VS-PLUS

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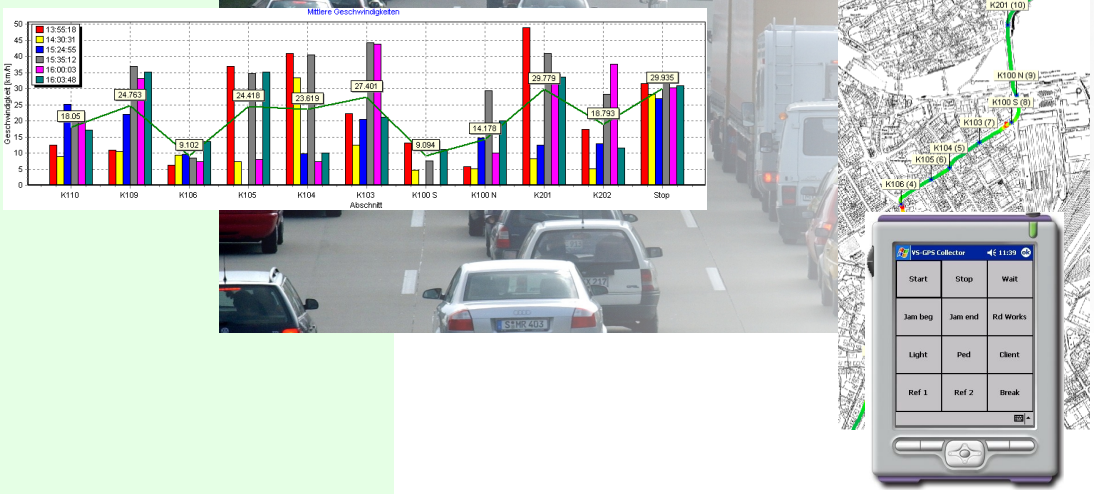

VS-GPS

GPS-BASED TRIP EVALUATION

Brief Introduction

Version 1.2 - March 2004

WWW.VS-PLUS.COM

Verkehrs-Systeme AG

Contents

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Introduction

VS-GPS is a GPS-based trip evaluation system. Using a commercially available PDA (Personal Digital Assistant) together with a GPS unit and custom software, it collects vehicle position data once per second and provides a wide range of detailed analysis. It can be used both for public transport and for individual traffic data collection and evaluation.

The mobile equipment records the position data of a vehicle each second. Additional user-input information such as waypoints and relevant traffic points can be stored by pushing pre-defined keys.

After recording, the data undergoes error correction to fix inaccuracies of the GPS protocol and the measuring method.

The collected data, once imported into the VS-GPS Analyzer can be shown in diagrams and tables. It is also possible to compare several trips by diagrams and tables.

The end result is a highly valuable use set of analytics, which include:

Before and After Studies. Whether for pre-defined routes or preset begin and endpoints, for traffic flows or public transportation, the ability to compare in great detail, both graphically and statistically can clearly illustrate the actual results of specific changes, or track long-term changes.

Measuring Time Loss. The evaluations can identify specifically (where and when) time is lost. This can be for public transportation, either in route sections or at intersections, or it can be for individual traffic flows.

Identifying Actual Level of Priority. By comparing different traffic flows (public, private, emergency) by location and time, the actual level of priority can be clearly identified.

Measurement of Variances. By comparing measurements, the actual level of variability in traffic flows (either individual or public transport) can be clearly identified.

Association of Probable Causes. By using the user-defined inputs, probable causes of time loss or variance can be identified.

Traffic Control Coordination Evaluation. Actual traffic coordination effectiveness can be measured. By using the user defined inputs, various associations can be included.

Traffic Engineering Statistics. The various data and analysis tools provide a rich world of traffic engineering statistics that can be used for both spot evaluations and, importantly, long-term evaluations.

VS-GPS Collector

The VS-GPS Collector is the “front-end” of the VS-GPS system. The Collector consists of a commercial PDA, a GPS plug-in chipset and antenna unit, and the VS-GPS PDA collector software. The collector on the PDA records GPS position data in a compressed binary file format. User defined data is saved in the same file.

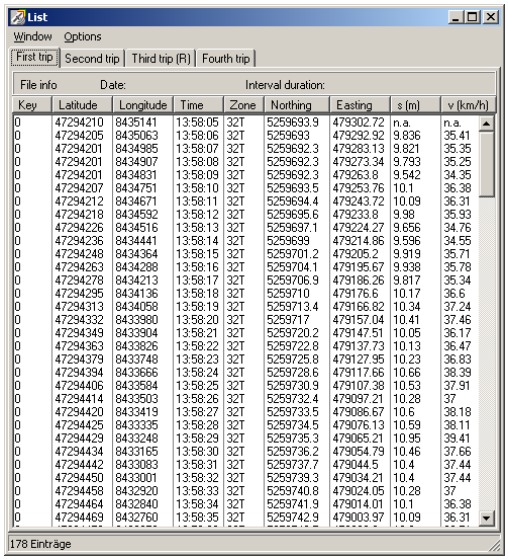
After recording, the data is transferred from the PDA to a Windows computer.

Recording on a portable computer is also possible.

VS-GPS Analyzer

The VS-GPS Analyzer is a software package designed specifically to supply a wide range of high value traffic and travel data analysis. The binary files, as supplied by the mobile unit, are read by the Analyzer and converted into Cartesian coordinates for use in evaluations, statistics and profiles.. Additionally, ASCII files can be imported, following the NMEA 0183 standard, which are provided by all commercially available GPS receivers.

A variety of data cleaning functions are available.



Key	Latitude	Longitude	Time	Zone	Northing	Easting	s (m)	v (km/h)
0	47294210	8435141	13:58:05	32T	5259693.9	479302.72	n.a.	n.a.
0	47294205	8435063	13:58:06	32T	5259693	479292.92	9.836	35.41
0	47294201	8434985	13:58:07	32T	5259692.3	479283.13	9.821	35.35
0	47294201	8434907	13:58:08	32T	5259692.3	479273.34	9.793	35.25
0	47294201	8434831	13:58:09	32T	5259692.3	479263.8	9.542	34.35
0	47294207	8434751	13:58:10	32T	5259693.5	479253.76	10.1	36.38
0	47294212	8434671	13:58:11	32T	5259694.4	479243.72	10.09	36.31
0	47294218	8434592	13:58:12	32T	5259695.6	479233.8	9.98	35.93
0	47294226	8434516	13:58:13	32T	5259697.1	479224.27	9.656	34.76
0	47294236	8434441	13:58:14	32T	5259699	479214.86	9.596	34.55
0	47294249	8434364	13:58:15	32T	5259701.2	479205.2	9.919	35.71
0	47294263	8434288	13:58:16	32T	5259704.1	479195.67	9.938	35.78
0	47294278	8434213	13:58:17	32T	5259706.9	479186.26	9.817	35.34
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0	47294332	8433980	13:58:20	32T	5259717	479157.04	10.41	37.46
0	47294349	8433904	13:58:21	32T	5259720.2	479147.51	10.05	36.17
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0	47294425	8433335	13:58:28	32T	5259734.5	479076.13	10.59	38.11
0	47294429	8433248	13:58:29	32T	5259735.3	479065.21	10.95	39.41
0	47294434	8433165	13:58:30	32T	5259736.2	479054.79	10.46	37.66
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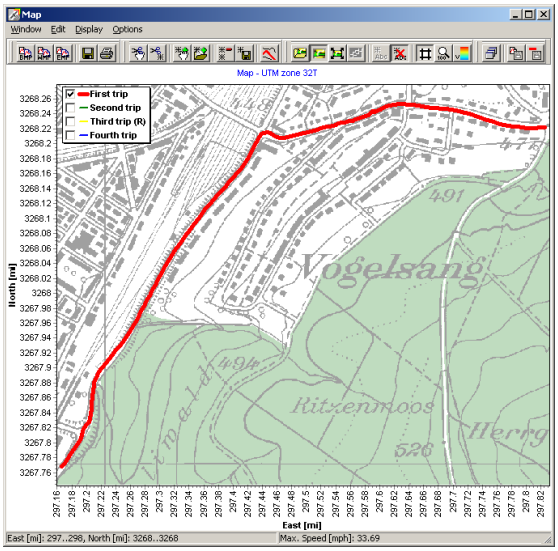
0	47294450	8433001	13:58:32	32T	5259739.3	479034.21	10.4	37.44
0	47294458	8432920	13:58:33	32T	5259740.8	479024.05	10.28	37
0	47294464	8432840	13:58:34	32T	5259741.9	479014.01	10.1	36.38
0	47294469	8432760	13:58:35	32T	5259742.9	479003.97	10.09	36.31

Geographical representation



Each trip is shown in two dimensions. Different measurements have different colors. A map bitmap can be selected as background picture.

It is also possible, to select the color according to the speed, which results in a good insight into the vehicle trajectory. This is possible in all geographical representations and evaluations.

In the geographical representation, further information can be shown or added to the data, like names of intersections or bus stops. Such information can also be copied into the actual measurements basing on earlier measurements having been exported into a reference point file.

The measurements can be cleaned from incorrect data. The measurements can be divided into sections, either on a straight trip or between the terminals of a public transport vehicle.

It is, for example, possible to cut a bus log file into parts between the two last stops, re-arrange the parts and evaluate bus data always driving in the same direction. Likewise, it is possible to cut vehicle trips into user defined sections for various levels of comparison and analysis

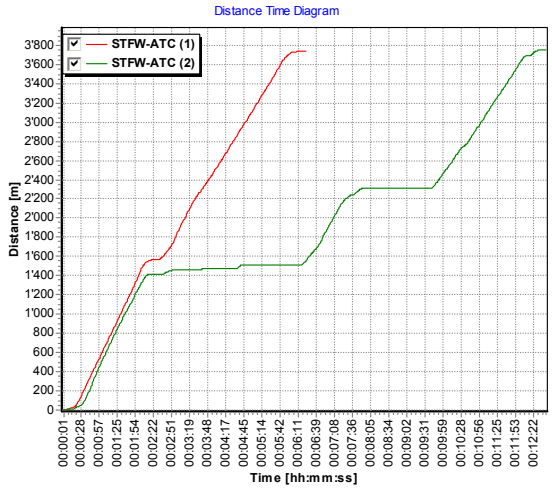
The same flexibility can also be applied to all of the specific evaluation diagrams described below.

Evaluations

Time Space Diagram

This diagram shows the driven distance in relation to the time needed.

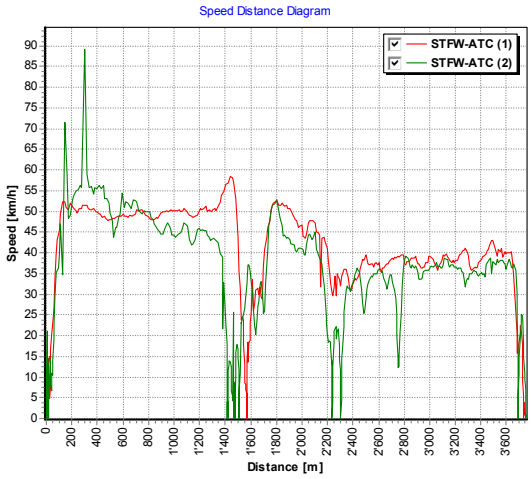
The Time-Space diagram is well suited for displaying several trips together and showing how some of the trips were faster and some were slower.



In the example, one sees that the two trips are very much alike for the first 1400 meters. Then however, the green trip gets stuck for more than 4 minutes in a queue before an intersection, while the red trip is stopped only a few seconds. At the second crossing, the red trip does not stop at all, while the green trip must wait again two more minutes.

Distance Speed Diagram

In the next graph, the parts of the trip between the stops can be seen nicely, as well as the driven speed.



This diagram is optimal for comparing several measurements among themselves, since the distance of all trips is constant and therefore provides a good reference for comparison.

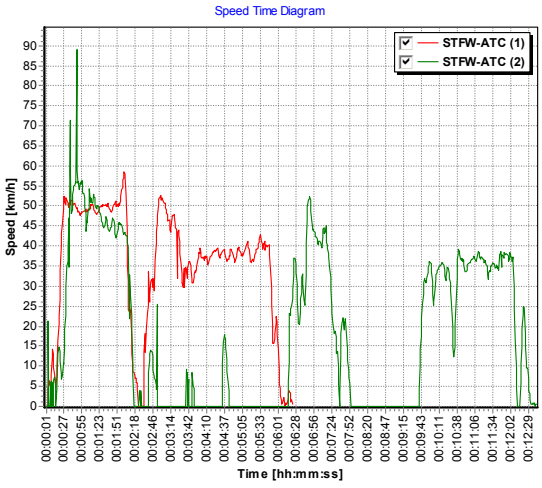
In the example, one can see at distance 1400m, that the green trip had to stop in front of a traffic light about 100 meters earlier than the red trip. At distance 2200m, the green trip had even to wait for two traffic light cycles before continuing. Red again was lucky and did not have to stop.

All measurements and analysis can be shown in metric units or in feet, miles and miles per hour.

Time Speed Diagram

The Time-Speed diagram shows the driven speed in relation of the necessary travel time. Various traffic conditions, such as the waiting time before traffic lights or in traffic back-ups among others can be seen very clearly in the diagram and are clearly associated with both time and location.

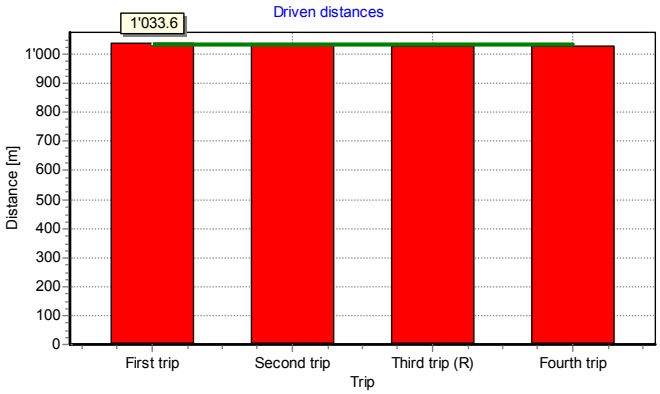
In the example, one sees the red trip recorded in a low traffic period. The green trip however was recorded at the peak hour on Friday afternoon. It can be seen very well that the green trip loses a lot of time at two signaled intersections. The red trip was able to almost drive without stops for the whole trip.



Statistics

Statistical functions combine several measurements. If only one single measurement is present, they cut this measurement in segments between reference points and name them according each destination reference point.

Distance



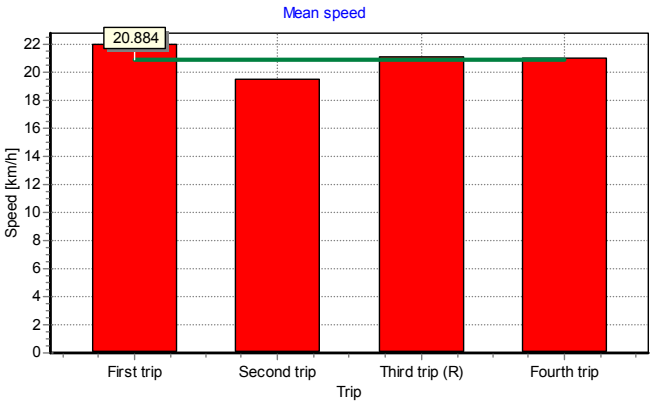
The evaluation of the distances guarantees that all trips are comparable due to their equivalent lengths. The evaluation method can also be interesting if a trip is only defined by the starting and the terminating point and the route choice in-between is free.

For each trip a bar is shown. Additionally the average distance is shown as a horizontal line.

Speed

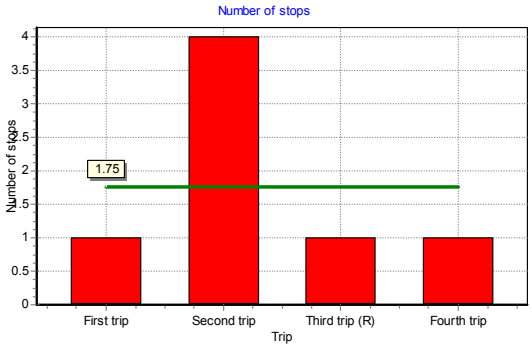
The speed statistics calculates the mean speed for each measurement or for each segment in case of only 1 measurement.

Detail speed information of each trip can be seen from the trip profile, which is described later.



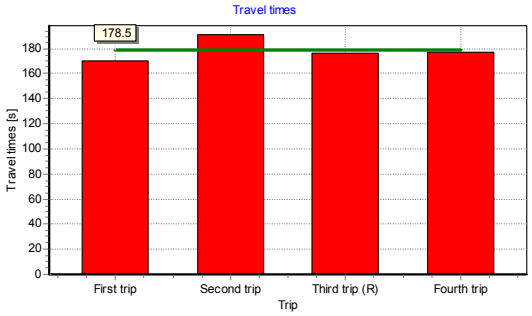
Number of Stops

The stops statistics calculates the number of stops for each measurement or for each segment in case of only 1 measurement. A stop is reached when the speed falls under a certain defined level.



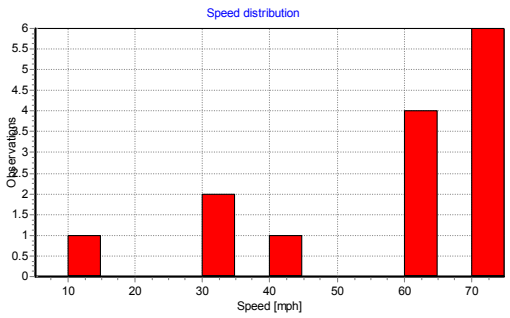
Travel time

The travel time statistics calculates the total time needed for each measurement or for each segment in case of only 1 measurement.



Distribution functions

All graphics panels can be shown in a distribution function view, e.g. a speed distribution of a speed statistics diagram:



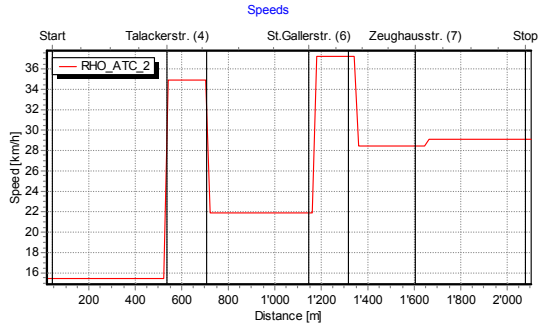
Numeric values

The numeric values of everything shown on the graphics panels and of the distribution panel can be copied or exported to other programs.

Profiles

Profiles are statistical diagrams as well, however they go much more into the details for each trip. Profiles are normally used for a group of trips along with a reference trip. They can be used for single trips as well. Profile evaluations break down the driven distance into discrete intervals and evaluate duration or speed per interval.

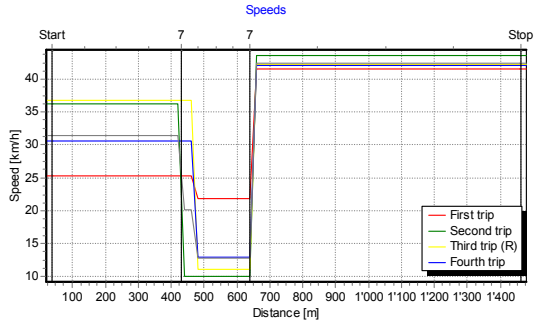
Speed of a Single Trip



Reference points can be defined for a single trip. The reference points can be recorded either during the measuring trip by pressing keys, or they can be inserted later into one of the evaluations. An average speed can be calculated between such reference points.

Speeds of Several Trips

The same evaluation applies for a group of trips. Additionally a mean speed per section can be calculated.

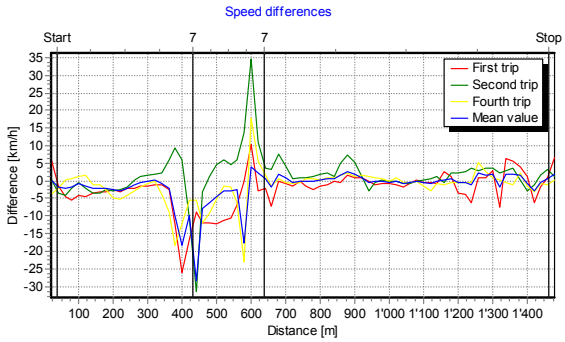


	Reference point			
Trip:	Start	Halt	Halt	End
First trip	25.35	21.90	41.59	
Second trip	36.29	10.00	43.62	
Third trip (R)	36.82	11.08	42.21	
Fourth trip	30.57	12.92	42.05	
Mean value	31.53	12.77	42.35	
	Speed [km/h]			

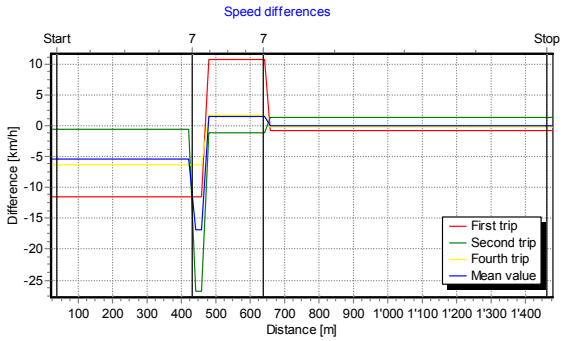
Speed differences

Any trip can be defined as being the reference trip. In this example we choose the measurement called "third trip". Now we can calculate the difference to the reference speed of each trajectory.

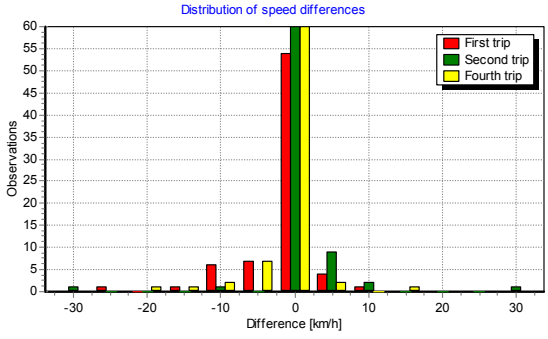
In order to do so, the entire distance is divided in equally long, short intervals (here of a length of 20 m), and in all of these short intervals the average speed of the reference trip and the other trips is computed.



Additionally, the computed values can be averaged between the reference points and shown in a graph or a table. This leads to a stepwise constant function that is constant within a section between two reference points.

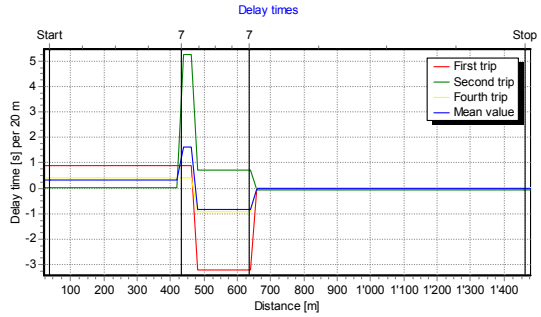


The next figure shows the distribution function of the speed differences to the reference trip.



The number of observations equals the number of sections of 20 m length, in which the corresponding speed difference was observed. The speed difference is here mapped into intervals of 5 km/h.

Delay Times

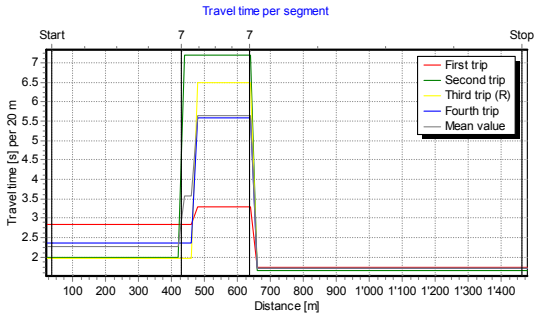


Instead of speed, delay time can be calculated. In order to be able to compare the individual sections between reference points among each other, the delay time has to be mapped to the small intervals as well (here of 20 m length).

The delay times are inverse proportional to the speed differences.

Travel Times

Finally travel time can be calculated without the link to a reference trip. The absolute travel time is, again, calculated per small interval (of 20 m).



Availability

VS-GPS is available at the following places:

USA
PB Farradyne
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