Preliminary Report

Estudo da fase de transição e coexistência entre os diversos níveis de automação veicular na mesma via com foco em Veículos Autônomos Conectados (CAV) e na tecnologia de comunicação entre veículos (V2V) através de microsimulação

Mestrado

Bruno Scarano Paterlini

1- Research general objective

- Analisar o impacto dos veículos autônomos e conectados inseridos em vias heterogêneas, que são compartilhadas por veículos não autônomos, autônomos e autônomos conectados. Nestas vias o objetivo é identificar e quantizar os benefícios para o fluxo de trânsito em vias com alta densidade de tráfego.

1.1- Specific Objectives

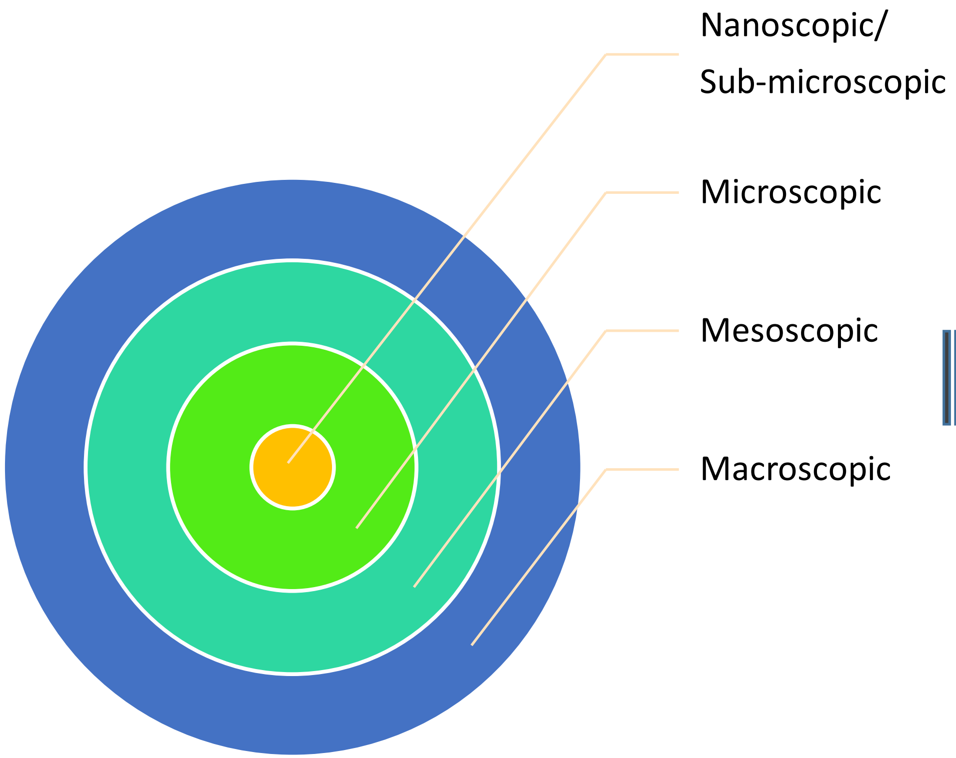
- Compreender as características dos microsimuladores de tráfego e optar por um adequado ao modelo e objetivos propostos na pesquisa
- Utilizar o microsimulador de tráfego VISSIM para construir um modelo com as seguintes características:
  - Via de grande fluxo na cidade de São Paulo-BR
  - Via com *merging* de veículos
  - Pontos de ônibus
  - Modelo base com motos
  - Driver
  - Inclusão de perturbações como acidentes na via
- Compreender modelos que descrevem o comportamento dos motoristas: o software objeto do estudo utiliza os modelos proposto Wiedemann.
- Compreender quais características dos veículos autônomos distinguem dos dirigidos por humanos e como essas características interferem nos modelos de microssimulação de tráfego
- Avaliar o impacto de veículos autônomos no fluxo de tráfego

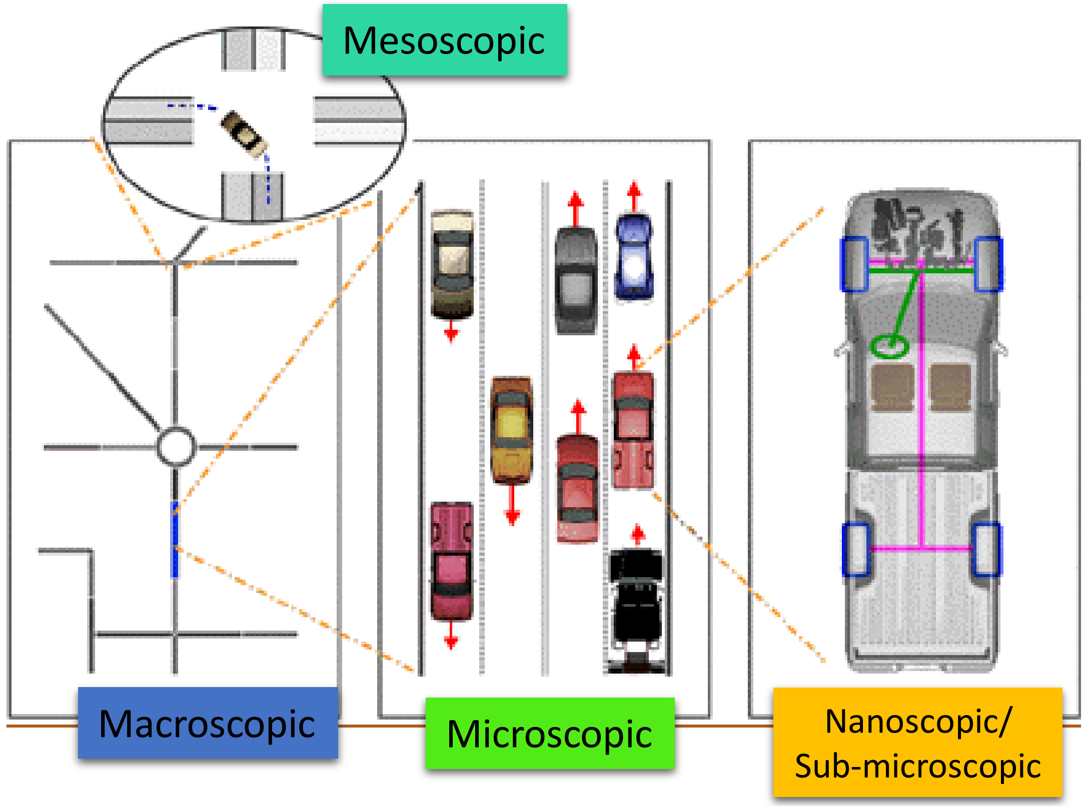
2. Tools to simulate traffic conditions

Traffic Simulator Types	Main characteristics	Simulator Examples
Nanoscopic/ Sub-microscopic	▪ Vehicles detailed characteristics as dynamic behavior and driver assistance systems (CC, ACC, Lidar, V2V) are considered in the model ▪ Few ready to market simulators available ▪ Research groups are developing add-on to microscopic simulators to include nanoscopic characteristics in the model	prescan ULTraSim HutSIM 2DSIM
Microscopic	▪ Small size networks ▪ Delineate the positions xa (t) and velocities va (t) of all interacting vehicles ▪ Focus on Driver Behaviour (car-following models) ▪ Most of traffic simulation available on the market focus on microsimulation ▪ Pedestrian simulation possible	aimsun. PTV VISSIM PARAMICS MICROSIMULATION SUMO
Mesoscopic	▪ Mid-sized networks ▪ Higher number of different routes ▪ Simulated traffic must be distributed realistically among the available alternatives	PTV VISSIM MEZZO SUMO
Macroscopic	▪ Big-sized networks ▪ Restrict to the description of the collective vehicle dynamics in terms of the spatial vehicle density p(x, t) and the average velocity V(x, t) as a function of the freeway location x and time t. ▪ Focus on overall outputs from vehicles, pedestrians, public transportation interaction (Kynectic-Gas models)	PTV VISUM SUMO

Level of details

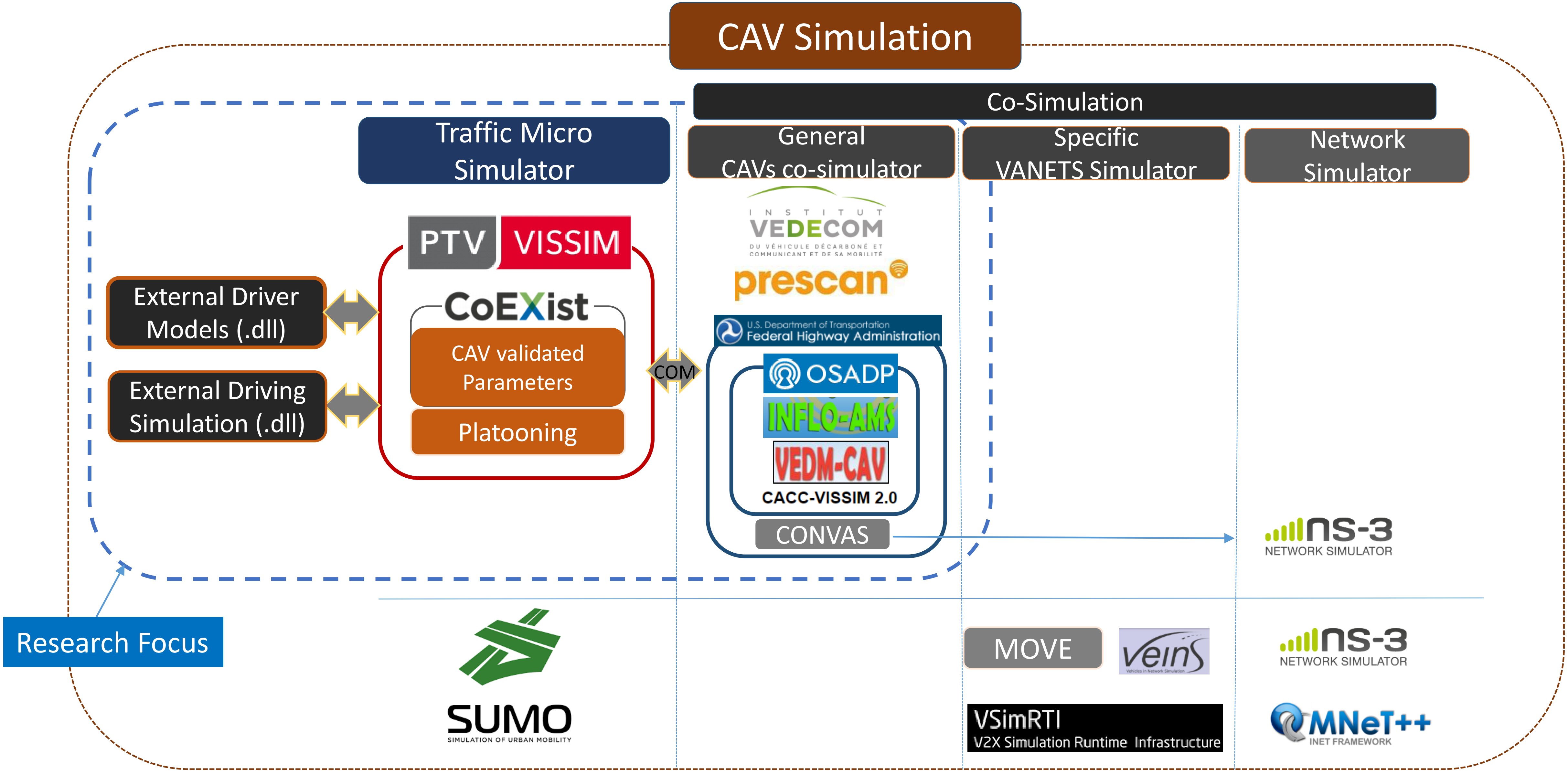
2.1 - Different kinds of Traffic simulator





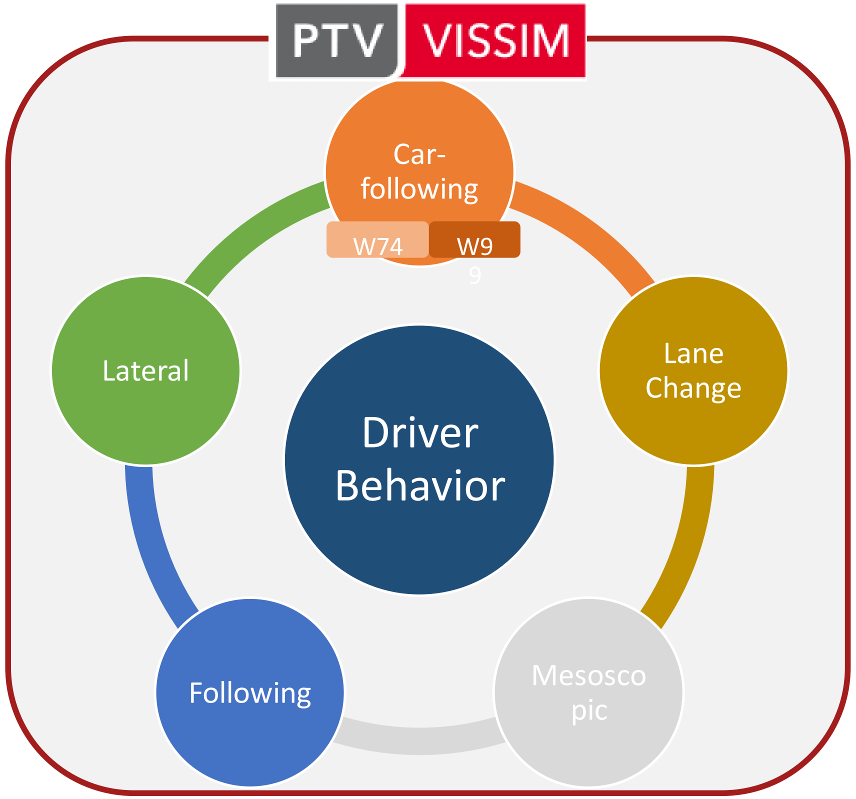
[http://sumo.sourceforge.net/userdoc/Theory/Traffic_Simulations.html]

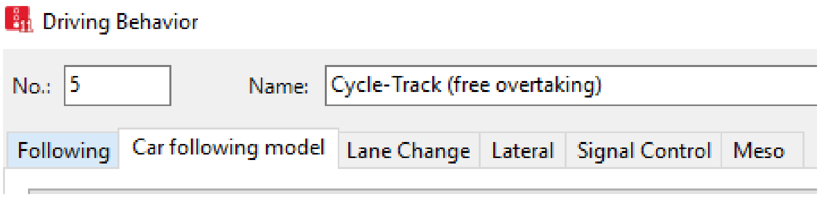
2.2- Traffic Microsimulators and Add-on Overview for CAVs



2.3 - Vissim input Data: Microscopic Driving Behavior

- Microscopic traffic simulation models consists of several **sub-models** that are used to **describe driving behavior**. These sub-models are referred to by Gao (2008) as the **"underlying logic" of a traffic simulation model**. In turn, this logic consists of a car-following logic, a lane-changing logic, and a gap-acceptance logic which are all highly relevant in driver behavior modeling.





- Driving Behavior parameters are the **key elements to distinguish a human driven vehicle to a autonomous one**.

3- Road segment model base:

Target for this study:
Segment 38G

Pesquisa de Monitoração da Mobilidade

Mobilidade no Sistema Viário Principal

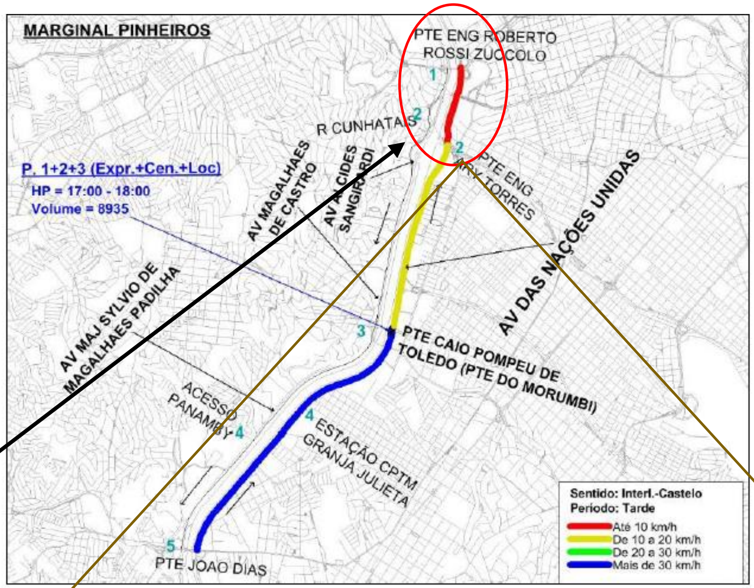
Volume e Velocidade - 2017

Julho / 2018

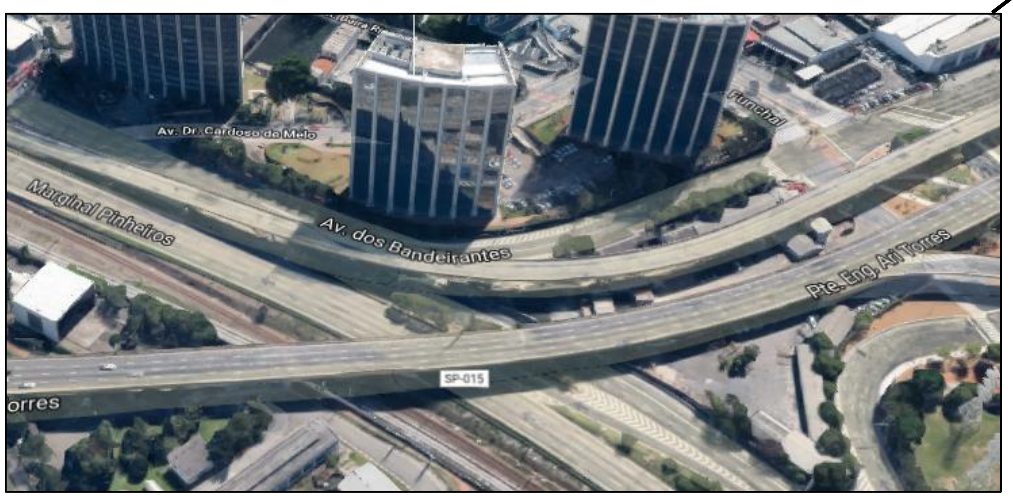
Companhia de Engenharia de Tráfego – CET
Diretoria Adjunta de Planejamento e Projetos – DP
Superintendência de Planejamento e Projetos – SPP
Gerência de Planejamento da Mobilidade – GPL
Departamento de Pesquisas de Tráfego – DPT

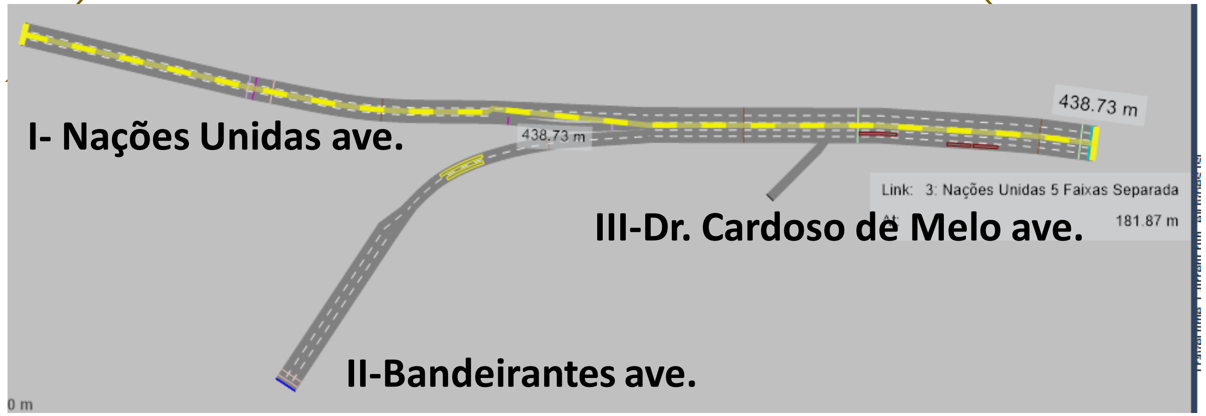
Report from CET (Traffic Engineer Company) released in july,2018.
Total of 39 urban roads were target of this report. Output data focus on:

- Volumes (veh/h)
- Vehicle speed (km/h)

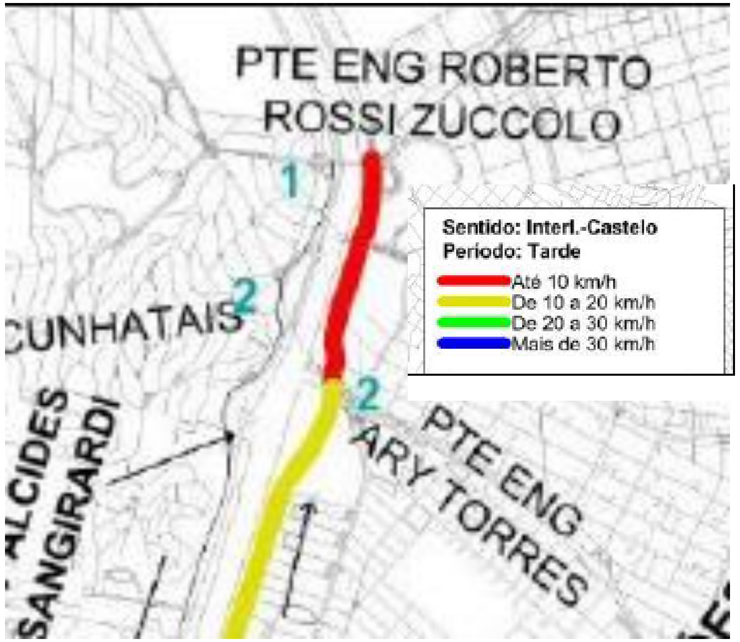


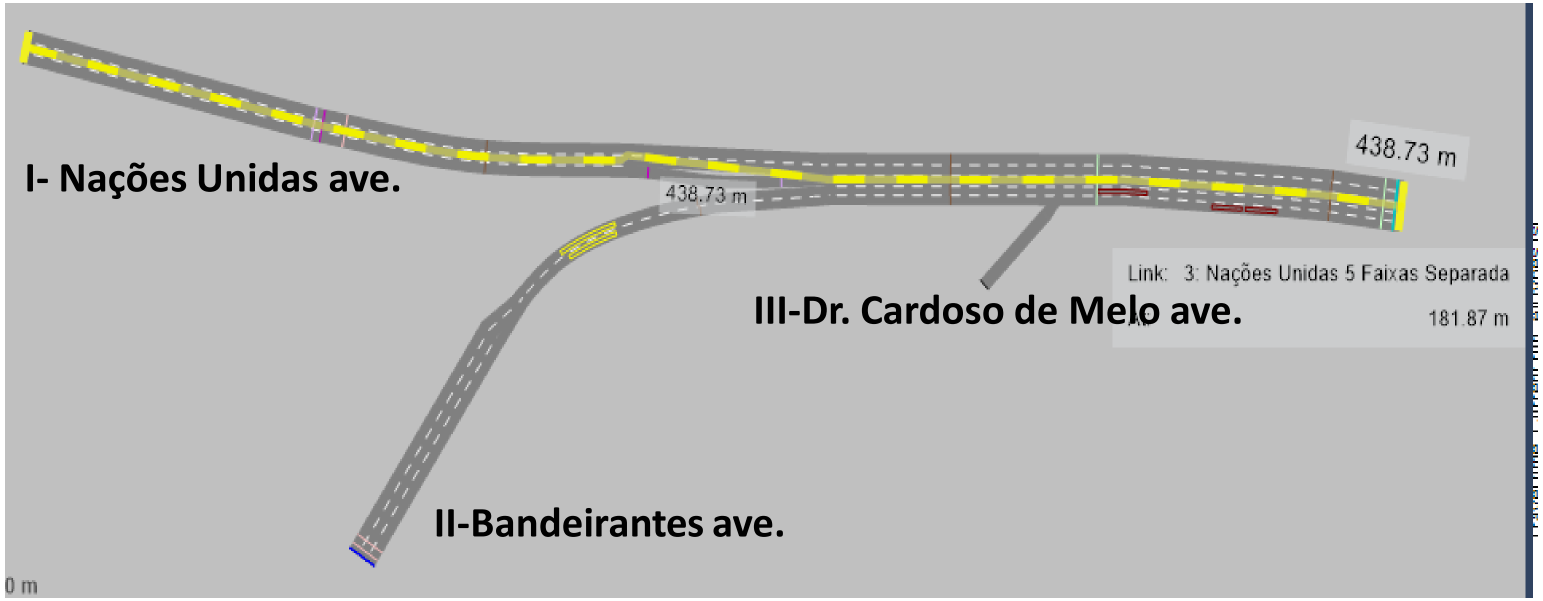
Intersection between Bandeirantes ave and Nações Unidas ave São Paulo City





3.1- Characteristics from base model: why this segment as chosen?

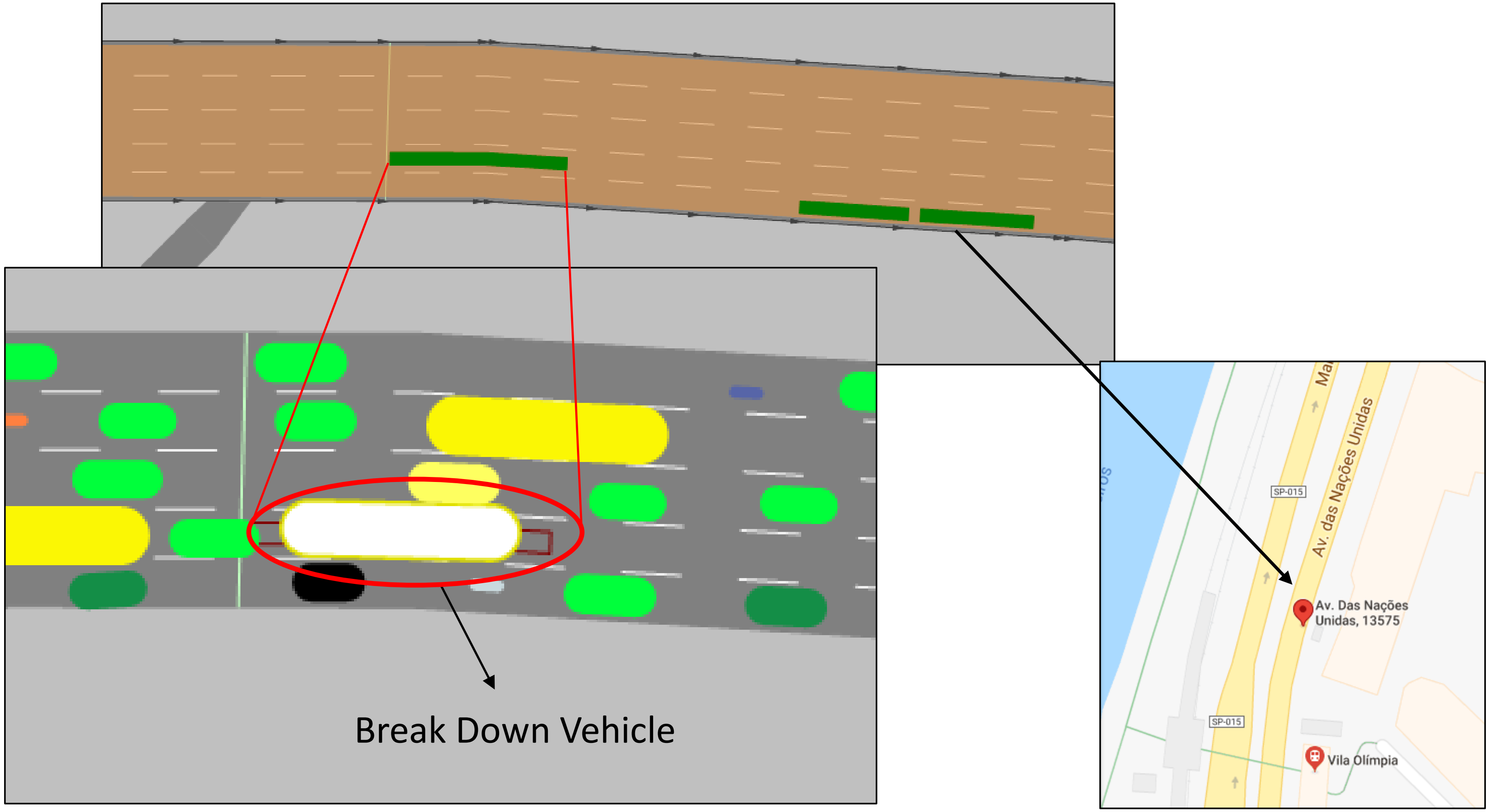




- Highly congested area on rush time: ~10km/h average speed
- Intersection from two large traffic flow roads (I and II)
- Intersection from I and III: aprox. 60° without speed increase area
- Bus stop with several lines: two busses together at the bus stop most of the time leading to a lane blocking
- >10% motorcycles relative flow: typical from São Paulo city

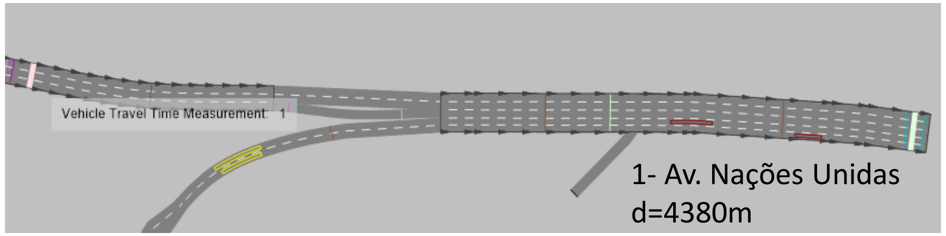
3.2 - VISSIM additional model elements

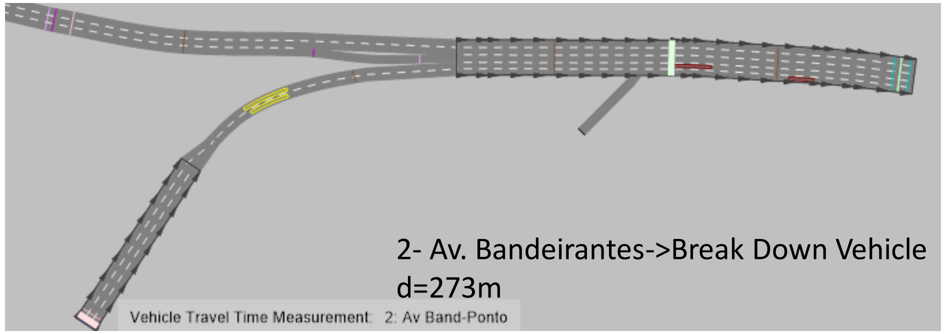
Bus Stops

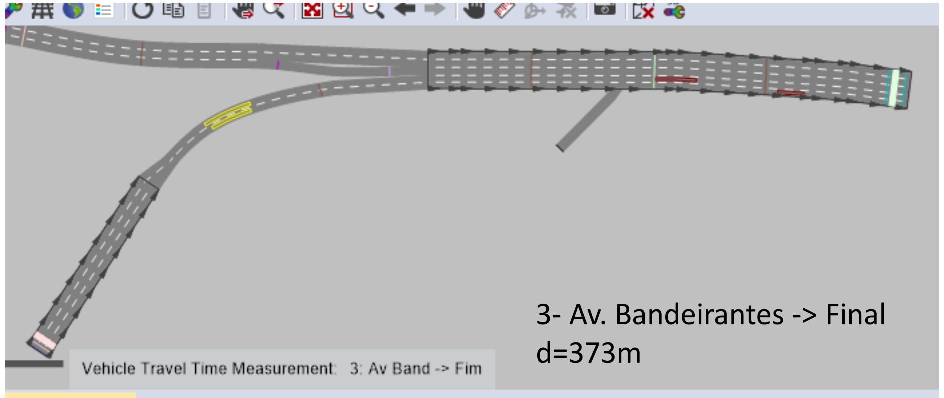


3.3 – VISSIM data output

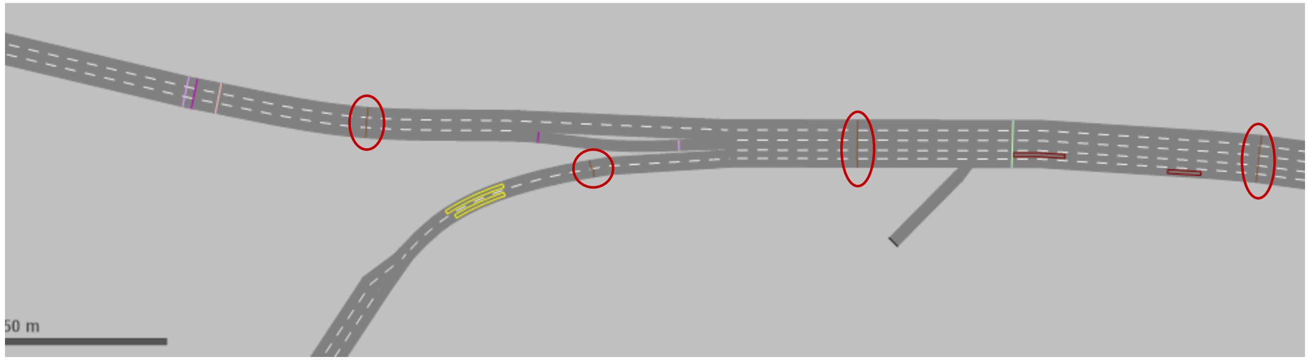
Travel Time Measurement







Data Collection Points



- Each lane has its own Data Collection Point
- VISSIM gives many different outputs. The key output element for this study is:
  - Arithmetic Average vehicles speed
  - Queue delay
  - Occupation Rate

Data Collection Results

Select layout...

135 / 1350	SimR	TimeInt	Data	Acceler	Dist(All)	Length(All)	Vehs(All)	QueueDelay(A	SpeedAvgArith	SpeedAvgHar	OccupRate(All)
1	156	0-200	1: F1I	0,02	149,07	4,06	41	0,0	12,24	12,13	24,61 %
2	156	0-200	2: F1	0,06	296,10	4,02	29	0,0	11,85	11,77	17,90 %
3	156	0-200	3: F1	0,04	416,62	4,02	18	0,0	12,13	11,90	10,89 %
4	156	0-200	4: F2I	-0,01	148,90	4,09	41	0,0	12,66	12,35	24,70 %
5	156	0-200	5: F2	0,03	293,94	3,98	30	0,0	13,71	13,11	16,46 %

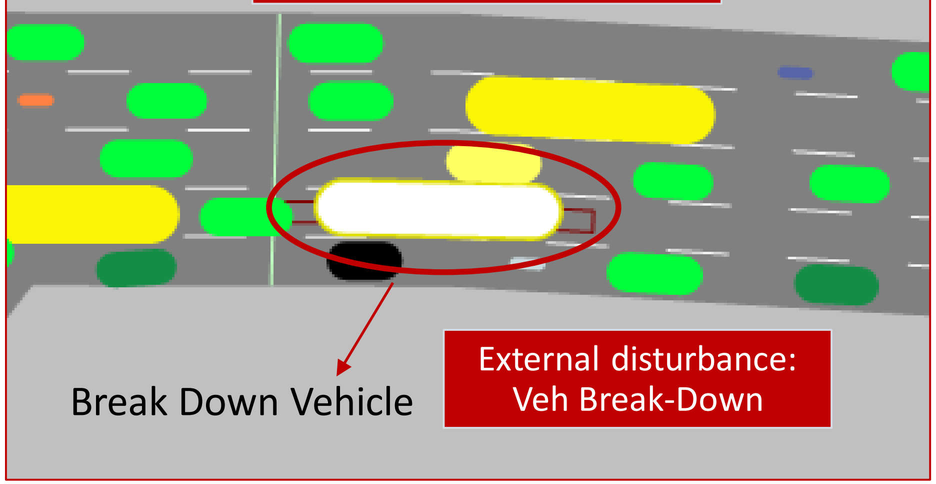
4- Reference Scenarios defined from 100% Human Driven Vehicles to 100% Autonomous Connected Vehicles

	Driver Behavior	Pen Rate
Scenario 1.1 / 1.1 (Baseline)	Human Driven (CoEXist Normal)	100%
Scenario 2.1/ 2.2	Human Driven (CoEXist Normal)	50%
	AV (CoExist All Knowing)	50%
Scenario 3.1 / 3.2	AV (CoExist All Knowing)	100%
Scenario 4.1 / 4.2	Human Driven (CoEXist Normal)	33%
	AV (CoExist All Knowing)	33%
	CAV	33%
Scenario 5.1/5.2	AV (CoExist All Knowing)	50%
	CAV	50%
Scenario 6.1/6.2	CAV	100%

Driver Behaviors

- Human Driven (CoEXist Normal)
- AV (CoExist All Knowing)
- CAV (Platooning)

For Scenarios "X".2



4.1- VISSIM data input for calibration: volumes and desired speed

Data source for model calibration

CET-SP (Traffic Engineering Company) report release in 2018.

do(Pte. do Morumbi) e Pte. Caio Pompeu de Toledo(Pte. do Morumbi)

Pico Tarde											
Hora	Auto	Ônibus		Caminhões			Moto	Bici-	Volume Total		FHP
		Urb	Fret	2eix	3eix	4eix		cleta	Simp.	Equiv.	
17:00 - 18:00	1.790	94	176	6	2	0	353	1	2.422	2.699	
17:15 - 18:15	1.813	96	192	7	4	0	356	1	2.469	2.767	0,90
17:30 - 18:30	1.673	87	184	5	4	0	386	1	2.340	2.619	

Interlagos - Castelo Branco
Início: 05.Pte. João Dias

Via	Trecho até	Dist (m)
TOTAL DA ROTA		7.800
Av. das Nações Unidas	04.Estação Granja Julieta (CPTM)	2.350
Av. das Nações Unidas	03.Pte. do Morumbi (Velha)	1.750
Av. das Nações Unidas	02.Pte. Engº Ary Torres	2.650
Av. das Nações Unidas	01.Ac.à Av.Cidade Jd.(Pç.Nic.David	1.050

Tarde					
Vel. Média (km/h)				Tempo Médio (mm:ss)	Ret. (%)
Geral	Viagem				
	01	02	03		
6,4	7,3	4,1	12,1	09:46	46

Relative Flows: Total 2469 veh/h (17:15-18:15)	
Autos	1813 veh/h (73%)
Bus	272 veh/h (11%)
Motorcycles	356 veh/h (14%)
Trucks (HGV)	11 veh/h (0,4%)

100% Human Driven

Count: 7	VehType	DesSpeedDistr	RelFlow	VehComp
1	100: Car	1047: 7kmh	73,000	1: NacUn
2	200: HGV	1047: 7kmh	0,004	1: NacUn
3	300: Bus	1047: 7kmh	13,000	1: NacUn
4	610: Bike	20: 20 km/h	14,000	1: NacUn
5	630: Car_	1047: 7kmh	0,001	1: NacUn
6	650: HGV	1047: 7kmh	0,001	1: NacUn
7	660: BUS	1047: 7kmh	0,001	1: NacUn

100% AVs

Count: 7	VehType	DesSpeedDistr	RelFlow	VehComp
1	100: Car	7: 7 km/h	0,001	1: NacUn
2	200: HGV	7: 7 km/h	0,001	1: NacUn
3	300: Bus	7: 7 km/h	0,001	1: NacUn
4	610: Bike	20: 20 km/h	0,001	1: NacUn
5	630: Car_	7: 7 km/h	87,000	1: NacUn
6	650: HGV	7: 7 km/h	3,000	1: NacUn
7	660: BUS	7: 7 km/h	10,000	1: NacUn

Motorcycles were replaced by:
- Cars and Busses

4.2- VISSIM input Data: Car following Psico-phisical perception model Wiedemann

- Well-known car-following models are Greenshields' fundamental model, as well as Pipes, Gipps, Van Aerdes, and **Wiedemanns models** which are incorporated in CORSIM, AIMSUN, INTEGRATION and **VISSIM** respectively
- VISSIM supports two different Wiedemann models: Wiedemann 74 and Wiedemann 99

Element	Description
List box	Car following model for the car-following behavior. Depending on the selected car following model the **Model parameters** change. ➤ **No interaction**: Vehicles do not recognize any other vehicles. Use this entry to model pedestrian flows in an easy way. ➤ **Wiedemann 74**: Model suitable for urban traffic and merging areas ➤ **Wiedemann 99**: Model for freeway traffic with no merging areas

[VISSIM Users Manual]

Chapter 7 – Standard Input Parameter Assumptions for Tools

Traffic Operations and Safety Analysis Manual — Version 1.0

Table 18: VISSIM Standard Input Parameters

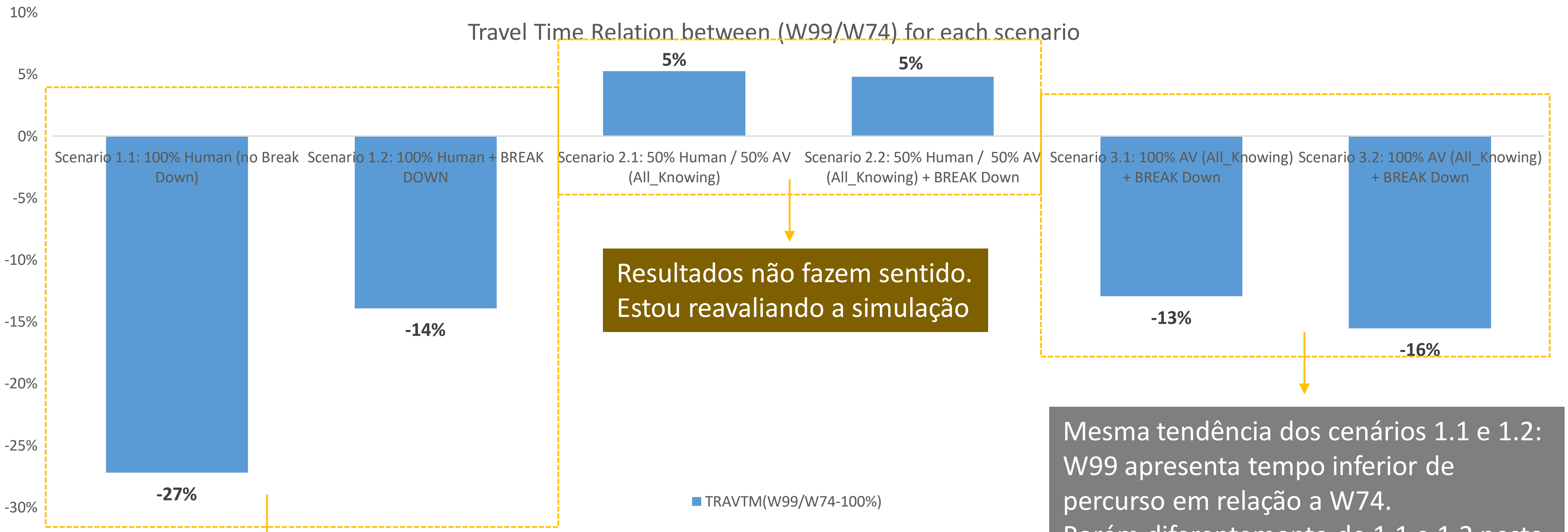
VISSIM INPUT PARAMETER	TYPICAL VALUE, ACCEPTABLE RANGES, and/or SPECIAL NOTES	
	Existing Conditions	Future Conditions
Geometric and Analysis Parameters		
Arrival Distribution	▪ Select to "Exact Volume" instead of the default "Stochastic Volume"	
Auxiliary Lane Length	▪ Use existing field measurements	▪ Based on existing field measurements or design plans
Car Following Model	▪ Use the Wiedemann 74 car following model (arterial links) OR ▪ Use the Wiedemann 99 car following model (freeway links)	
	▪ Enter as 15-minute volumes for a period long enough to account for PHS and for a	

> **Note:** Although the table above also contains the parameters for the Wiedemann 74 model, it is recommended to use Wiedemann 99 to simulate automated vehicles because of more options to control the behaviour through the driving parameters.

[CoEXIst]

[https://www.diva-portal.org/smash/get/diva2:1195623/FULLTEXT01.pdf - Driving behavior modeling and evaluation of merging control strategies - A microscopic simulation study on Sirat Expressway, 2018, Linköping University]

4.2 - Comparison between W99 and W74



Resultados não fazem sentido.
Estou reavaliando a simulação

W99 se mostrou com tempo de percurso bastante inferior em relação ao W99, principalmente para o cenário base

Mesma tendência dos cenários 1.1 e 1.2: W99 apresenta tempo inferior de percurso em relação a W74.
Porém diferentemente de 1.1 e 1.2 neste caso os cenários com e sem acidente apresentaram resultados próximos na relação entre W99/W74.

5- How to simulate autonomous in VISSIM? CoEXist Project

PARTNERS

CoEXist: ENABLING CITIES TO GET AUTOMATION-READY

CoEXist

CoEXist is an H2020 project (May 2017 - April 2020) which aims at preparing cities for the transition phase during which connected and automated vehicles (CAVs) and conventional vehicles will co-exist on their roads.

COEXIST USE CASES

In October 2017, the CoEXist project held an internal workshop to further develop the use cases that are going to be investigated. The modelling and impact assessment tools developed in the project will be used to assess the

As part of the consultation process, on 28th September 2017 CoEXist held a transport automation in cities focus group meeting/workshop at the CIVITAS Forum 2017. In addition, on 10th October 2017, the Polis network hosted a joint workshop between three H2020 projects: CoEXist, MAVEN and TransAID.

CoEXist

7.3 Validation results

The test-track results and co-simulation results showed fundamental differences between automated vehicles and human driven vehicles in following behaviour. Modelling of such automated vehicles in PTV Vissim (directly within GUI without the need for use of interfaces & programming work) required not only change of existing driving behaviour parameters, but also adding some new features into PTV (see deliverable D2.4: "Vissim extension – new features and improvements"). Simulation test proved, that using new features and adapted driving behaviour parameters it is possible to model such behaviour with satisfactory level of accuracy.

Although PTV Vissim allows to simulate a lot of expected or assumed driving behaviours, some specific use cases, significantly different driving logics or complex strategies (especially communication and cooperation) might still require the use of exact algorithms (algorithm used by automated vehicles) with one of PTV Vissim interfaces – drivermodel.dll, drivingsimulator.dll or COM.

- Within CoEXist, work package 2 (WP2) will **develop and validate transport modelling** software extensions aimed at the analysis of impacts arising from the **coexistence of conventional vehicles (CVs) and connected and automated vehicles (CAVs)**

- **CoEXist will overcome the technical limitations that currently exist in traffic simulation and transport modelling, by developing default driver behaviour parameter values for CAVs**.

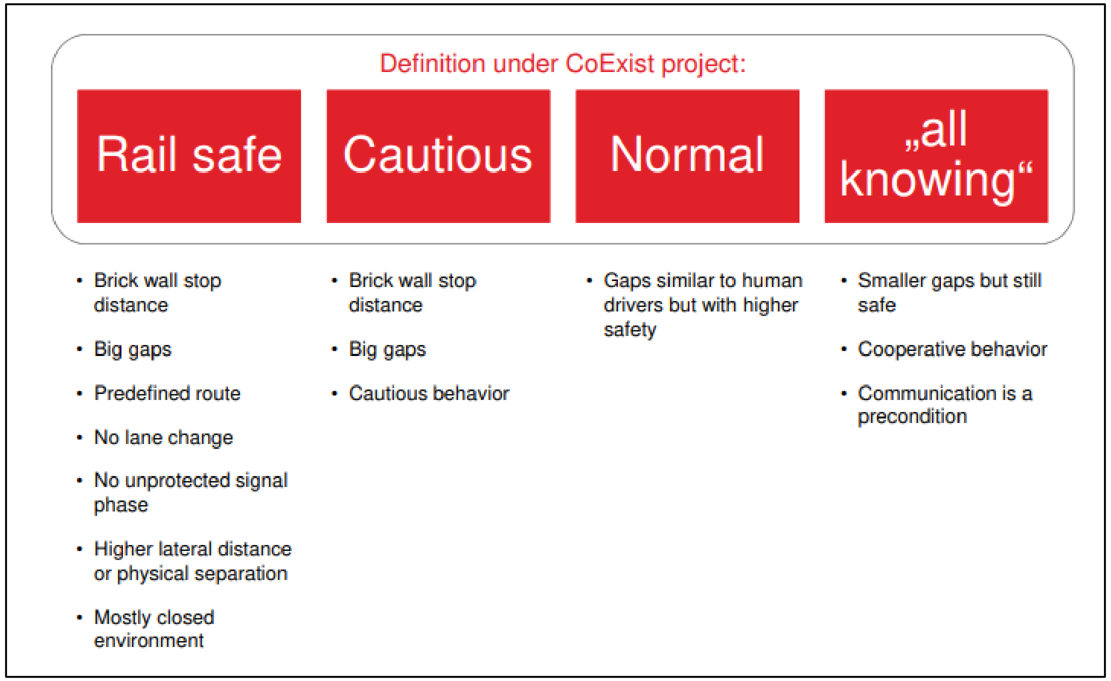
- **Validation process with data collected from three CAVs that are operated by TASS1 , test track in Helmond, Netherlands.** Deliverable D2.6 (due April 2018) will further elaborate on this within a "technical report on data collection and validation process".

[https://www.h2020-coexist.eu/wp-content/uploads/2018/10/D2.2_Technical_Report_on_connecting_AV-Control_Logic_and_AV_Simulator.pdf]

5.1- Vissim partnership with CoExist program led to new features development and parameters to make the simulator fits to automated vehicle behavior

Is it possible to replicate the behavior of automated vehicles using microscopic simulation software PTV Vissim?

- For this purpose, several simulation tests have been done in Vissim with different parameter & feature settings. The results of data evaluation in combination with the proposed concept of **4 different driving logics** led to new develop



https://www.h2020-coexist.eu/wp-content/uploads/2018/10/D2.4-Vissim-extension-new-features-and-improvements_final.pdf

https://www.h2020-coexist.eu/wp-content/uploads/2018/10/D2.6-Technical-report-on-data-collection-and-validation-process_FINAL.pdf

5.1.1- Validated Wiedemann parameters for each driving logic proposed by CoEXist program

CoEXist

7.3 Validation results

The test-track results and co-simulation results showed fundamental differences between automated vehicles and human driven vehicles in following behaviour. Modelling of such automated vehicles in PTV Vissim (directly within GUI without the need for use of interfaces & programming work) required not only change of existing driving behaviour parameters, but also adding some new features into PTV (see deliverable D2.4: "Vissim extension – new features and improvements"). Simulation test proved, that using new features and adapted driving behaviour parameters it is possible to model such behaviour with satisfactory level of accuracy.

Although PTV Vissim allows to simulate a lot of expected or assumed driving behaviours, some specific use cases, significantly different driving logics or complex strategies (especially communication and cooperation) might still require the use of exact algorithms (algorithm used by automated vehicles) with one of PTV Vissim interfaces – drivermodel.dll, drivingsimulator.dll or COM.

PTV GROUP CoEXist

			driving logic				
	model	parameter**	rail safe	cautious	normal	all knowing	def
following behavior	Wiedemann 99	CC0	1.5	1.5	1.5	1	1.5
		CC1	1.5	1.5	0.9	0.6	0.9
		CC2	0	0	0	0	4
		CC3	-10	-10	-8	-6	-8
		CC4	-0.1	-0.1	-0.1	-0.1	-0.35
		CC5	0.1	0.1	0.1	0.1	0.35
		CC6	0	0	0	0	11.44
		CC7	0.1	0.1	0.1	0.1	0.25
		CC8	2	3	3.5	4	3.5
		CC9	1.2	1.2	1.5	2	1.5
	W74	ax	2	2	2	1	2
		bxadd	2	2	2	1.5	2
		bxmult	3	3	3	2	3

5.1.2-CoEXist in partnership with VISSIM developed new features and proposal of configuration to simulate autonomous behavior

USE IMPLICIT STOCHASTICS

Idea: the stochastic imperfection of human driving is replaced by deterministic machines.

In the internal behavior model (for humans), there are several stochastic values indicating the spread of human behavior:
- the risk acceptance,
- the ability to estimate distance and speed difference,
- the precision when operating the throttle and braking pedals.

⇨ For AVs, deterministic values for these parameters can be assumed.

If the attribute "use implicit stochastics" is false, a deterministic average value is used instead of such a stochastically distributed value whenever the distribution cannot be set by the Vissim user.

This option affects:
- desired safety distance,
- desired acceleration,
- desired deceleration,
- decision points (when to start braking / accelerating).

the user may also specify a distribution or function but these are not adjusted automatically, only an implicit stochastic term is suppressed

PTV GROUP CoEXist

Driving Behaviors / Vehicle Class Following Behaviors

Count: 9	No	Name	NumInteractObj	StandDistIsFix	StandDist	CarFollowModType	W74bxAdd	W74bxMult	UseImplicStoch	LnChgRule
3	3	Freeway (free lane selection)	2	☐	0,50	Wiedemann 74	2,00	3,00	☑	Free lane selection
4	4	Footpath (no interaction)	2	☐	0,50	No interaction	2,00	3,00	☑	Free lane selection
5	5	Cycle-Track (free overtaking)	4	☑	1,00	Wiedemann 74	2,00	3,00	☑	Free lane selection
6	6	AV_cautious (CoEXist)	2	☐	0,50	Wiedemann 99	2,00	3,00	☑	Free lane selection
7	7	AV_normal (CoEXist)	2	☐	0,50	Wiedemann 99	2,00	3,00	☑	Free lane selection
8	8	AV_allknowing (CoEXist)	10	☐	0,50	Wiedemann 99	1,50	2,00	☐	Free lane selection

INCREASED ACCELERATION

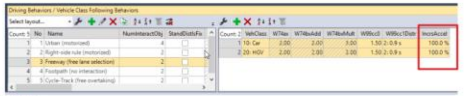
Idea: AVs, especially if using C2C communication, can use a tight coupling with small headways.

The normal "human" acceleration behavior cannot use reliable information about the future behavior of the leading vehicle.

⇨ normal Vissim vehicles tend to fall behind when the leading vehicle is accelerating.

In order to allow vehicles to keep a small headway even during an acceleration process, there is the **new parameter "Increased acceleration"**.

This value defines a percentage (usually > 100%) of the normal acceleration to be used when the leading vehicle is accelerating. The vehicle cannot exceed its maximum acceleration (which defines the technical limit) but it can exceed its desired acceleration in this situation.



PTV GROUP CoEXist • 14

NEW FEATURES & DRIVING LOGICS

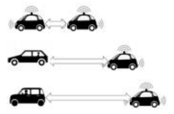
driving logic	recommended setting for new features: enforce absolute breaking distance (EABK)	use implicit stochastics	number of interaction vehicles*	increased desired acceleration
rail safe	ON	OFF	1	100%
cautious	ON	OFF	1	100%
normal	OFF	OFF	1	100-110%
all knowing	OFF	OFF	>1	110%

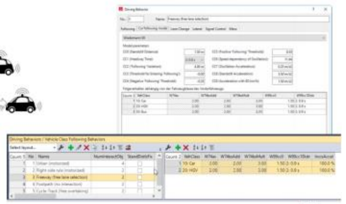
* for advanced sensors and/or communicating vehicles choose more than 1 if information from more than one vehicle ahead is available

Pendente

HEADWAY BASED ON LEADING VEHICLE CLASS

Idea: the headway to followed vehicle depends on the followed vehicle type





Implementation:
- New field in the dialog
- New coupled list for following analogical to „lateral"

PTV GROUP CoEXist • 16

Pendente

Source – Webinar: https://www.youtube.com/watch?v=C_bouqPNSw4

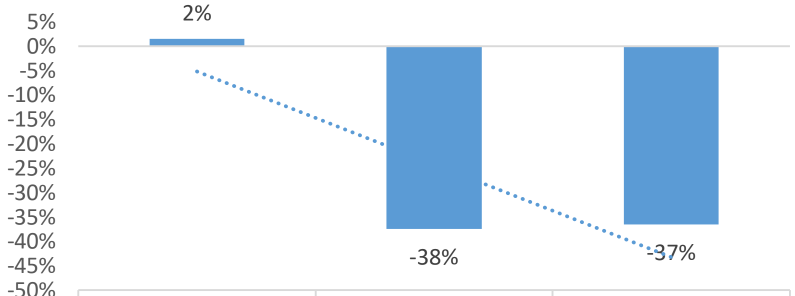
5.2-Motorcycles volumes after automated vehicles intro

- Premise: no autonomous motorcycles will share fully autonomous roads. Motorcycles volumes will be Split between:
  - Busses
  - Autonomous vehicles
  - Other modals: bikes, e-bikes, scooters, etc…
- Example for scenarios 2 and 3:

	Sc1.1 / 1.2 100% Human		Sc2.1 / 2.2 50% Human		Sc3.1 / 3.2 100% AV	
	Rel Flow (%)	Volume	Rel Flow (%)	Volume	Rel Flow (%)	Volume
100: Car	73	3577	36,5	1788,5	0	0
200: HGV	3	147	1,5	73,5	0	0
300: Bus	14	686	7	343	0	0
610: Bike man	10	490	5	245	0	0
630: Car_AV (All Knowing)	0	0	36,5	1788,5	76	3545,4
650: HGV_AV (All Knowing)	0	0	1,5	73,5	3	139,95
660: BUS_AV (All Knowing)	0	0	7	343	21	979,65
Total	100	4900	95	4655	100	4665

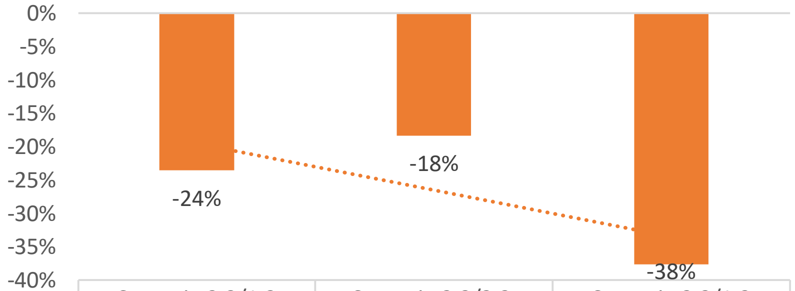
5.3 – Results Comparison between Human Driven and Hybrid for W99 and W74

TRAVTM Difference between scenarios
No Break Down (W74)



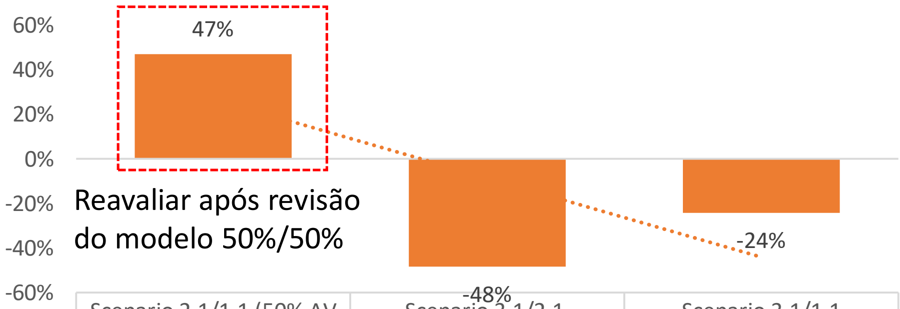
	Scenario 2.1/1.1 (50% AV vs. 100HD)	Scenario 3.1/2.1 (100%AV vs. 50%AV)	Scenario 3.1/1.1 (100%AV vs. 100HD)
TRAVTM Diference	2%	-38%	-37%

TRAVTM Difference between scenarios
With Break Down (W74)



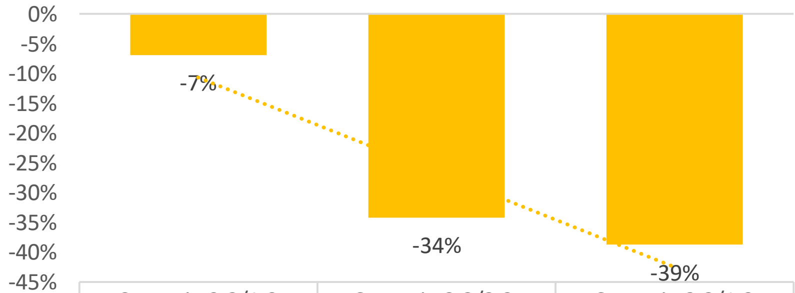
	Scenario 2.2/1.2 (50% AV vs. 100HD)	Scenario 3.2/2.2 (100%AV vs. 50%AV)	Scenario 3.2/1.2 (100%AV vs. 100HD)
TRAVTM Diference	-24%	-18%	-38%

TRAVTM Difference between scenarios
No Break Down (W99)



	Scenario 2.1/1.1 (50% AV vs. 100HD)	Scenario 3.1/2.1 (100%AV vs. 50%AV)	Scenario 3.1/1.1 (100%AV vs. 100HD)
TRAVTM Diference	47%	-48%	-24%

TRAVTM Difference between scenarios
With Break Down (W99)



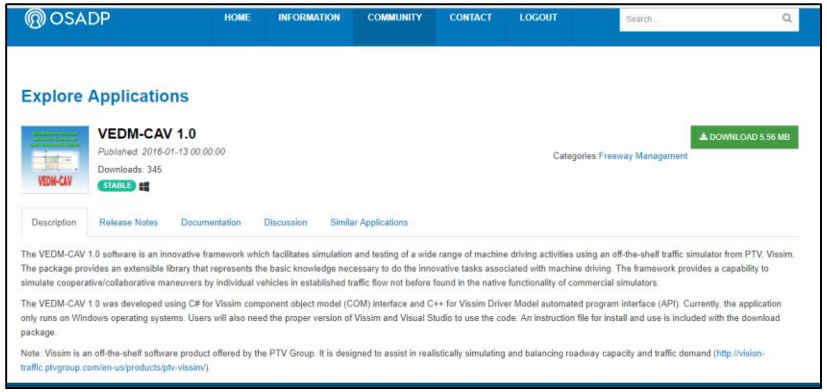
	Scenario 2.2/1.2 (50% AV vs. 100HD)	Scenario 3.2/2.2 (100%AV vs. 50%AV)	Scenario 3.2/1.2 (100%AV vs. 100HD)
TRAVTM Diference	-7%	-34%	-39%

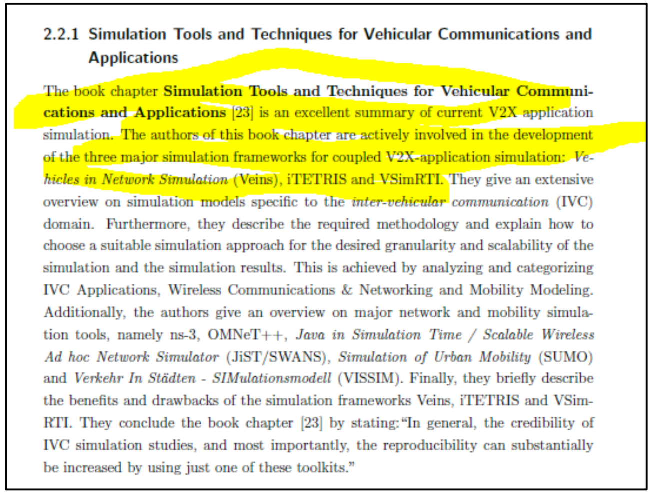
Primeiras conclusões:

- Resultados mostraram uma tendência de redução do tempo de percurso com o aumento da proporção de veículos autônomos, como esperado.
- Diferenças entre W74 e W99 ainda são consideráveis entre os modelos

6- CAV: Connected Automated vehicle

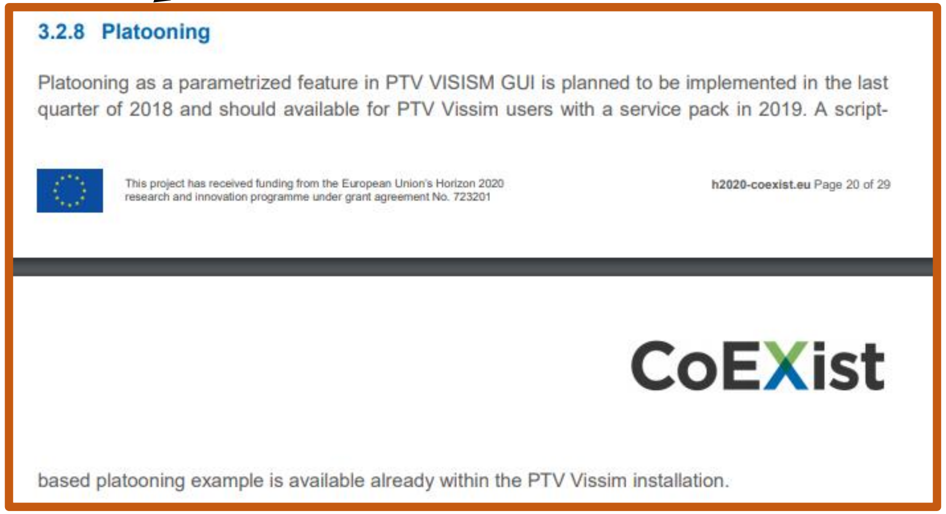
- There are software than can be combined to simulate the characteristics of networks inside traffic simulator.
- For SUMO there are several open source software simulators which integration validated (VEINS,VSimRTI, Convas, iTETRIS...).
- Any of them has a solid documentation to integrate in VISSIM
- Research group from Prof Dr Jose Setti (USP São Carlos) started to search the integration of VEDM-CAV 1.0 (add on developed for OSADP: https://www.itsforge.net/index.php/forum/vedm-cav
- **Platooning feature planed August.19 release from VISSIM 11** (information from VISSIM Product Owner inside PTV forum in Linkedin)





2.2.1 Simulation Tools and Techniques for Vehicular Communications and Applications

The book chapter **Simulation Tools and Techniques for Vehicular Communications and Applications** [23] is an excellent summary of current V2X application simulation. The authors of this book chapter are actively involved in the development of the three major simulation frameworks for coupled V2X-application simulation: *Vehicles in Network Simulation* (Veins), iTETRIS and VSimRTI. They give an extensive overview on simulation models specific to the *inter-vehicular communication* (IVC) domain. Furthermore, they describe the required methodology and explain how to choose a suitable simulation approach for the desired granularity and scalability of the simulation and the simulation results. This is achieved by analyzing and categorizing IVC Applications, Wireless Communications & Networking and Mobility Modeling. Additionally, the authors give an overview on major network and mobility simulation tools, namely ns-3, OMNeT++, *Java in Simulation Time / Scalable Wireless Ad hoc Network Simulator* (JiST/SWANS), *Simulation of Urban Mobility* (SUMO) and *Verkehr In Städten - SIMulationsmodell* (VISSIM). Finally, they briefly describe the benefits and drawbacks of the simulation frameworks Veins, iTETRIS and VSimRTI. They conclude the book chapter [23] by stating:"In general, the credibility of IVC simulation studies, and most importantly, the reproducibility can substantially be increased by using just one of these toolkits."



3.2.8 Platooning

Platooning as a parametrized feature in PTV VISISM GUI is planned to be implemented in the last quarter of 2018 and should available for PTV Vissim users with a service pack in 2019. A script-

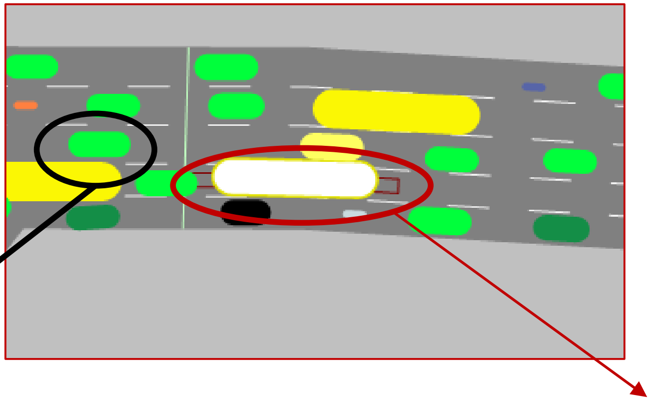
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723201

h2020-coexist.eu Page 20 of 29

CoEXist

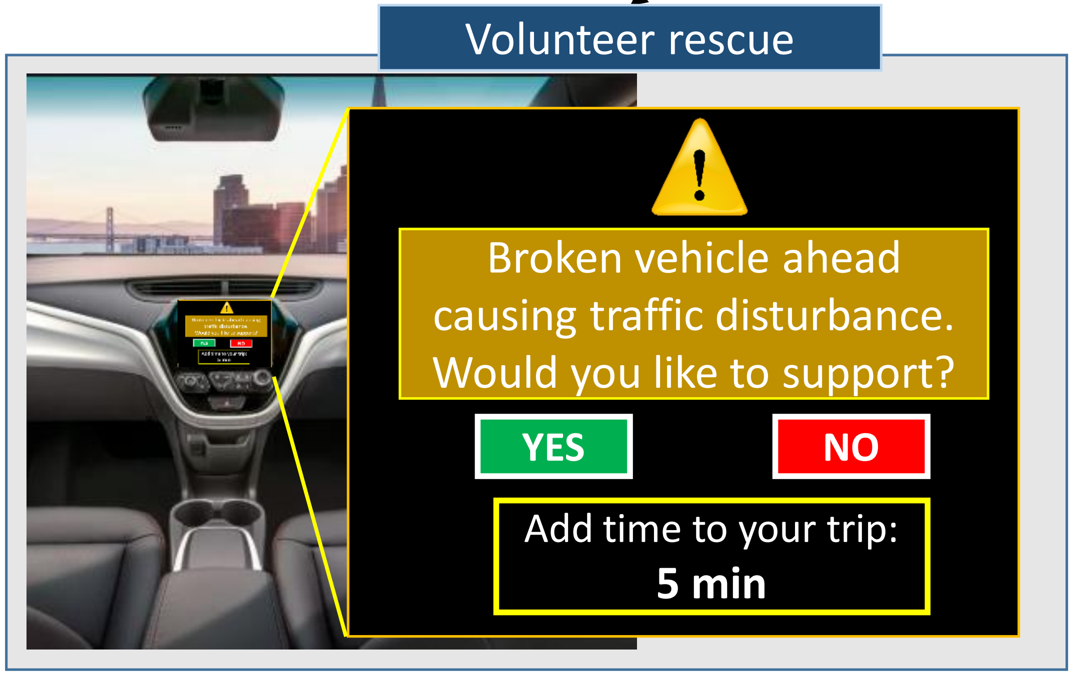
based platooning example is available already within the PTV Vissim installation.

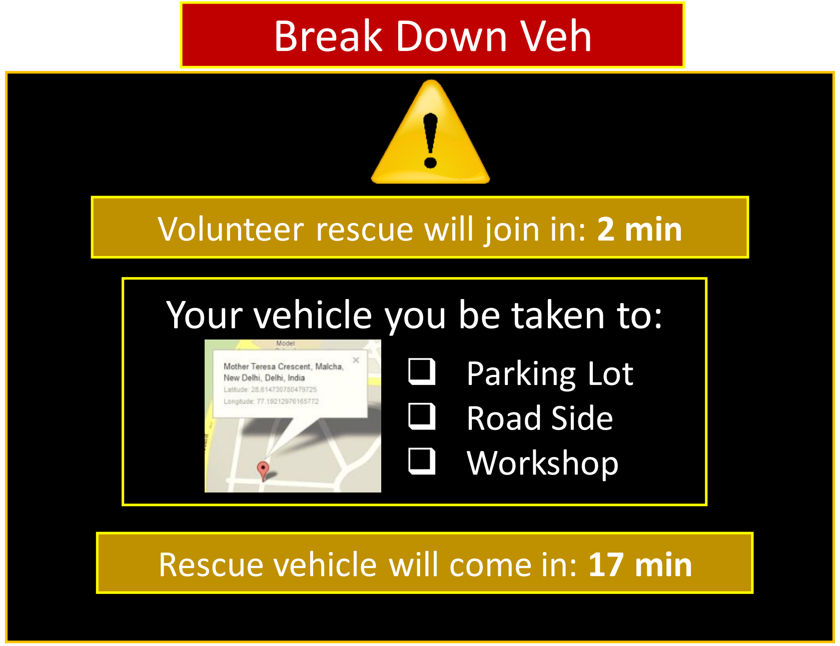
7.1. Ideas - New scenario for CAVs - Rescue vehicles shared model: faster disturbance release



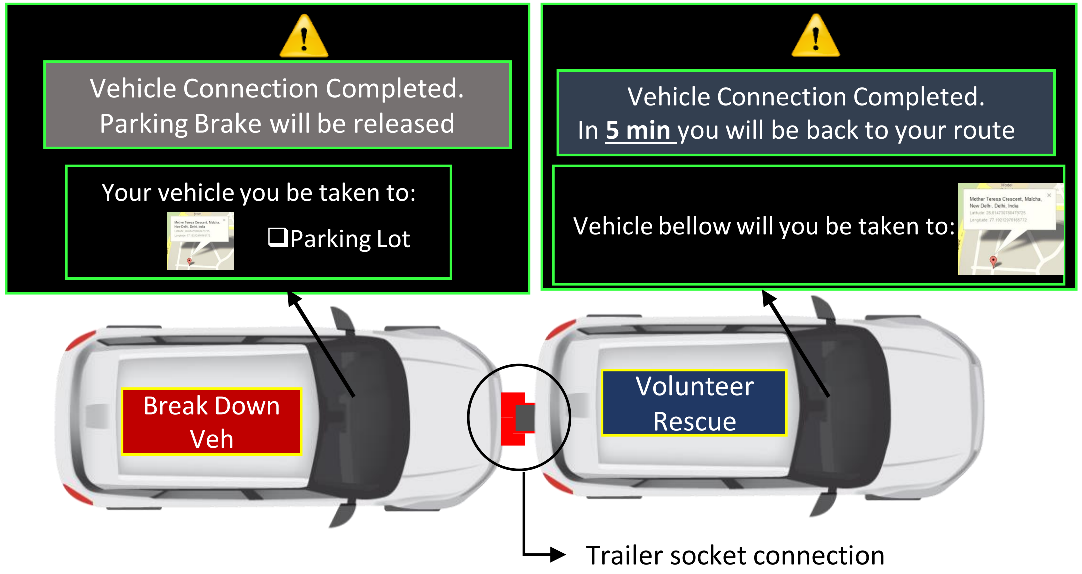
How to simulate?

- Addapt the time that the break down vehicles stays stopped: over a bus stop simulation





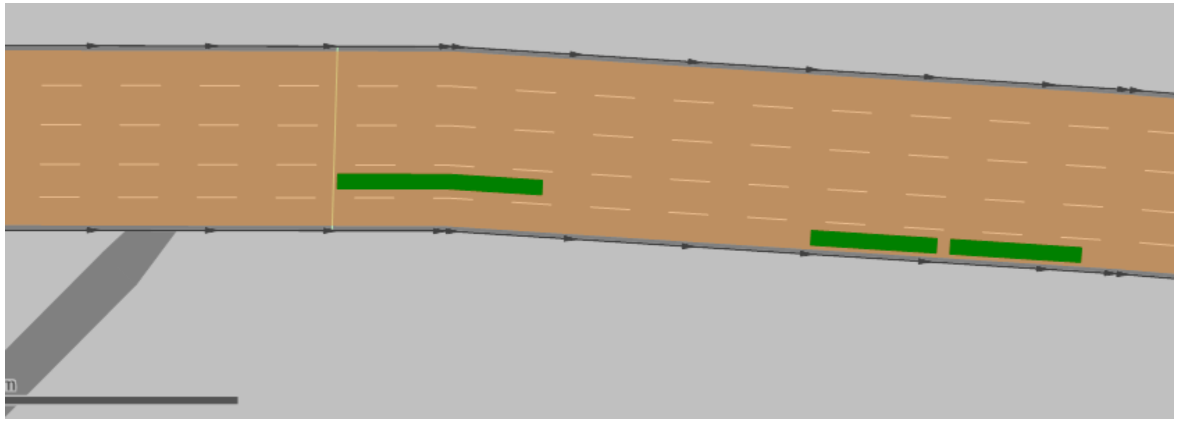
7.1. Ideas: Rescue vehicles shared model- faster disturbance release - Automatic Trailer Connection: faster



- After time to connect a rescue vehicles the break down vehicle will be out of simulation
- Standard rescue vehicles from government can be distributed along the streets (as Tow Trucks)

7.2 - Ideas

- Adequação das vias (faixa exclusiva autônomo)/ aumentar 1 faixa)



8 – Next Steps

- Dúvida: nº ocupantes nos ônibus interfere em modelos sem pedestres?

Base data | Departure times | PT telegrams

Count: 91	Dep	TeleCour	Occup
1	0,0	0	0
2	20,0	0	0
3	40,0	0	0
4	60,0	0	0
5	80,0	0	0
6	100,0	0	0
7	120,0	0	0
8	140,0	0	0
9	160,0	0	0

- Revisar modelos, principalmente 50% HD /50% AV
- Definir aplicação de W74 e W99
- Aplicar veículo de resgate como variação do cenário 3.1
- Escrever trabalho para qualificação até cenário 3 (autônomo não Conectado)
- Marcar Quali para Outubro 19
- Pesquisar opções para simulação de CAV (platooning no VISSIM a partir de agosto como backup)