WHITEPAPER

LatDev

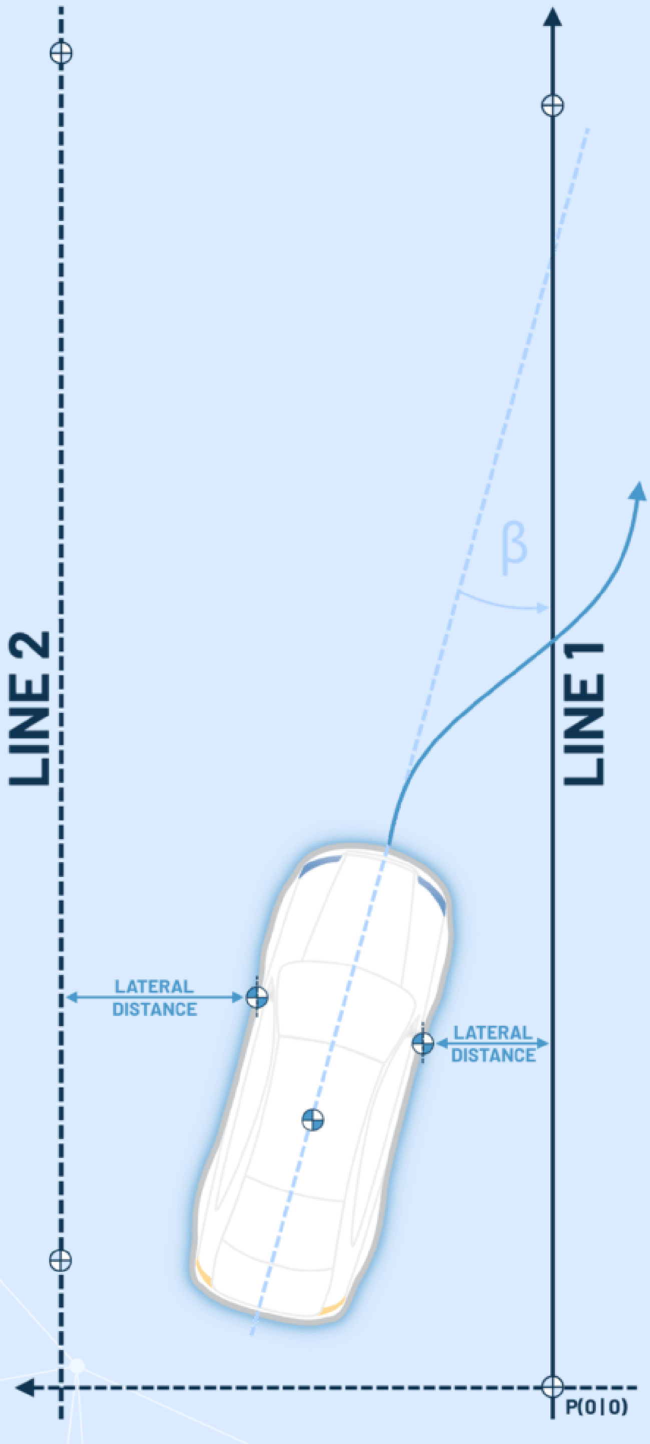
GeneSys

Sensor Systems, Service & Smiles

Lateral Deviation

TOPICS

- LATDEV COORDINATE SYSTEM
- VUT REFERENCE POINTS
- CALCULATIONS
- DATA OUTPUT



LatDev

Real-time calculation of the lateral deviation

The Add-On Lateral Deviation (short: LATDEV) is used to test and validate Lane Departure Warning (LDW/LSS) systems. It calculates in real-time the distance to two predefined straight lines, a fixed object, the angle to the straight lines, the lateral speed and acceleration in relation to three user-defined POIs (Point of Interests).

THE CHALLENGE

Validation of assistance systems

The LatDev function is useful for testing and validating technologies in the vehicle such as radar, laser or camera systems. These technologies are used in cars and trucks, e.g. in lane departure warning systems. The lane departure warning system (LDW) - or lane support systems - warns the driver of a vehicle that it is about to leave its lane on a road or actively intervenes to keep the vehicle on track.

For this purpose, various optical systems and computers are used to determine the position of the vehicle within the lane. The system warns when the distance to the lane marking is undershot (Distance to Line Crossing criterion (DLC)) and can predict this undershooting with the help of the Time to Line Crossing criterion (TLC).

One of the templates for the specification of the LatDev function is the EURO NCAP test protocol - LSS (Lane Support Systems). Euro NCAP | Protocols

LATDEV COORDINATE SYSTEM

LatDev CS

The AddOn LatDev creates an independent relative coordinate system parallel to a user-defined straight line. This straight line defines the origin (P0|0) and orientation of the reference coordinate system defined by two discrete points: A1 (Latitude; Longitude) and A2 (Latitude; Longitude). In the current specification it will be possible to define either two straight lines or one straight line and a circle as well as a fixed object. The points of interest POI1 to POI3 are used as reference points for the calculation.

POI1 is the main reference point for the calculations. POI2 and POI3 are always used to calculate the lateral distance to the respective right or left line; depending on the direction of travel, the reference is swapped here. Background: Referencing of the lateral distance to the line in relation to the respective optical sensor.
The straight lines are each defined by two discrete points (latitude and longitude). The circle is defined by three points. These points can be defined either by manual input or by taking over the current position at a specific location. The ADMA reference points POI1, POI2, POI3 ... POI8 and GNSS are available.

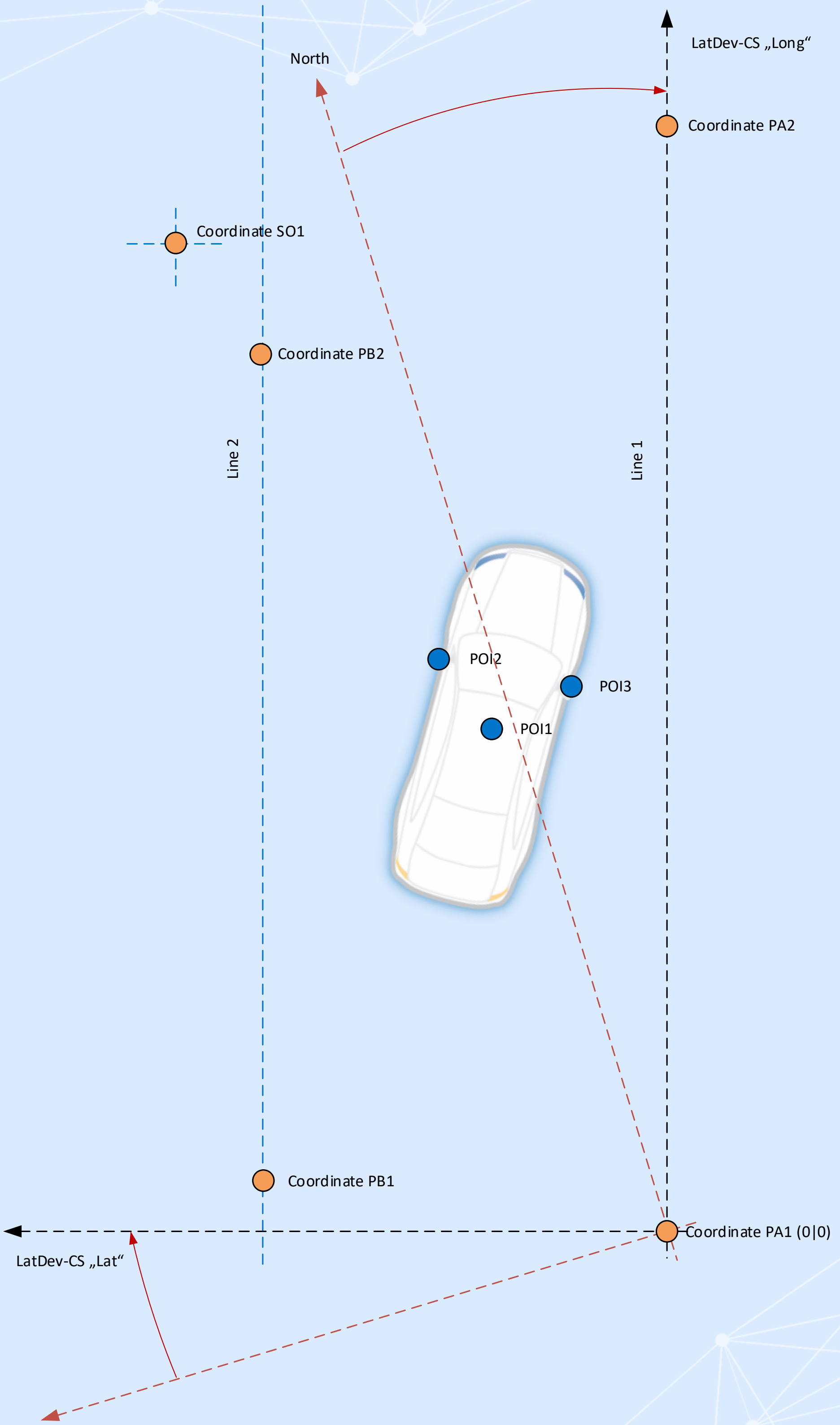


Figure 1: LatDev CS

VUT REFERENCE POINTS

Point Of Interest POI1 - 3

POI1 represents the central reference point of the vehicle, which can be defined as either the center of gravity or the geometric center.

In addition to POI1, there are two other auxiliary points POI2 and POI3 that can be placed on the outside of the vehicle. POI2 is located on the left exterior and has a negative LA-Y component (POI2 <0). POI3 is located on the right exterior of the vehicle and has a positive LA-Y component (POI3 >0). These auxiliary points allow specific calculations to the left and right side of the vehicle.

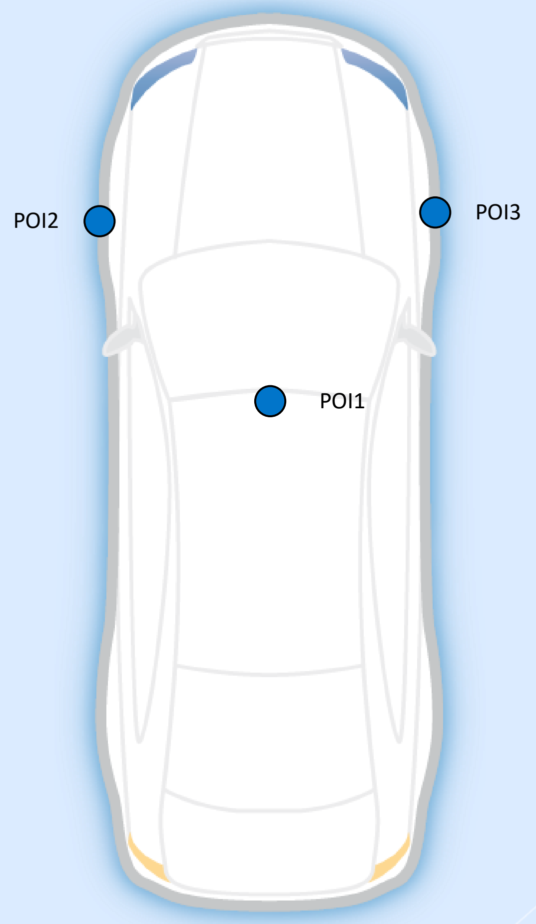


Figure 2: VUT reference points

CALCULATIONS

LatDev mathematics

This section deals with the determination of various values related to a particular Point of Interest, transformed in the LatDev-CS.

For POI1 (transformed into the LatDev-CS):

These measurement values include the relative position of POI1 in the LatDev-CS and the length of the vector connecting it to the origin of the coordinate system.

Furthermore, the distance of POI1 to coordinate A2 is calculated, including the result as a vector as well as the length of the vector in the LatDev-CS. The shortest distance of POI1 to line "1" is determined as POI1 Y-component in the LatDev CS, while the lateral distance to line "1" is given as lateral distance in the vehicle CS. Similarly, the distance and lateral distance of POI1 to line "2" are calculated.

The lateral speed and acceleration of the vehicle with respect to line "1" and line "2" are also indicated in the vehicle CS, with a positive sign indicating an approach to the line and a negative sign indicating a distance from the line. Similarly, the speed and acceleration of the vehicle perpendicular to line "1" and "2" are determined in the vehicle CS.

The angles between the longitudinal axis of the vehicle and lines "1" and "2" are calculated, with the angle to the right of the line defined as negative and the angle to the left of the line defined as positive. In the case of a circle, the angle to the tangent of the intersection with the straight line of the shortest distance between the circle and the position is determined.

Finally, the distance of POI1 to coordinate S01 is determined, including the result as a vector and the length and width of the vector. The angle to coordinate S01 is given from the point of view of the vehicle CS.

For POI2 and POI3 (transformed into LatDev-CS):

To determine the lateral position of the vehicle on the road, the relative position in the LatDev-CS (Lateral Deviation Coordinate System) is needed. This position is represented by the coordinates POI2 and POI3.

With respect to POI2 and POI3 next, the shorter distance to the line on the left and right side in the direction of travel is determined. The number of the referenced line (1 or 2) is determined and output.

Additionally, the shortest distance to the left and right line is calculated as "Shortest Distance Line Right/Left". The lateral distance to the left and right line in the vehicle CS (Coordinate System) is called "Lateral Distance Line Left/Right".

Finally, the time to cross the nearest line is calculated, also referred to as "Time To Departure" (TTD). The TTD is calculated by dividing the lateral distance to the line (Δy) by the lateral speed of the vehicle at position POI2 and POI3.

For SO1 (transformed into the LatDev-CS):

In conjunction with the Simple Object, various calculations are performed to determine the position of the object relative to the vehicle.

These include determining the distance between the Simple Object and Point of Interest 1 (POI1) and the vector components of longitudinal and transverse distance. In addition, the angle to POI1 is calculated from the vehicles point of view.

Another important value is the Time To Collision (TTC), which indicates the time needed to reach POI1 with the X-coordinate of SO1. This quantity is calculated by dividing the distance in the X-direction by the speed in the X-direction.

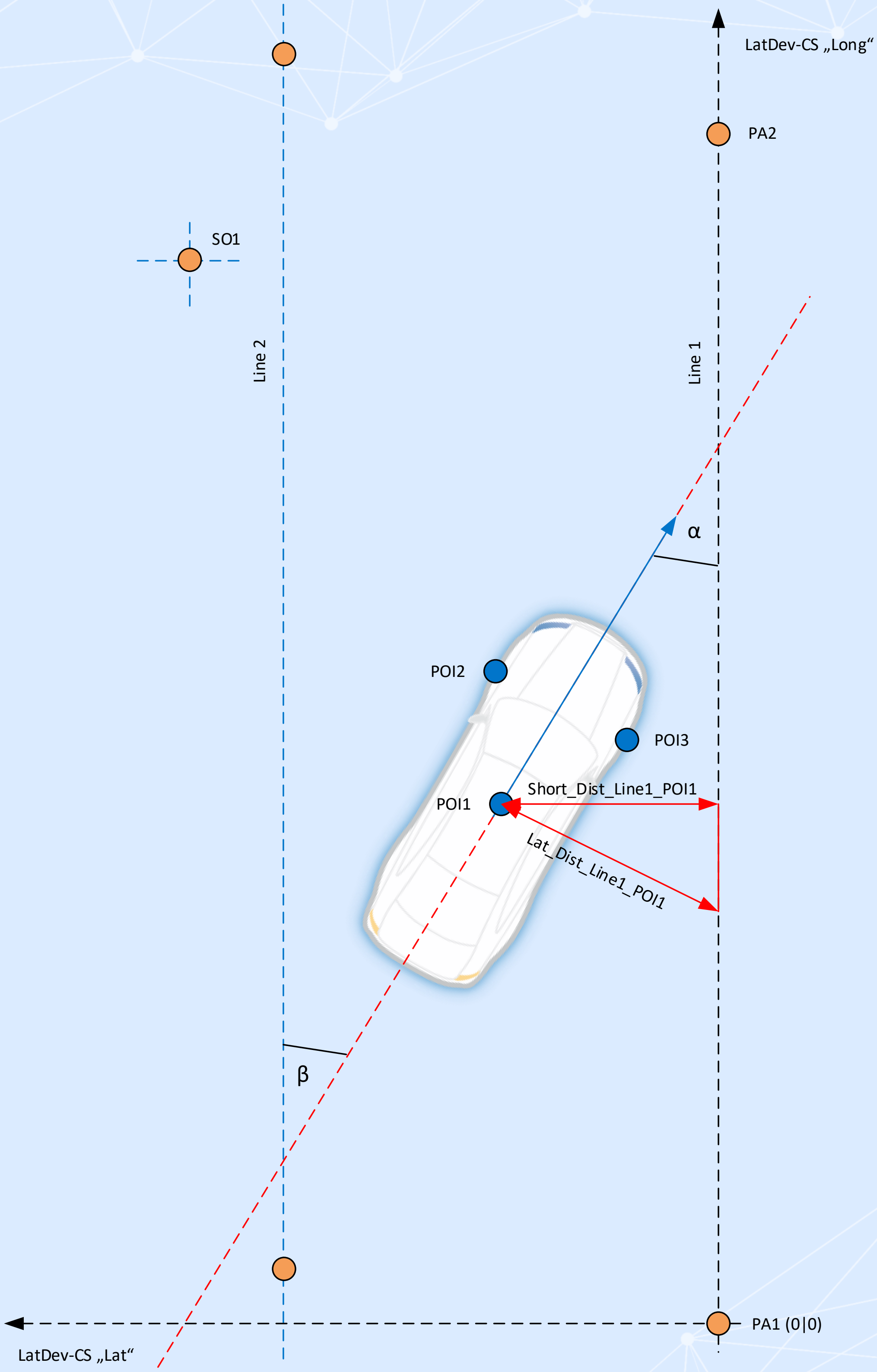


Figure 3: Lateral Distance Line to POI1

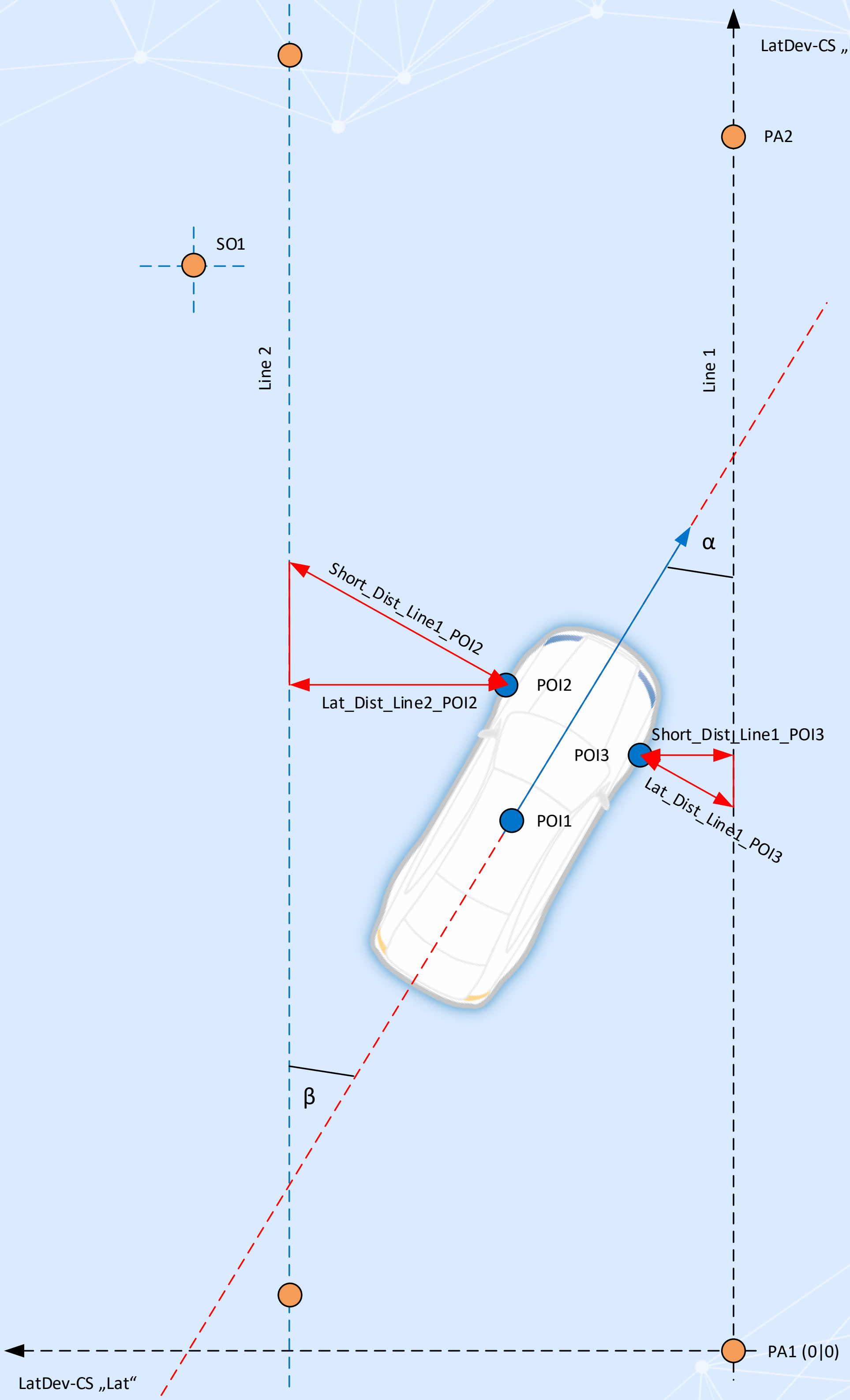


Figure 4: Lateral Distance Line1/2 to POI2/3

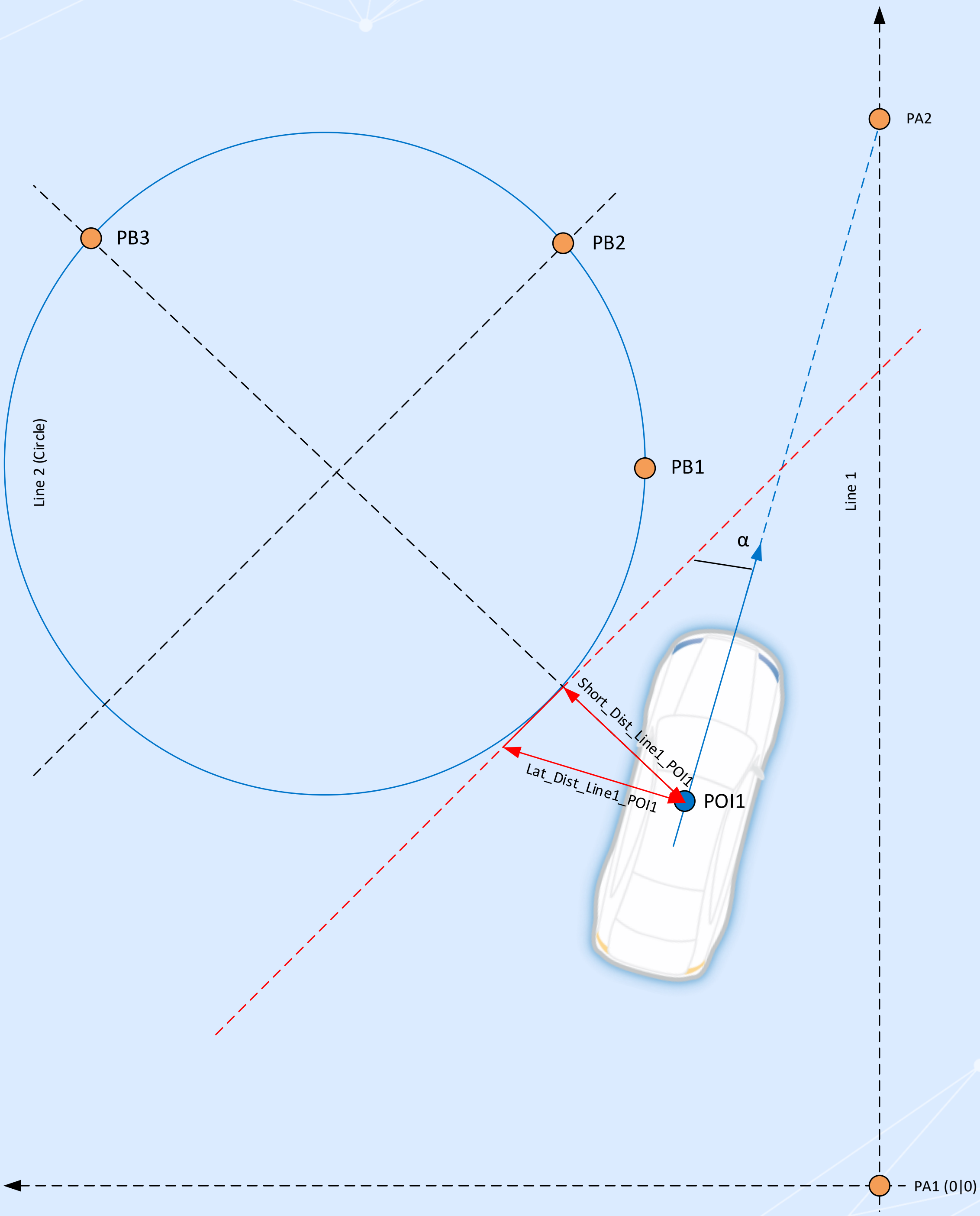


Figure 5: Lateral Circle

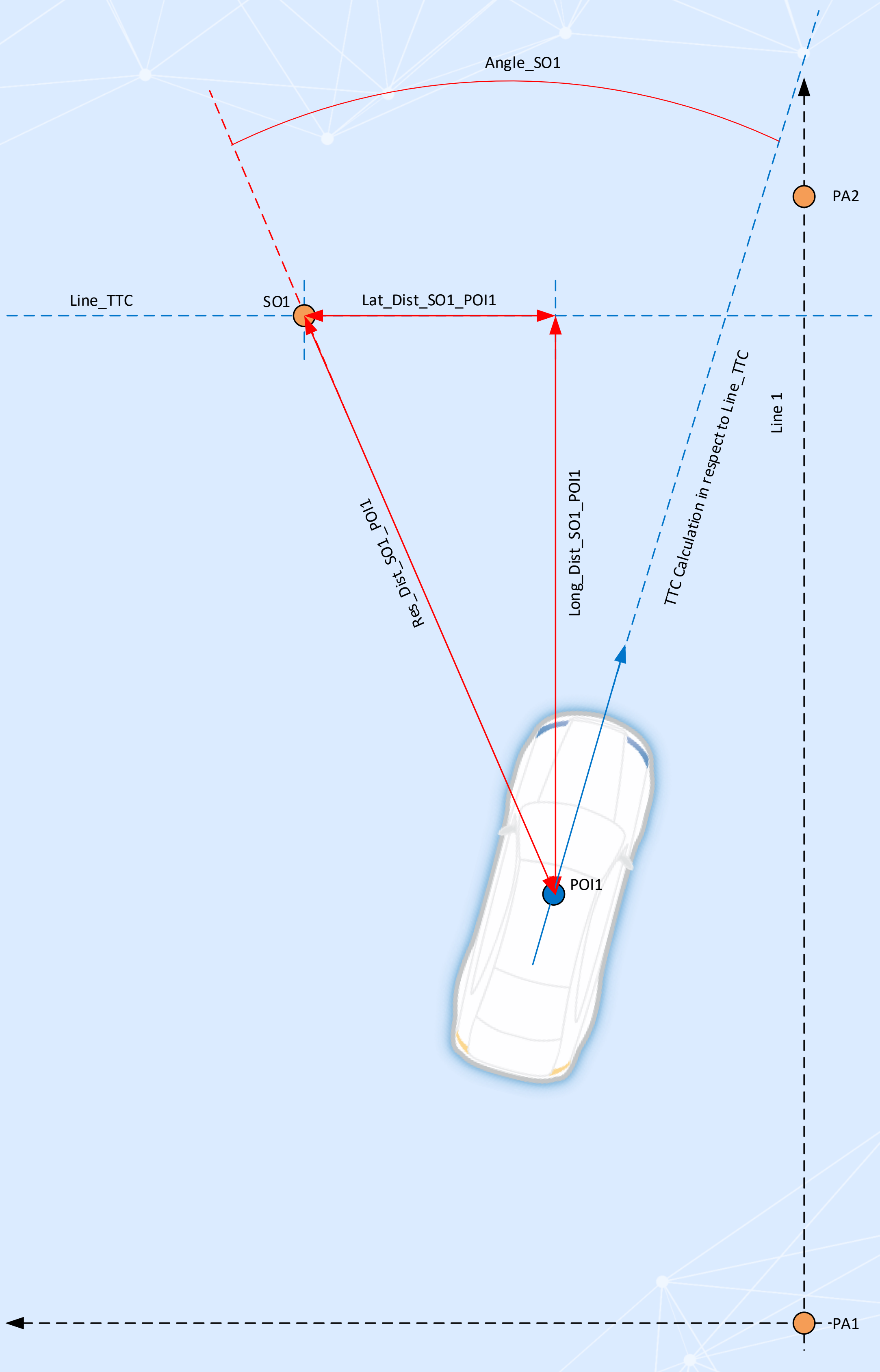


Figure 6: Simple Object

DATA OUTPUT

CAN / Ethernet Data Output

Channel-Name	Description	Unit
GeneSys ID	Used to uniquely identify the beginning of a data packet "GBIN" = GeneSys Binary (public) "GRnD" = GeneSys debug data (not public)	
Header Version	Used to uniquely identify the beginning of a data packet	
Format ID	Contains the format ID of the following data	
Format Version	Contains the version of the following data	
Reserved		
Serial Number	ADMA serial number	
Alias	ADMA Alias	
Config ID	Contains the Config ID, which is sent in the dynamic header	
Config Format	Contains the Config format, which is sent in the dynamic header	
Config Version	Contains the Config version, which is sent in the dynamic header	
Config Size	Contains the total file size of the configuration in bytes	
Byte Offset	Contains the position of the "Slice Data" within the configuration file	
Slice Size in Byte	Includes the size of "Slice Data"	
Slice Data	Values for the configuration file	
INS Time msec	Time in Milliseconds, UTC	ms
INS Time Week	Weeks, Start 0h 6-Jan-1980	week
Leap Seconds	Leap seconds	s
Status		
Reserved		
Lat Rel POI1	Relative position POI1 in X / Y in LatDev coordinate system (defined via line 1)	m
Long Rel POI1	Relative position POI1 in X / Y in LatDev coordinate system (defined via line 1)	m
Lat Rel POI2	Relative position POI2 in X / Y in LatDev coordinate system (defined via line 1)	m
Long Rel POI2	Relative position POI2 in X / Y in LatDev coordinate system (defined via line 1)	m
Lat Rel POI3	Relative position POI3 in X / Y in LatDev coordinate system (defined via line 1)	m
Long Rel POI3	Relative position POI3 in X / Y in LatDev coordinate system (defined via line 1)	m
Lat Dist Line1 POI1	Lateral distance between line 1 and POI1 in Vehicle coordinate system	m
Lat Dist Line2 POI1	Lateral distance between line 2 and POI1 in Vehicle coordinate system	m
Short Dist Line1 POI1	Shortest distance between line 1 and POI1	m
Short Dist Line2 POI1	Shortest distance between line 2 and POI1	m
Angle Line1	Angle to the line 1 in relation to the vehicle yaw	°
Angle Line2	Angle to the line 2 in relation to the vehicle yaw (in relation to POI1 if line 2 is circle)	°
Reserved		
Long Dist PA1 POI1	Longitudinal distance between PA1 and POI1 in LatDev coordinate system (defined via line 1)	m
Long Dist PA2 POI1	Longitudinal distance between PA2 and POI1 in LatDev coordinate system (defined via line 1)	m
Res Dist PA1 POI1	Resultant distance between PA1 and POI1	m
Res Dist PA2 POI1	Resultant distance between PA2 and POI1	m
Lat Acc Line1	Lateral acceleration to line 1 with respect to POI1 in Vehicle coordinate system	g
Lat Vel Line1	Lateral velocity to line 1 with respect to POI1 in Vehicle coordinate system	m/s

Channel-Name	Description	Unit
Lat Acc Line2	Lateral acceleration to line 2 with respect to POI1 in Vehicle coordinate system	g
Lat Vel Line2	Lateral velocity to line 2 with respect to POI1 in Vehicle coordinate system	m/s
Perp Acc Line1	Perpendicular acceleration to line 1 with respect to POI1	g
Perp Vel Line1	Perpendicular velocity to line 1 with respect to POI1	m/s
Perp Acc Line2	Perpendicular acceleration to line 2 with respect to POI1	g
Perp Vel Line2	Perpendicular velocity to line 2 with respect to POI1	m/s
Lat Dist S01 POI1	Lateral distance between S01 and POI1	m
Long Dist S01 POI1	Longitudinal distance between S01 and POI1	m
Res Dist S01 POI1	Resultant distance between S01 and POI1	m
Angle S01	Angle to the S01 in relation to the vehicle yaw	°
TTC S01 POI1	Time To Collision POI1 to S01	sec
Lat Dist LineLeft POI2	Lateral distance between line left and POI2	m
Lat Dist LineNr POI2	Number of the reference line	
Reserved		
Short Dist LineLeft POI2	Shortest distance between line left and POI2	m
TTD LineLeft POI2		sec
Reserved		
Lat Dist LineRight POI3	Lateral distance between line right and POI3	m
Lat Dist LineNr POI3	Number of the reference line	
Reserved		
Short Dist LineRight POI3	Resultant distance between line right and POI3	m
TTD LineRight POI3		sec
Reserved		

THE EXPERT

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