinement

The described methodology is implemented in Mobile Survai. The Gaussian smoothing parameters have been selected to suppress short-duration road impacts while retaining sustained lateral acceleration through curves.

The current parameters are transparent and repeatable. They may be refined as comparative survey datasets become available, provided any change is documented, version-controlled and assessed against representative raw IMU data before field deployment.

Any future change to the Gaussian standard deviation, window extent, target lateral acceleration, minimum lateral threshold or minimum speed should be treated as a controlled methodology revision.

16. Pseudocode

```
for each IMU sample:
    map sensor axes to vehicle axes
    signed_lateral_g := vehicle lateral acceleration
    filtered_lateral_g := causal GaussianWeightedFilter(signed_lateral_g)
    if abs(filtered_lateral_g) > record_peak:
        record_peak := abs(filtered_lateral_g)
        speed_at_peak := current GNSS speed

when the Record is finalised:
    if record_peak >= 0.03 g and speed_at_peak > 10 km/h:
        advisory_speed := speed_at_peak × sqrt(0.20 / record_peak)
        advisory_speed := round(clamp(advisory_speed, 0, 200))
    else:
        advisory_speed := 0
    write advisory_speed to Data.User10
    reset the per-Record peak
    retain Gaussian history
```

17. Validation & QA

- Confirm the IMU is rigidly mounted and the correct Switch_X_Y configuration is selected.
- Complete the two-position calibration before survey collection.
- Check that the speed associated with each peak is plausible and consistent with the GNSS trace.
- Compare repeat passes and opposing travel directions.
- Investigate isolated low advisory-speed values against imagery, roughness, potholes and vehicle-path disturbances.
- Document the software version and methodology version supplied with project outputs.

18. Reference Framework

This methodology has been prepared with reference to the electronic accelerometer approach described in the Transport for NSW curve advisory-speed factsheet supplied to Survai Systems, together with the broader framework of AS 1742.2, relevant Transport supplements and Austroads guidance.

The cited Transport for NSW material identifies the Vericom VC4000DAQ as an example of a suitable digital accelerometer and the Curve Advisory Speed Tool (CAST) as an example analysis package, while permitting other suitable devices and software.

Mobile Survai is an independently implemented system. It does not claim to reproduce proprietary Vericom or CAST filtering algorithms.