National Research Council of Italy

Institute of Electronics Computer and Telecommunication Engineering

LTEV2Vsim Tutorial

Giammarco Cecchini
Alessandro Bazzi
Barbara Mavì Masini
Alberto Zanella

CNR-IEIIT, Italy

Email: *giammarco.cecchini@ieiit.cnr.it, alessandro.bazzi@ieiit.cnr.it, barbara.masini@ieiit.cnr.it,* alberto.zanella@ieiit.cnr.it

LTEV2Vsim simulator: principles, models and structure

LTEV2Vsim

- **Objective**
  - To develop a dynamic LTE-V2V MATLAB simulator
    - Focus on the cooperative awareness service
    - Simulation of realistic vehicular scenarios
    - Investigation of algorithms for resource allocation (both controlled and autonomous)
    - Freely accessible (open source) and with a modular structure

- **Motivation**
  - How to optimally assign and reuse LTE resources for V2V is still under discussion

LTEV2Vsim

Maps

PTV Vissim

Realistic traffic simulation

$$x = f(t, \dots)$$
$$y = f(t, \dots)$$

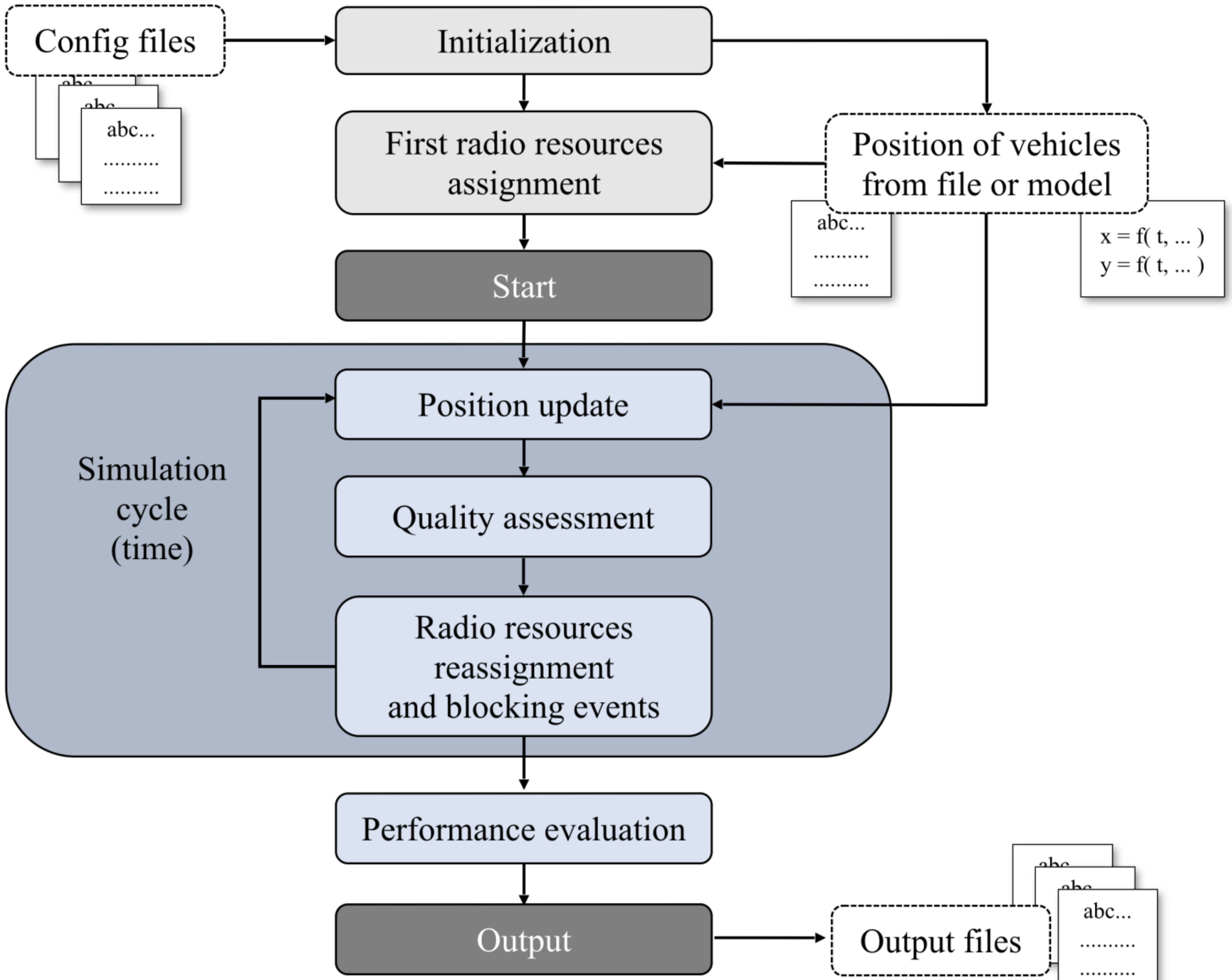
Traffic traces

LTEV2Vsim

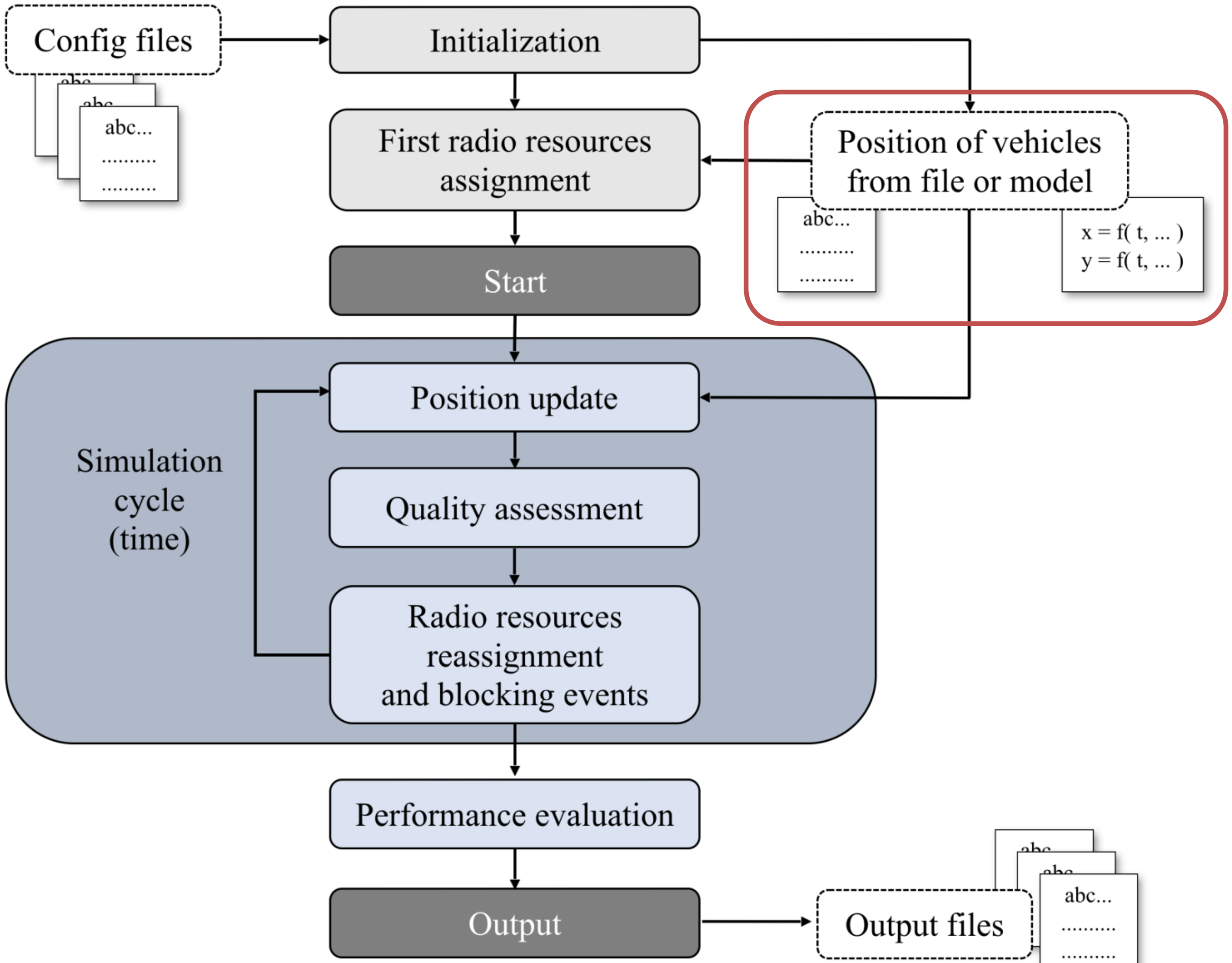
Network simulator

LTEV2Vsim is developed by CNR-IEIIT and publicly available upon request at:
http://www.wcsg.ieiit.cnr.it/products/LTEV2Vsim.html

LTEV2Vsim: structure



LTEV2Vsim: structure



LTEV2Vsim: scenario

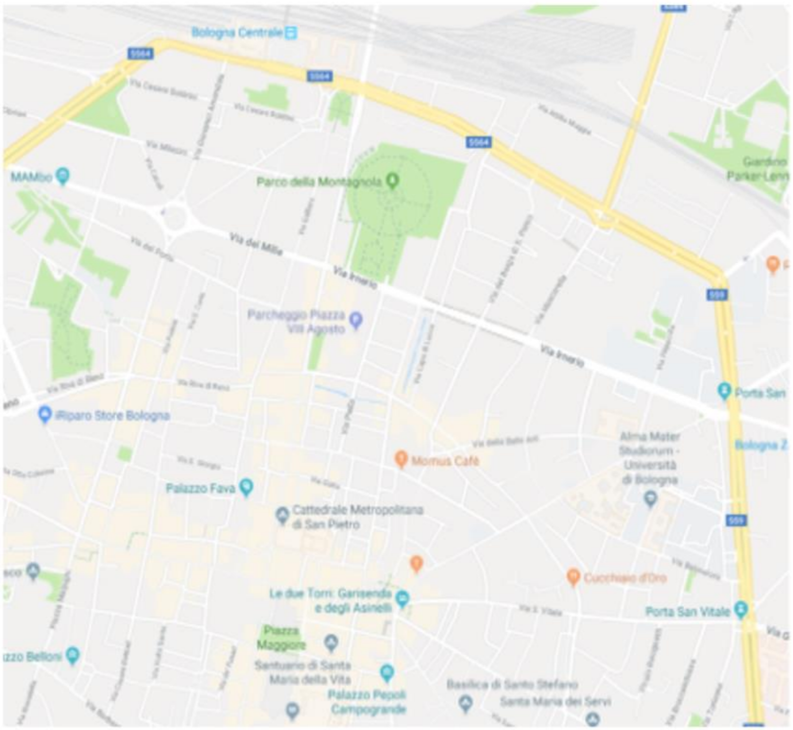
Positions:

The positions of the vehicles can be taken either from

- Theoretical model: Poisson distribution simulating a highway
  - Main parameters: linear density, road length, road width, number of lanes per direction, mean and variance of the speed
- Realistic traffic traces: highway or urban area
  - *Congested highway*: metropolitan area of Bologna, 16 km length, 3 lanes per direction, 125 vehicles/km, average of 2000 vehicles per cycle, 50 ± 3 kph as speed.
  - *Bologna*: portion of 2.88 km^2 of the center of Bologna
    - Two different times of the day:
      - A (less congested): average of 452 vehicles per cycle, 156 vehicles/km^2
      - B (heavily congested): average of 667 vehicles per cycle, 231 vehicles/km^2

LTEV2Vsim: scenario

Example:



Urban traffic trace of Bologna

LTEV2Vsim: scenario

<u>Interpolation</u>:

Since traces are normally provided with a granularity that is much larger than the beacon period (often 1 or 2 s versus 100 ms beacon period), a proper <u>interpolation module</u> allows to infer the positions with the specified time interval.

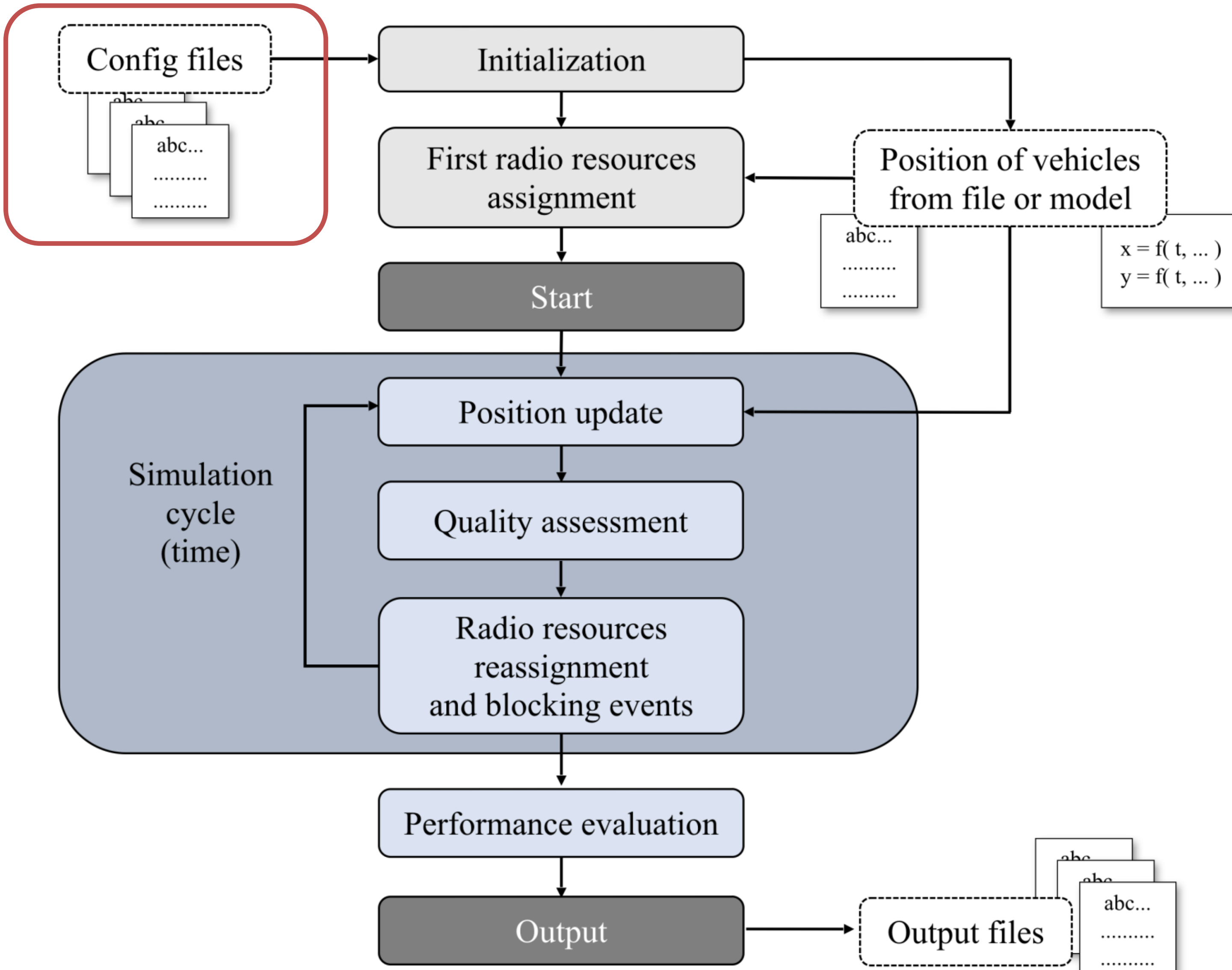
- *Up to v3.1*: interpolation was performed on the traffic trace before starting the simulation, computing intermediate steps of the Euclidean distance between the time instances.

- *From v3.3*: a new interpolation method is introduced. It exploits native MATLAB function "*interp1*" and starts together with the simulation, providing significant performance improvements, as well as a smoother trajectory (more realistic).

LTEV2Vsim: scenario

Interpolation methods comparison:

LTEV2Vsim: structure



LTEV2Vsim: initialization

Input parameters:

To facilitate the initialization, each setting has a default value.

At the beginning of the simulation, a configuration file (*LTEV2Vsim.cfg* or a *custom fileConfig*) is read and the values of the parameters contained in the file overwrite the default values.

Settings can also be passed through the command line, which has the priority over the first two methods, thus these values are overwritten.

Default → fileConfig → Command line

Hierarchy of input parameters (the right side has the highest priority)

Help:

LTEV2Vsim('help') in the command window allows to get a list of the parameters and their default values.

LTEV2Vsim: initialization

Example of default values

```
Physical layer settings
Bandwidth (MHz):         [BwMHz] = 10.000000 (default)
Awareness range (m):     [Raw] = 150 (default)
Transmitted power (dBm):         [Ptx_dBm] = 23.000000 (default)
Transmitter antenna gain (dB):   [Gt_dB] = 3.000000 (default)
Receiver antenna gain (dB):      [Gr_dB] = 3.000000 (default)
Noise figure of the receiver (dB):       [F_dB] = 9.000000 (default)
Modulation and coding scheme:    [MCS] = 4 (default)
Duplexing type: [duplex] = HD (default)
```

Example of fileConfig

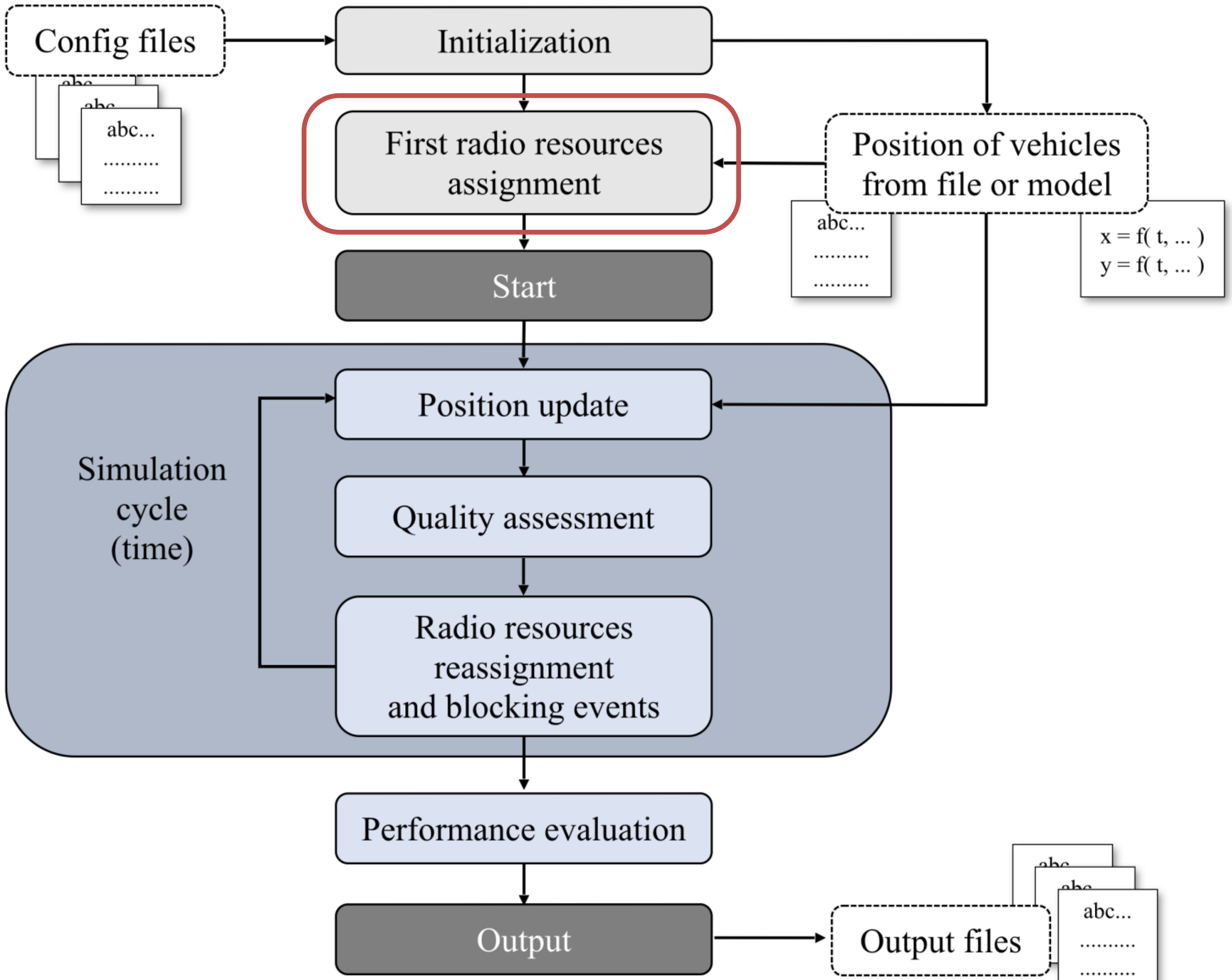
LTEV2Vsim.cfg

```
[fileTrace] true
[filenameTrace] BolognaAPositions.txt

[fileObstaclesMap] true
[filenameObstaclesMap] streetsfileBO.txt

[beaconSizeBytes] 190
[simulationTime] 90

[winnerModel] true
```

Example of command line

```
LTEV2Vsim('default','simulationTime',90,'Technology','LTEV2V',...
    'BRAlgorithm',101,'beaconSizeBytes',190,'printDistanceDetails',true);
```

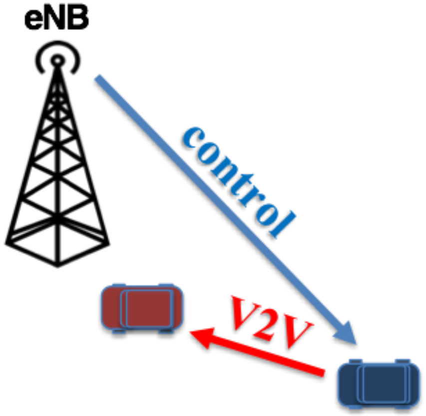
LTEV2Vsim: structure



LTEV2Vsim: structure

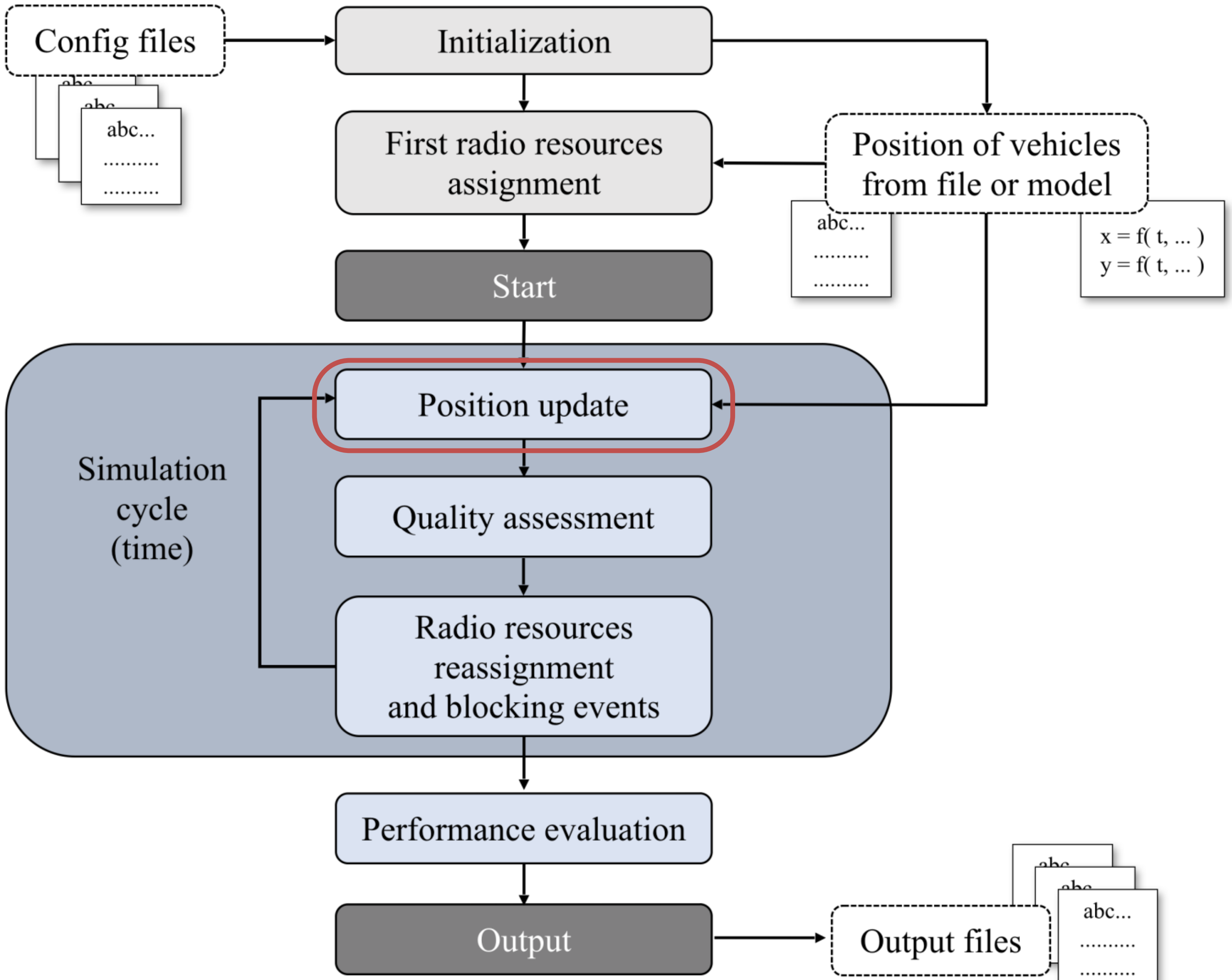
First radio resource assignment:

In order to reduce the duration of the initial transient period, a first resource assignment is carried out for all the vehicles in the scenario at the beginning of the simulation, just as they have all been under cellular coverage, and their positions perfectly estimated by the network.



This approach, adopted also when autonomous resource allocations are investigated, avoids unrealistic bursts of collisions during the first beacon periods due to many vehicles appearing in the scenario at the same time.

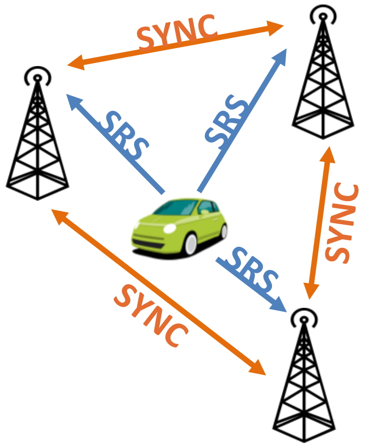
LTEV2Vsim: structure



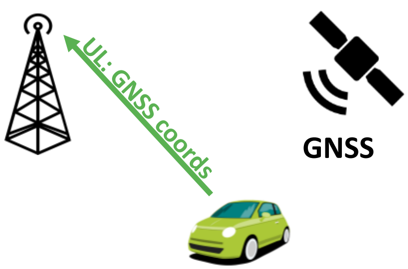
LTEV2Vsim: structure

<u>Position update</u>: Update the current position of all the vehicles and the position estimated by the network, if considering Mode 3. It is possible to add a positioning error or delay in order to reproduce different levels of localization accuracy at the eNodesB.

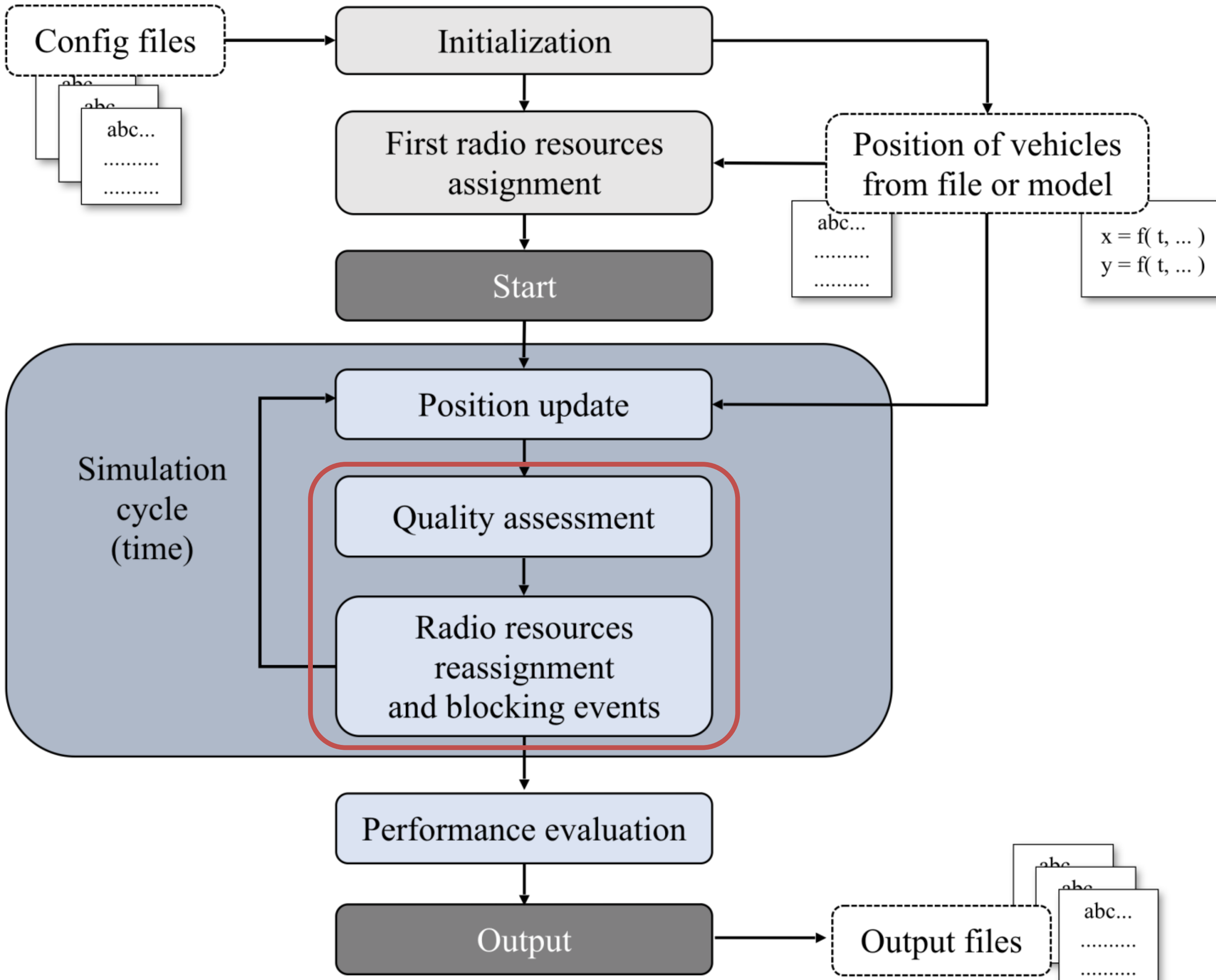
- <u>Uplink Time Difference of Arrival</u> (UTDOA)
  - Introduced in LTE Release 11
  - Multiple synchronized eNBs use multilateration
  - Avoids periodic uplink signaling
  - <u>Positioning error</u>: 2-dimensional Gaussian random variable
    - Norm of the error vector modeled as $|N \sim (0, \sigma_{pos}^2)|$
    - Angle of the error vector modeled as $U \sim (0, 2\pi)$



- <u>Global Navigation Satellite System</u> (GNSS)
  - Vehicles periodically report their coordinates
  - Possible overhead on uplink resource
  - <u>Positioning inaccuracy</u>:
    - Delay due to uplink periodic transmission
    - Negligible error thanks to the capabilities of modern GNSS devices



LTEV2Vsim: structure



LTEV2Vsim: structure

<u>Quality assessment</u>:

A beacon is considered successfully received if its signal-to-noise plus interference ratio (*SINR*) is higher than the minimum threshold $\gamma_{\min}$ computed following the 3GPP standard, given the MCS and packet size.

SINR = *C*/(*N*+*I*), where *C* is the useful received power, *N* the noise contribution and *I* the interfering power.

<u>Radio resources reassignment and blocking events</u>:

Core part of the simulator: resources are reassigned depending on the choice of the <u>resource allocation algorithm</u> (*BRAlgorithm*).
In Mode 3: central entity (perfectly synchronized eNBs)
In Mode 4: follows distributed schemes

A <u>blocking event</u> occurs when the selected algorithm assign no resource for the transmission of the next packet.

LTEV2Vsim

Simulator assumptions:

- The Physical Sidelink Control Channel (PSCCH) is assumed to be transmitted on the RBs adjacent to the ones used for the Physical Sidelink Shared Channel (PSSCH), thus on the same subframe in which the beacon is transmitted; in the simulator, it is considered when the number of RBs is calculated.

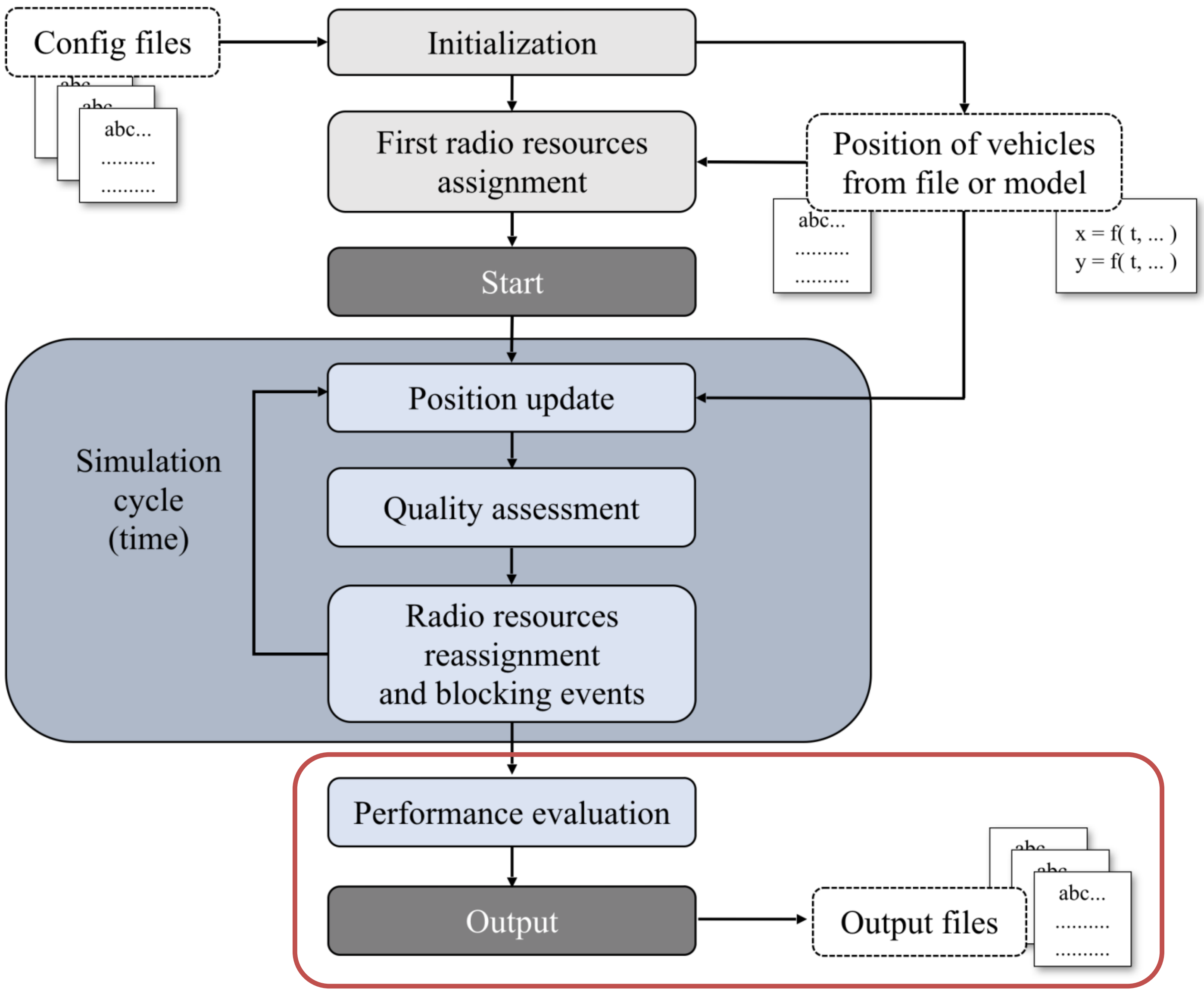
PSCCH carries the Sidelink Control Information (SCI) that contains the information the receiving vehicle requires in order to be able to receive and demodulate the beacon

- In Mode 3, the Scheduling Assignment (SA), used by the eNB to indicate the resources to be used for the next transmission, is assumed to be always successfully received by the vehicle.

- In Mode 3, full LTE coverage and perfect synchronization among eNBs are assumed.

- Hybrid automatic repeat request (HARQ) that considers retransmissions is not implemented.

LTEV2Vsim: structure



LTEV2Vsim: main outputs

Main key performance indicators (KPIs):

Cause: unavailability of resources

$$Average\ blocking\ rate\ (ABR) = \frac{Number\ of\ blocked\ transmitters}{Total\ number\ of\ vehicles}$$

Cause: *SINR* < $SINR_{min}$

$$Average\ error\ rate\ (AER) = \frac{Number\ of\ not\ correctly\ decoded\ beacons}{Total\ number\ of\ beacons\ expected\ to\ be\ received}$$

Summarizes the effects of both ABR and AER

$$Packet\ reception\ ratio\ (PRR) = \frac{Number\ of\ successfully\ received\ beacons}{Sum\ of\ the\ number\ of\ neighbors}$$

Main inputs and outputs

Resource allocation algorithms

3GPP standard only defines one mode 4 algorithm based on power sensing, while mode 3 is left to network operators.

LTEV2Vsim v3.3 features 9 resource allocation algorithms for LTE-V2V.

- <u>Simulation parameter</u>: *BRAlgorithm*

1 → Network-controlled with reuse range (Mode 3)
2 → Network-controlled with reuse range and scheduled reassignments (Mode 3)
3 → Autonomous with sensing range (Mode 4)
4 → Autonomous with BR Map (Mode 4)
5 → Autonomous with sensing by Qualcomm (pre-standard proposal) (Mode 4)
6 → Autonomous with sensing by Intel (pre-standard proposal) (Mode 4)
8 → Autonomous with sensing (3GPP standard) (Mode 4)

101 → Random allocation (Benchmark)
102 → X-coordinate ordered allocation (Benchmark)

Channel model

- **Useful received power:**

$$P_r = \frac{P_t \cdot G_t \cdot G_r \cdot S}{PL}$$ ere

P_t: transmitted power
G_t: transmitter antenna gain
G_r: receiver antenna gain
S: shadowing coefficient
PL: path loss

- **LTEV2Vsim implements two channel models:**

1. **Generic path loss (PL) model:**

$$PL = \frac{L_0 \cdot d_{ij}^{\beta}}{A}$$

where L_0 is the path loss at 1m, β is the loss exponent, d_{ij} is the distance between vehicle i and vehicle j, A is the supplementary attenuation.

Channel model

- *Line-of-sight* (LOS) links: $A = 1$
- *Non-line-of-sight* (NLOS) links: A depends on the number of obstacles that affects the propagation of the signal between the two vehicles. In this case, to compute the supplementary attenuation, LTEV2Vsim finds the number of walls crossed by the signal and counts the meters of propagation inside buildings, as from [B]

- <u>Simulator parameters</u> regarding the supplementary attenuation:
  - *Abuild_dB* = attenuation for every meter inside buildings (dB)
  - *Awall_dB* = attenuation for each wall crossed (dB)

[B] *C. Sommer, D. Eckhoff, R. German, F. Dressler: "A computationally inexpensive empirical model of IEEE 802.11p radio shadowing in urban environments," 2011 8th International Conference on Wireless On-Demand Network Systems and Services (WONS), pp. 84–90*

Channel model

2. <u>WINNER+ B1</u>:

The PL is computed following the recommendations of 3GPP for vehicular communications [C], hence considering an antenna height of 1.5 m and calculating <u>correlated shadowing</u> as a log-normal distribution with standard deviation σ of 3 dB in LOS and 4 dB in NLOS.

The value of shadowing S_i is updated to its new value S_{i+1} as follows:

$$S_{i+1} = \exp\{-D/D_{corr}\}S_i + \sqrt{(1-\exp\{-2 * D/D_{corr}\})}N_{i+1}$$

where D is the change in distance between the transmitter and the receiver, D_{corr} is the <u>de-correlation distance</u> (equal to 10m for the urban scenario and to 25m for the freeway case), N_{i+1} is a log-normal independent random variable with standard deviation σ.

Small-scale fading is not simulated as a speed-accuracy compromise.

[C] *Table A.1.4-1 of 3GPP TR 36.885 V2.0.0 (2016-06)*

Channel model

Scenario	Path loss [dB]	Shadowing std [dB]	Applicability range, antenna height default values
LOS	$PL = 22.7\log_{10}(d) + 27.0 + 20.0\log_{10}(f_c)$	σ=3	$d < d'_{BP}$
	$PL = 40.0\log_{10}(d) + 7.56 - 17.3\log_{10}(h'_{MS})$ $-17.3\log_{10}(h'_{MS}) \quad +2.7\log_{10}(f_c)$	σ=3	$d'_{BP} < d < 5\text{km}$ $h_{MS} = 1.5\text{m}$
NLOS	$PL = (44.9 - 6.55\log_{10}(h_{MS}))\log_{10}(d) +$ $5.83\log_{10}(h_{MS}) + 18.38 + 23\log_{10}(f_c)$	σ=4	$d < 2\ 000$ m $h_{MS} = 1.5$m

"D5.3: WINNER+ final channel models," Wireless World Initiative New Radio WINNER+, June 2010.

where the effective breakpoint distance d'_{BP} is calculated as $d'_{BP} = 4\ h'_{MS} h'_{MS} f_c/c$; f_c is the central frequency in Hz, in this case equal to 5.9 GHz (ITS band), $c = 3\times10^8$ m/s is the propagation velocity in free space, and h'_{MS} is the effective antenna height at the MS.

The effective antenna height h'_{MS} is computed as follows: $h'_{MS} = h'_{MS} - 1.0$ m, where h'_{MS} is the actual antenna height, and the effective environment height in urban environments is assumed to be equal to 1.0 m.

LTEV2Vsim: main output

<u>Main output file: “*MainOut.xls*”</u> (always generated)

Each row of the file contains the main information about the performed simulation:
- ID of the simulation, simulator version, date, seed, simulation duration (s) and computation duration (s)
- The most relevant application, physical and resource allocation settings

Eventually, the following KPIs for the selected <u>awareness range</u> are reported:
- <u>Average number of neighbors</u> and variance of neighbors (a vehicle is considered as neighbor when its distance is within the awareness range)
- <u>Average resource reassignments</u> per vehicle per cycle, where cycle means a single snapshot of the simulation (equal to the beacon time)
- <u>Average blocking rate</u>, <u>average error rate</u>, <u>packet reception ratio</u>

SimID	Sim version	When	Seed	Simulated duration	Computation duration	Vehicles position	Sim (Mborder,Pos
1	v2.0.2	01-Jun-	10	90	1277.355564	File: HighwayPositions_interpolated2D90sec.txt	500,0.0,0.100000
2	v2.0.2	01-Jun-	10	90	1397.989193	File: HighwayPositions_interpolated2D90sec.txt	500,0.0,0.100000
3	v2.0.2	01-Jun-	10	90	1509.010732	File: HighwayPositions_interpolated2D90sec.txt	500,0.0,0.100000
4	v2.0.2	01-Jun-	10	90	1616.627575	File: HighwayPositions_interpolated2D90sec.txt	500,0.0,0.100000
5	v2.0.2	01-Jun-	10	90	1733.384213	File: HighwayPositions_interpolated2D90sec.txt	500,0.0,0.100000
6	v2.0.2	01-Jun-	10	90	1877.541933	File: HighwayPositions_interpolated2D90sec.txt	500,0.0,0.100000
7	v2.0.2	01-Jun-	10	90	2148.003761	File: HighwayPositions_interpolated2D90sec.txt	500,0.0,0.100000
8	v2.0.2	01-Jun-	10	90	2587.131696	File: HighwayPositions_interpolated2D90sec.txt	500,0.0,0.100000

Example of mainOut.xls

LTEV2Vsim: distance details

Output file: "*distanceDetails_simID.xls*" (*printDistanceDetails* = true)

This file provides detailed information on the fate of transmissions.

- Goal: to compute various metrics for distances up to the maximum awareness range (the maximum transmission range to have SINR above the minimum threshold when only noise is present)

- Following the order of the file, columns contain the following data:
  - Awareness range (m)
  - Number of correctly received beacons
  - Number of errors
  - Number of blocked neighbors
  - Number of neighbors

- For each row, the number of events is counted among the neighbors at a distance lower than the value in the first column. The distance varies from 1 m to the maximum awareness range with 1 m step.

LTEV2Vsim: distance details

Output file: "*distanceDetails_simID.xls*"

Awareness range (m)	correctly received	errors	blocked	neighbors
1	52	0	0	52
2	147	1	0	148
3	5162	34	0	5196
4	64997	307	38	65342
5	159850	778	52	160680
6	242830	1208	54	244092
7	313882	1684	76	315642
8	429393	2487	98	431978
9	536441	3351	110	539902
10	625164	4147	117	629428
11	715920	5031	119	721070
12	789229	5851	122	795202
13	883956	7035	125	891116
14	979234	8325	135	987694
15	1099221	10393	154	1109768

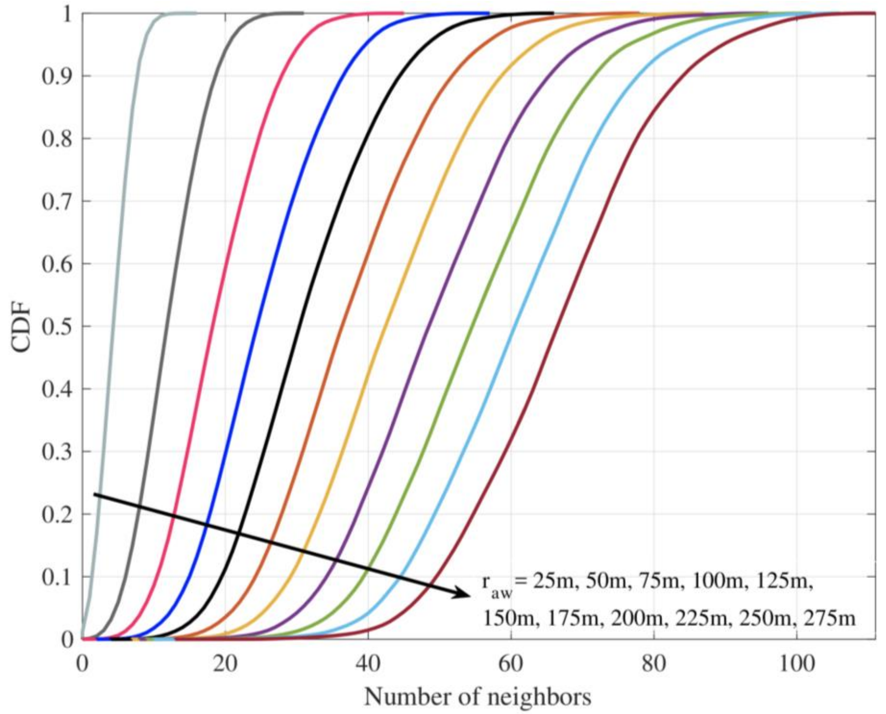
Example of distanceDetails_simID.xls

LTEV2Vsim: print neighbors

<u>Output file: "*neighbors_simID.xls*"</u> (when *printNeighbors* = true)

This file contains only one column with the number of neighbors of each vehicle within the selected <u>awareness range</u>. It is useful to analyze the traffic trace.

Example:



Cumulative distribution function (CDF) of the number of neighbors at the variation of the awareness range in the highway scenario (traffic trace)

LTEV2Vsim: delay

Output file: "*update_delay_simID.xls*" **(when *printUpdateDelay* = true)**

The update delay is defined as the time interval between two consecutive successfully received beacons from the same node within the selected awareness range.

The file contains the following 3 columns in order:
- update delay time (according to the set *delayResolution* → default = 1 ms)
- number of events
- CDF

Output file: "*packet_delay_simID.xls*" **(when *printPacketDelay* = true)**

The packet delay is defined as the time interval between the generation of the packet and its effective transmission. The metric is computed for each successful reception within the selected awareness range.

The file contains the following 3 columns in order:
- packet delay time (according to the set *delayResolution* → default = 1 ms)
- number of events
- CDF

LTEV2Vsim: PRR map

Output file: *"PRRmap_simID.png"* **(when *printPRRmap* = true)**

This file is an image of the scenario and of the traces of the vehicles.

- Requirements:

urban scenario with *fileObstaclesMap* = true $\longrightarrow$ presence of the input file that stores the map of roads, buildings and obstacles

- Colors:

From green (PRR_{map} = 1) to black (PRR_{map} = 0), where $PRR_{map} = (1 - \sqrt{1 - PRR^2})$

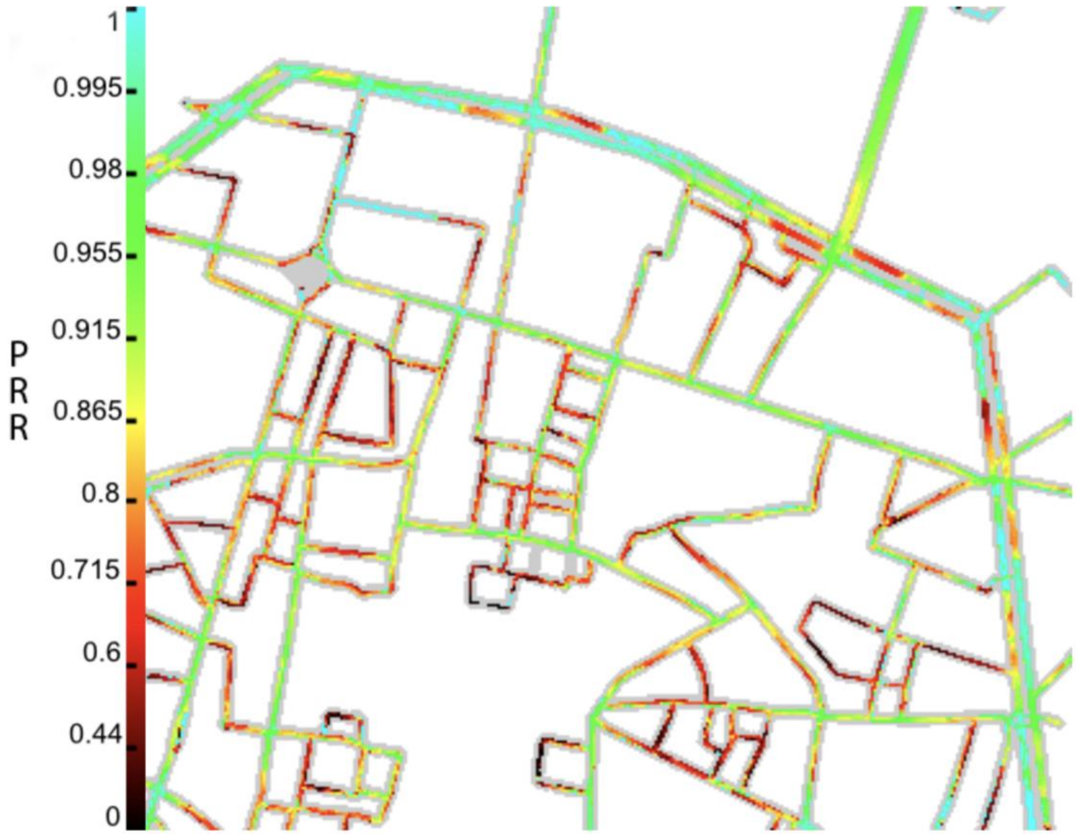
Note that: when $PRR_{map} = 1 \longrightarrow PRR = 1$
when $PRR_{map} = 0 \longrightarrow PRR = 0$

Since the urban scenario is often complex, usually with roads with different levels of congestion, PRRmap is useful to analyze the performance in terms of PRR in the different portions of the scenario.

LTEV2Vsim: PRR map

Output file: "*PRRmap_simID.png*"

Example:



PRR map in urban scenario (Bologna A), with labelled color bar.

List of parameters

LTEV2Vsim

Complete list of input parameters:

Parameter	Case of utilisation	Description (unit of measurement)	Value	Default
Application settings				
Tbeacon	Always	Beacon period (s)	Double, > 0	0.1
beaconSizeBytes	Always	Beacon size (Bytes)	Integer, > 0 & <10000	190
resourcesV2V	Always	Resource allocated to V2V (%)	Integer, > 0 & <=100	100
Simulation settings				
Technology	Always	Choice between LTE-V2V and 802.11p	String, [LTEV2V, 80211p]	LTEV2V
simulationTime	Always	Simulation duration (s)	Double, > 0	10
seed	Always	Seed for random numbers generation	Integer; if set to 0 it is randomly selected	0
fileTrace	Always	Set file trace	Boolean	false
filenameTrace	When *fileTrace*=true	File trace name	String	null.txt

LTEV2Vsim

Parameter	Case of utilisation	Description (unit of measurement)	Value	Default
fileObstaclesMap	When *fileTrace*=true	Set obstacles map file	Boolean	false
filenameObstaclesMap	When *fileTrace*=true	File obstacles map name	String	null.txt
roadLength	When *fileTrace*=false	Length of the road to be simulated (m)	Double, > 0	4000
roadWidth	When *fileTrace*=false	Width of each lane (m)	Double, >= 0	3.5
NLanes	When *fileTrace*=false	Number of lanes per direction	Integer, > 0	3
rho	When *fileTrace*=false	Density of vehicles (vehicles/km)	Double, > 0	100
vMean	When *fileTrace*=false	Mean speed of vehicles (km/h)	Double, >= 0	114.23
vStDev	When *fileTrace*=false	Standard deviation of speed of vehicles (km/h)	Double, >= 0	12.65
Mborder	Always	Margin for border effect removal (m)	Integer, >= 0	0

LTEV2Vsim

Parameter	**Case of utilisation**	**Description (unit of measure)**	**Value**	**Default**
Simulation settings				
XminTrace	When *fileTrace*=true	Minimum X coordinate to keep in the traffic trace (m)	Double, >= 0	-1
XmaxTrace	When *fileTrace*=true	Maximum X coordinate to keep in the traffic trace (m)	Double, >= 0	-1
YminTrace	When *fileTrace*=true	Minimum Y coordinate to keep in the traffic trace (m)	Double, >= 0	-1
YmaxTrace	When *fileTrace*=true	Maximum Y coordinate to keep in the traffic trace (m)	Double, >= 0	-1

LTEV2Vsim

Parameter	Case of utilisation	Description (unit of measurement)	Value	Default
Physical layer settings				
BwMHz	Always	Bandwidth (MHz)	Double, [1.4, 5, 10, 20]	10
Raw	Always	Awareness range (m)	Integer, > 0	150
Ptx_dBm	Always	Transmitted power (dBm)	Double	23
Gt_dB	Always	Transmitter antenna gain (dB)	Double	3
Gr_dB	Always	Receiver antenna gain (dB)	Double	3
F_dB	Always	Noise figure of the receiver (dB)	Double	9
Mode	When *Technology* = 80211p	802.11p TX Mode	Integer, [1,2,3,4,5,6,7,8]	3
CW	When *Technology* = 80211p	Contention Window	Integer, >= 1	16
MCS	When *Technology* = LTEV2V	Modulation and coding scheme	Integer, >= 0 & <= 28	5

LTEV2Vsim

Parameter	Case of utilisation	Description (unit of measurement)	Value	Default
duplex	When *Technology* = LTEV2V	Duplexing type	String, [HD,FD]	HD
Ksi_dB	When *Technology* = LTEV2V & *duplex* = FD	Self-interference cancellation coefficient (dB)	Double	-110
NumBeaconsFrequency	When *Technology* = LTEV2V	Maximum number of BRs in the frequency domain	Integer, > 0 or -1(meaning all BRs)	-1
winnerModel	Always	Set Winner+ channel model	Boolean	True
stdDevShadowLOS_dB	Always	Standard deviation of shadowing in LOS (dB)	Integer	3
stdDevShadowNLOS_dB	Always	Standard deviation of shadowing in NLOS (dB)	Integer	*4*
L0_dB	When *winnerModel* = false	Path loss at 1m (dB)	Double	47.86
beta	When *winnerModel* = false	Path loss exponent	Double	2.20

LTEV2Vsim

Parameter	Case of utilisation	Description (unit of measurement)	Value	Default
Abuild_dB	When *winnerModel* = false & *fileObstaclesMap* = true	Attenuation every meter inside buildings (dB)	Double	0.4
Awall_dB	When *winnerModel* = false & *fileObstaclesMap* = true	Attenuation for each wall crossed (dB)	Double	6
Settings of resource allocation algorithm				
BRAlgorithm	Always	Allocation algorithm	Integer, [1,2,3,4,5,6,8,101,102]	1
			1 - Controlled	
			2 - Controlled with scheduled BR reassignment	

LTEV2Vsim

Parameter	Case of utilisation	Description (unit of measurement)	Value	Default
			3 - Autonomous with sensing range	
			4 - Autonomous with BR map	
			5 - Autonomous with sensing (Qualcomm)	
			6 - Autonomous with sensing (Intel)	
			8 - Autonomous with sensing (3GPP standard mode 4)	
			101 - Random allocation	
			102 - Ordered allocation following x coordinate	

LTEV2Vsim

Parameter	Case of utilisation	Description (unit of measurement)	Value	Default
randomOrder	All algorithms except *BRAlgorithm* = 101,102	Set whether resources are selected randomly (at first assignment for all BRAlgorithm except 101,102,7 and for BRAlgorithm 1,2)	Boolean	True
Tupdate	When *BRAlgorithm* = 1,2	Time interval between position updates at the eNodesB (s)	Double, > 0	*Tbeacon*
posError95	When *BRAlgorithm* = 1,2	LTE positioning error - 95th percentile (m)	Double	0
Mreuse	When *BRAlgorithm* = 1,2	Reuse margin (m)	Integer	0
Treassign	When *BRAlgorithm* = 2,6	Interval of scheduled reassignment (s)	Double, > 0	*Tbeacon*
Rsense	When *BRAlgorithm* = 3	Sensing Range (m)	Integer, >= Raw & <Rnoise (distance at which rx power is equal to noise power)	*Raw*

LTEV2Vsim

Parameter	Case of utilisation	Description (unit of measurement)	Value	Default
pReselect	When *BRAlgorithm* = 5	Probability of resources reselection	Double	0.1
kBest	When *BRAlgorithm* = 5	Number of best candidates for resource reselection	Integer	20
hysteresysM	When *BRAlgorithm* = 5	Hysteresys Margin (dB) for resource reselection	Double	6
Tsps	When *BRAlgorithm* = 6	Resource Reselection Period for Semi-persistent Scheduling (s)	Double	0.5
MBest	When *BRAlgorithm* = 6	Number of best candidates for resource reselection	Integer	20
probResKeep	When *BRAlgorithm* = 8	Probability to keep the previously selected BR	Double, >=0 & <=0.8	0.8
NsensingPeriod	When *BRAlgorithm* = 8	Number of beacon periods during which performing sensing	Integer, >0	10

LTEV2Vsim

Parameter	Case of utilisation	Description (unit of measure)	Value	Default
Output settings				
outputFolder	Always	Folder for the output files	String	Output
printNeighbors	Always	Activate the print to file of the number of neighbors	Boolean	False
printUpdateDelay	Always	Activate the print to file of the update delay between successive successfully received beacons	Boolean	False
printPacketDelay	Always	Activate the print to file of the packet delay between successive successfully received beacons	Boolean	False
delayResolution	When *printUpdateDelay* = true or *printUpdateDelay* = true	Delay resolution (s)	Double, >0	0.001

LTEV2Vsim

Parameter	Case of utilisation	Description (unit of measure)	Value	Default
printDistanceDetails	Always	Activate the print to file of the details on reception rate for distances from 0 up to the max awareness range	Boolean	False
printPRRmap	When *fileObstaclesMap* = true	Activate the creation and print of a PRR map	Boolean	False