Scenario Generation

The RF Simulation is based on a RF Scenario Generation which sets parameters such as positions of RF transmitters / receivers or specific transmitter / receiver characteristics. The scenario parameters and its meanings will be explained hereafter.

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Description

At present 2 sources for scenario generation are available. The block Load Scenario from Spreadsheet utilizes an Excel Spreadsheet for Scenario Definition.

Another option is Load Scenario from File which employs a previously recorded scenario.

As the Scenario Definition the same set of parameters, the Excel Spreadsheet is used for scenario parameter description. An example of a scenario and the parameter description is given below:

Time	ID	Lat	Long	Alt	Roll	Pitch	Yaw	RxTx Type	Ant Type	Gain	Center-Freq	Band-Width	SNR	x	y	z	Technical Parameter	Remark
0	-1	0	0	0	0	0	0	0	0	0	0	10000000	70	70	50	0		
0	0	0	0	0	0	0	0	1	0	10	100190000	3000	120	100	4	0		
0,1	0	0	0	0	0	0	0	1	0	10	100190000	3000	120	-85	4	0		
0,2	0	0	0	0	0	0	0	1	0	10	100190000	3000	120	-70	4	0		

Time

Unit: [s]; Type: float32; range: ≥0; Decimal digits: 4

This is the simulation time at which the parameters (following the Time parameter in the same line) are set. All transmitters and receivers used in the simulation **MUST BE SET** at start of the simulation, i.e. at Time=0.

For **Static Scenarios**, where positions or characteristics settings never change throughout the simulation, the Time column only contains zero's.(see following example)

Time	ID	Lat	Long	Alt	Roll	Pitch	Yaw	RxTx Type	Ant Type	Gain	Center-Freq	Band-Width	SNR	x	y	z	Technical Parameter	Remark
0	-1	0	0	0	0	0	0	0	0	0	0	10000000	70	70	50	0		
0	-2	0	0	0	0	0	0	0	0	0	0	10000000	70	-80	10	0		
0	-3	0	0	0	0	0	0	0	0	0	0	10000000	70	0	0	0		
0	-4	0	0	0	0	0	0	0	0	0	0	10000000	70	-80	--80	0		

0	0	0	0	0	0	0	0	3	0	10	100110000	1000	120	0	0	0		
0	1	0	0	0	0	0	0	1	0	10	100190000	3000	120	-100	4	0		

To simulate **Dynamic Scenarios**, line entries may be added to the table (after the initial Static Scenario entries). These entries may contain the changes of transmitter / receiver positions or their characteristics and the simulation time of respective changes. The Scenario Generation updates the settings tiioupon reaching the given simulation time. See following example:

Time	ID	Lat	Long	Alt	Roll	Pitch	Yaw	RxTx Type	Ant Type	Gain	Center-Freq	Band-Width	SNR	x	y	z	Technical Parameter	Remark
0	-1	0	0	0	0	0	0	0	0	0	0	10000000	70	70	50	0		
0	-2	0	0	0	0	0	0	0	0	0	0	10000000	70	-80	10	0		
0	-3	0	0	0	0	0	0	0	0	0	0	10000000	70	0	0	0		
0	-4	0	0	0	0	0	0	0	0	0	0	10000000	70	-80	-80	0		
0	0	0	0	0	0	0	0	3	0	10	100110000	1000	120	0	0	0		
0	1	0	0	0	0	0	0	1	0	10	100190000	3000	120	-100	4	0		
0,1	1	0	0	0	0	0	0	1	0	10	100190000	3000	120	-80	4	0		
0,2	1	0	0	0	0	0	0	1	0	10	100190000	3000	120	-60	4	0		
0,3	1	0	0	0	0	0	0	1	0	10	100190000	3000	120	-40	4	0		
0,4	1	0	0	0	0	0	0	1	0	10	100190000	3000	120	-20	4	0		
0,5	1	0	0	0	0	0	0	1	0	10	100190000	3000	120	0	4	0		
0,6	1	0	0	0	0	0	0	1	0	10	100190000	3000	120	20	4	0		

ID

Unit: [---]; Type: integer16; range: $-1000 \dots 1000$ *Decimal digits: none*

Every scenario element (i.e. transmitter, receiver) must be assigned an unique ID. Negative ID's are reserved for receivers while all other ID's are transmitters by default. Some applications (i.e. TDoA Emitter Localization) require a reference transmitter. For these applications ID=0 is the reference transmitter. Receivers must be assigned first in the table, followed be transmitters (with ID=0 being the first). After the Static Scenario, update of ID's requires no specific order. Note that definition of new transmitters/receivers after the Static Scenario is prohibited.

Lat,Long,Alt

*Unit: [deg] (***Lat,Long***) [m] (***Alt***) [m]* **(x,y,z)***; Type: float32; range: (***Lat***)* $-90 \dots 90$ *(***Long***)* $-180 \dots 180$ *(***Alt***)* $0 \dots 100000$*; Decimal digits: (***Lat,Long***) 8 (***Alt***)* 2

`Lat,Long,Alt` define the transmitter / receiver positions (WGS84 format). Transmitter / receiver positions can be set in a local coordinate system (see columns `x,y,z`) with the transmitter (ID=0) being the center position.

`Lat,Long,Alt` is used (instead of `x,y,z`) if `Lat,Long` and `Alt` is all non-zero and `x,y,z` is all zero. Otherwise `x,y,z` is used instead.

If `Lat,Long,Alt` is used, it will be internally converted to the local coordinate system.

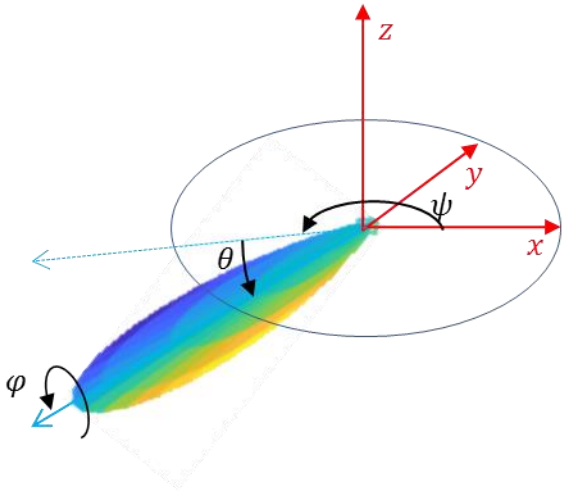
Note: All computation in the RF simulation takes place in the local coordinate system `x,y,z`.

Roll,Pitch,Yaw

Unit: [deg]; Type: float32; range: Roll, Yaw: $\{-180, 180\}$*; Pitch:* $\{-90, 90\}$*; Decimal digits: 2;*

Orientation: Roll: in x,y-plane, Yaw: in x,z-plane, Pitch in x,y-plane; for all: positive in direction of arrow.

These parameters set the orientation of transmitter and receiver antennas in a local antenna coordinate system (see figure below). The respective antenna type is defined by **AntType**. The RF simulation uses the antenna orientation to compute the resulting signal power at the receivers.



Orientation of antenna angles (Example of a Radar Beam-Antenna) with $\{\boldsymbol{\varphi = Roll};\ \boldsymbol{\theta = Pitch};\ \boldsymbol{\psi = Yaw}\}$

RxTxType

Unit: [---]; Type: integer16; range: $-32768 \ldots -1,\ 1 \ldots 32768$ *(Note: 0 is not allowed); Decimal digits: none*

For all receivers (i.e. ID's < 0) this parameter defines the SDR being used. Currently available receivers are:

SDR	RxTxType	Simulation-Model	Physical	Comment
IdealSDR	1	yes	no	Ideal SDR receiver (no noise, distortion, etc.)
HackRF	2	yes	yes	HackRF One
B200mini	3	Yes	yes	Ettus B200mini

Note: The actual list of usable SDR is available here:
6300_SIG_SW1_SIGENCE_System\03_Blocks\html\SDR_ModelList.docx

If **negative**, RxTxType defines the physical SDR (where the signal is received from the Ether). For e.g., RxTxType = 1 defines a "HackRF One" SDR (Simulation Model) while RxTxType = -1 defines the respective "HackRF One" SDR (Physical). For some SDR, only a physical of a simulation model is currently available (see list above for details).

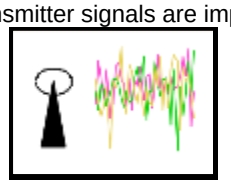
All receivers are implemented in the Software Defined Radio block:

For transmitters (i.e. ID's >= 0) this parameter defines transmitter signal type. Currently available transmitters are:

RxTxType	SDR (Designator)	Comment
1	QPSK	QPSK Signal with 2kHz Bandwidth
2	SIN	This is a Sine Generator a 500Hz Frequency
3	FM Broadcast	This is a FM Broadcast Radio Transmitter (AWGN Noise Signal) with input 20kHz Signal and 50kHz bandwidth
4	GPS Jammer	10MHz L1 GPS Jammer
5	Iridium	Iridium Satcom Transmitter
6	LTE	LTE Signal
7	AIS	AIS Signal
8	NFM Radio	Narrow FM Band (Voice with 5kHz bandwidth)

RxTxType	SDR (Designator)	Comment
9	GSM	200kHz GSM signal with random data
10	S-Band Radar	SIMRAD's Argus S-Band Radar

The transmitter signals are implemented in block GeneratesTxSignals:

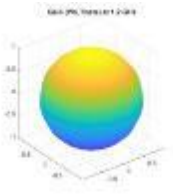
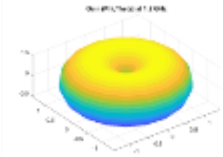
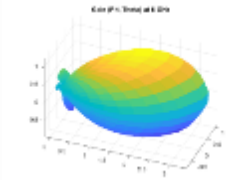
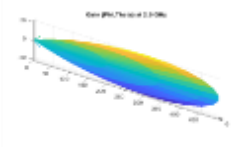


AntType

Unit: [---]; Type: integer16; range: 0 ... 10000*; Decimal digits: none*

`AntType` defines the antenna type used for transmitter and receiver respectively.

Currently available Antennas are:

Antenna	Antenna Type	Comment	3D-Antenna Pattern Image	Antenna Model Description
OmniDirectional	0	Isotropic radiator (always gain 1)		
Dipole	1	Dipole		Run in the Matlab command window: `open('0001_DipolAntenna.mlx')` Note: Dipole length can be set in the Antenna Model: `'0001_DipolAntenna.mlx'`
Hyperlog60100	2	Aaronia beam antenna		Run in the Matlab command window: `open('0002_perlog_Aaronia_Hyperlog60100.mlx')`
OmniLog30800	3	Aaronia omni antenna **NOT YET IMPLEMENTED**		TBD
IsoLog3Dmobile	4	Aaronia isotropic antenna **NOT YET IMPLEMENTED**		TBD
SimradArgusRadar	5	Simrad S-Band Argus Radar		Run in the Matlab command window: `open('0005_pulseRadar_SIMRAD_Argus-S.mlx')`

Gain

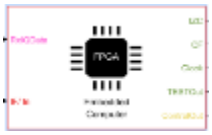
Unit: [dBm]; Type: float32; range: 0 ... 1000*; Decimal digits: 2*

For transmitters (i.e. ID's >= 0) this parameter defines transmitter signal power [dBm]. For receivers (i.e. ID's < 0) this parameter is currently unused.

CenterFreq

Unit: [Hz]; Type: float32; range: $0 \ldots 10^{11}$*; Decimal digits: 2*

For transmitters (i.e. ID's >= 0) this parameter defines transmitter signal center frequency. For receivers (i.e. ID's < 0) this parameter is currently unused.
Note: This parameter is currently unused. Instead, the receiver bandwidth is set within the Receiver Terminal (block Embedded Computer)



BandWidth

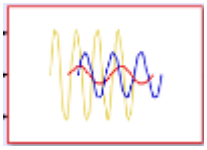
Unit: [Hz]; Type: float32; range: $0 \ldots 10^{11}$*; Decimal digits: 2*

Note: **BandWidth** is unused will be removed from the Scenario in the future. For transmitters the bandwidth is inherently set in the respective signal generation, while the bandwidth for the receivers is set by the Receiver Terminal application which controls the SDR bandwidth.

SNR

Unit: [dB]; Type: float32; range: $-1000 \ldots 1000$*; Decimal digits: 2*

Defines the Ratio of signal power to noise power.
For **receivers (i.e. ID's < 0)** this parameter is imposes Gaussian White Noise to the respective receiver signal. For transmitters (i.e. ID's >= 0) this parameter is unused.
The White Noise is added to the receiver signals in block 'Impairments':



x,y,z

Unit: [m]; Type: float32; range: $-10^6 \ldots 10^6$*; Decimal digits: 2*

x,y,z define the transmitter / receiver positions in a local coordinate system with the transmitter (ID=0) being the center position.

TechnicalParameters

Unit: [---]; Type: string; range: – Decimal digits: <255

Text field for future purposes. This field shall contain individual commands to be used in the RF Simulation (e.g. to command specific settings in the Radar Signal Generation) .

Remark

Unit: [---]; Type: string; range: – Decimal digits: <255

Comment field to be used for clarification purposes. This field will not be evaluated by the RF Simulation.
TechnicalParameters

Outputs

- ***Scenario***: Scenario Bus with following elements:

  `x,y,z,ID,Lat,Long,Alt,Roll,Pitch,Yaw,SNR,Gain,RxTxType,AntType,CenterFreq,BandWidth`

  The Dimension of Scenario Bus is [Number of Transmitters + Number of Receivers]