Specification for TISA QBench Calculations

Version 1.0

26-January-2016

TISA Specification: 'TISA QBench Calculations'

Document Control Sheet

Document Title:	Specification for TISA QBench Calculations
Document reference:	SP16001_TISA_QBench_Calculations_v1.0.docx
Issues:	26-January-2016
Status:	Final
Editor:	TISA QBench Task Force

Contents

1 Purpose of this document

This document describes the metric calculations for measuring the quality of Traffic Flow information. The Traffic Flow information is assumed to be broadcasted in near real-time to reflect either current or future conditions.
The metrics can be applied toward quality assurance and data validation purposes. They can also serve as benchmark measurements in order to compare data quality between several information sources or commercial and public providers on a given roadway or within a metropolitan region, or to establish comparisons across multiple regions.
Guidelines are provided aside these metric calculations to provide an insight on the values that should be used for these calculations.

2 Definitions and Abbreviations

For the purposes of this specification, the following terms and definitions apply.

Definitions:

Travel Times	Expressed in seconds
Lengths and Distances	Expressed in meters
Speeds	Expressed in meters per seconds

Abbreviations & Parameters:

Symbol	Suggested Value	Description
d		Travelled distance
Cap	10%	Capping (in function of the Free Flow speed) to bound the measured speeds to limit the impact of single events
α	0.5	A factor used to reduce the impact on overestimating the travel time when calculating the Actual Benefit
V_{ff}	the maximum allowed speed for conditional access roads 80% of the maximum allowed speed for non-conditional access roads	Free Flow speed
T_{ff}		Free Flow travel time
V_{gt}		Ground Truth speed
T_{gt}		Ground Truth travel time
V_{rep}		Reported speed
T_{rep}		Reported travel time
V_{ss}	1m/s	Stand Still speed (lowest possible speed)
T_{ss}		Stand Still travel time
V_{ct}	50% of the Free Flow speed (V_{ff})	Congestion Threshold speed
T_{ct}		Congestion Threshold travel time
V_{lower}		Lower boundary of the Tolerance around the Ground Truth
V_{upper}		Upper boundary of the Tolerance around the Ground Truth

3 Metrics

3.1 Remove Free Flow to Free Flow comparisons

If both the Ground Truth speed and Reported speed are above the congestion threshold then both the Ideal Benefit and the Actual Benefit (see further) are set to zero. These free flow to free flow comparisons are not considered in the calculations and no score is added to the TISA QBench.

If both $V_{gt} \geq V_{ct}$ and $V_{rep} \geq V_{ct}$ then set $B_{ideal} = B_{actual} = 0$.

3.2 Eliminate Extremities

Speeds are adjusted to the defined boundaries:

* bounded from above by the ***Free Flow speed.***

* bounded from below by the ***Stand Still speed*** and a ***capping*** to limit the impact of single events to the overall value. The capping is set to 10% of the ***Free Flow speed.***

$$V_{gt} = \min(V_{gt}, V_{ff})$$
$$V_{rep} = \min(V_{rep}, V_{ff})$$
$$V_{gt} = \max(V_{gt}, V_{ss}, Cap * V_{ff})$$
$$V_{rep} = \max(V_{rep}, V_{ss}, Cap * V_{ff})$$

3.3 Apply Tolerance

A ***Tolerance*** is defined around the Ground Truth by V_{lower} and V_{upper} (a mix of a relative 15% of V_{gt} with an absolute 0.5 m/s). If the Reported travel time is within this Tolerance then no penalty is applied to the actual benefit (see section 3.5).

$$V_{lower} = 0.85V_{gt} - 0.5$$

$$V_{upper} = 1.15V_{gt} + 0.5$$

Calculate:

$$T_{gt} = \frac{d}{V_{gt}}; T_{rep} = \frac{d}{V_{rep}}; T_{ff} = \frac{d}{V_{ff}}; T_{ss} = \frac{d}{V_{ss}}; T_{ct} = \frac{d}{V_{ct}}$$

$$T_{\boldsymbol{lower}} = \frac{d}{V_{\boldsymbol{upper}}}; T_{\boldsymbol{upper}} = \frac{d}{V_{\boldsymbol{lower}}}$$

3.4 Calculate the Ideal Benefit

The ***Ideal Benefit*** is defined as the Ground Truth delay (the delay [in seconds] that should be reported ideally).

$$B_{ideal} = T_{gt} - T_{ff}$$

3.5 Calculate the Actual Benefit

The ***Actual Benefit*** is defined as the Ideal Benefit minus a penalty.

Within the Tolerance, the penalty is zero and the Actual Benefit equals the Ideal Benefit. Outside the Tolerance a penalty is applied for overestimating or underestimating the travel time. This penalty differs for underestimating versus overestimating the travel time.

In case of overestimating the travel time, the penalty is the difference of the Reported travel time and the Upper Tolerance boundary, multiplied by a factor (α) of 0.5. This results in an Actual Benefit equaling the Ideal Benefit when the Reported travel time equals the Upper Tolerance boundary. And the Actual Benefit declines linearly when the Reported travel time is bigger than the Upper Tolerance boundary.

For underestimating the travel time the penalty is linearly interpolated between the Ideal Benefit (for a Reported travel time equaling the Free Flow travel time), resulting in an Actual Benefit of 0, and 0 (for a Reported travel time equaling the Lower Tolerance boundary), resulting in an Actual Benefit equal to the Ideal Benefit.

$$Penalty = \begin{cases} (1 - (T_{rep} - T_{ff})/(T_{lower} - T_{ff})) * B_{ideal} & , if\ T_{rep} < T_{lower} \\ 0 & , if\ T_{lower} \leq T_{rep} \leq T_{upper} \\ \alpha * (T_{rep} - T_{upper}) & , if\ T_{rep} > T_{upper} \end{cases}$$

$$B_{actual} = B_{ideal} - Penalty$$

3.6 TISA QBench

The final ***TISA QBench*** calculation is given by summing all the Actual Benefits and dividing it by the sum of all the Ideal Benefits.

$$TISA\ QBench = \frac{\sum_{all} B_{actual}}{\sum_{all} B_{ideal}}$$

3.7 Noise Reduction by Travel Time Aggregation (Rolling Window)

All measured Ground Truth and Reported information come with some inherent noise. This will decrease the TISA QBench score of any source regardless of its quality. In order to reduce the impact of the noise, travel times are aggregated over longer stretches before they are used for the TISA QBench computation. The length of the aggregation interval (the aggregation window) is crucial: too short intervals do not sufficiently reduce the noise and too long intervals even out over- / underestimations of the travel time reported by source and thus falsely increase the TISA QBench score.

There are two different methods to determine the aggregation window:

- Static window and
- Rolling window.

The static window is used for a feed which reports travel times for fixed and rather long stretches, e.g. a travel time feed based on TMC links or travel times for specific routes. In this case the Ground Truth travel time and Reported travel time are aggregated for the entire stretch.

For a generic travel time feed the rolling window is used: For a Ground Truth measurement (e.g. a GPS trace or test-drive trace) the rolling window aggregates the travel time for the last 2.5 km every 500m. All these aggregated travel times (and the corresponding travel times reported by the source) are used for the TISA QBench computation. Thus each part of the Ground Truth measurement is used five times in the evaluation.

Typically TISA QBench evaluations are done on a discrete digital map with map segments of arbitrary length and the rolling window will not be aligned with discretization of the map in general. In case map segments are only partially covered by the rolling window, their partial travel times are used for the aggregated travel time. This is in contrast to rounding the rolling window to the discretization of the map which would favour coarse maps (i.e. longer map segments would yield longer aggregation windows).