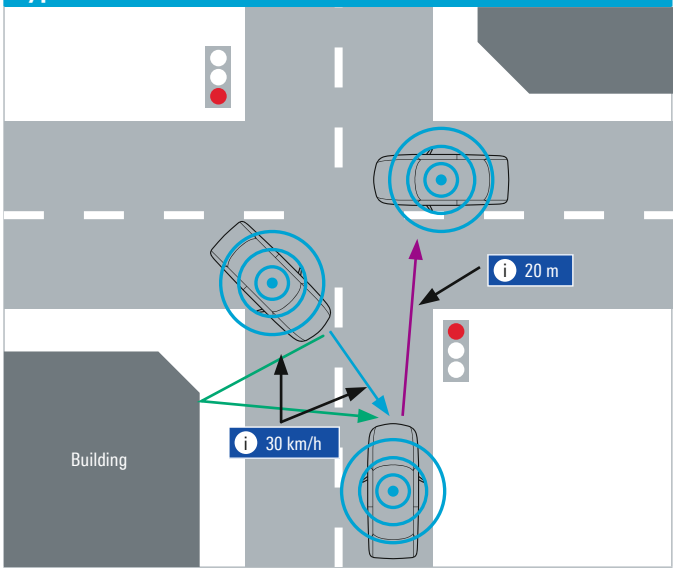
Reproducible receiver tests under car-to-car fading conditions

In car-to-car communications scenarios, fading is always present and has an enormous impact on the received signal. The R&S®SMW200A vector signal generator lets you perform the most accurate and reproducible receiver tests under car-to-car fading conditions. The required car-to-car radio channel models have been extracted from real field trials and specified by the CAR 2 CAR Communication Consortium. Now it is possible to verify receiver performance under controlled conditions in the lab.

Typical car-to-car communications scenario



Introduction

In car-to-car communications scenarios, vehicles wirelessly share information and warning messages with each other. The information is only broadcast – there is no feedback. Currently, a good candidate for establishing the communications link between the vehicles is the IEEE 802.11p WLAN standard. Well-established vehicle sensors, e.g. radar sensors, cameras and tachometers, already provide information about distances to surroundings and velocities. Through sharing information, critical traffic situations such as collisions can be detected. The vehicles then display messages to warn the drivers so that they can initiate countermeasures to avoid accidents or create a better traffic flow. As a result, the number of injured people, material damage and congestion can be greatly reduced.

Your task

Car-to-car communications systems require a stable wireless link to maximize the throughput of information, which increases driver safety. To ensure a good wireless link, receivers must be able to detect signals such as IEEE 802.11p even under the worst conditions, e.g. low signal-to-noise ratio (SNR), poor error vector magnitude (EVM) and heavy fading. In car-to-car communications scenarios, Rayleigh fading, which is caused by relative movements between receivers and transmitters, mostly impairs the performance of receivers. In general, fading is caused by multipath propagation of a transmitted signal. The received signal is the sum of all signals traveling along multiple paths. Each path can influence the amplitude, phase, Doppler shift and time delay of the signal. The major challenge engineers face in the lab is to apply to signals the fading models that best characterize the multipath propagation behavior of car-to-car communications scenarios. Only then can receivers be properly tested in the lab during the development and verification cycle to determine how well they detect signals under car-to-car fading conditions.

T&M solution

The R&S®SMW200A vector signal generator equipped with the R&S®SMW-B14 fading simulator and the R&S®SMW-K72 enhanced fading models options is ideal for applying car-to-car fading conditions to signals such

as IEEE 802.11p in order to create the most accurate and reproducible receiver test cases. The R&S®SMW-K72 enhanced fading models option supports all car-to-car radio channel models specified by the CAR 2 CAR Communication Consortium:

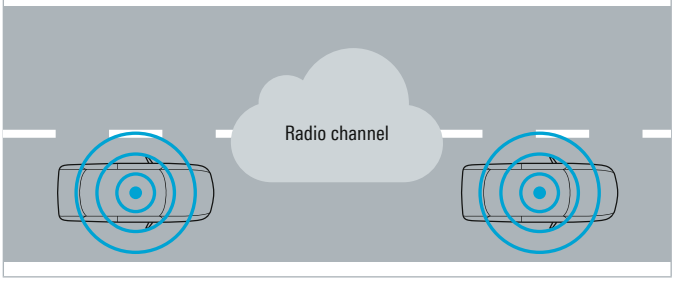
- Rural line-of-sight
- Urban approaching line-of-sight
- Street crossing non-line-of-sight
- Highway line-of-sight
- Highway non-line-of-sight

As an example, the rural line-of-sight radio channel model will be described in more detail.

Rural line-of-sight radio channel model

Independent field trials have been performed by universities and companies to determine statistical models for different car-to-car radio channels, such as for the rural line-of-sight scenario depicted below.

Rural line-of-sight scenario



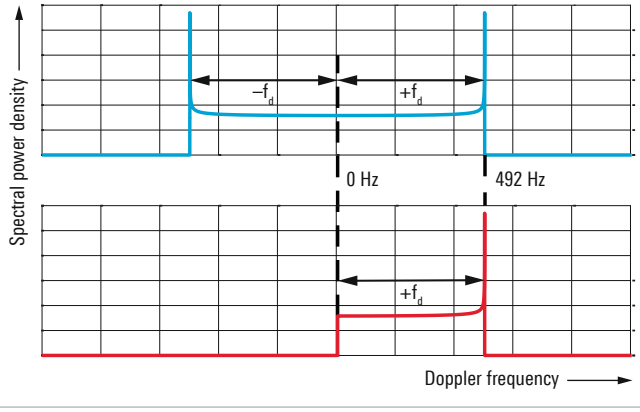
The rural line-of-sight scenario is a wide-open environment free of buildings, large objects and other vehicles. The configuration specified by the CAR 2 CAR Communication Consortium for the rural line-of-sight radio channel model is shown in the following table.

Rural line-of-sight configuration

Parameters	Path 1	Path 2	Path 3
Path loss	0 dB	14 dB	17 dB
Delay	0 ns	83 ns	183 ns
Doppler	0 Hz	492 Hz	–295 Hz
Profile	static	half Rayleigh	half Rayleigh

The configuration is based on three paths. Each path contains a specified path loss, delay, Doppler frequency f_d and distribution profile of the Doppler spectrum. The CAR 2 CAR Communication Consortium defined just one-half of the classical Rayleigh Doppler spectrum as the distribution profile for specific paths. The half Rayleigh Doppler spectrum is better suited than the full Rayleigh Doppler spectrum for the car-to-car radio channel models. A typical distribution profile of the positive half of the Rayleigh Doppler spectrum of path 2 for the rural line-of-sight scenario is depicted below.

Normalized Rayleigh Doppler spectra



Thanks to the powerful fading capabilities of the R&S®SMW200A vector signal generator, engineers benefit from the R&S®SMW-K72 enhanced fading models option during all stages of receiver testing for car-to-car communications scenarios. All five car-to-car radio channel models can be easily applied to signals such as IEEE 802.11p. The user can fully focus on receiver testing without spending valuable time defining and implementing the car-to-car radio channel models. This is a quick and convenient way to simulate real-world car-to-car communications scenarios under lab conditions. Creating receiver test cases under real-world car-to-car fading conditions becomes simpler than ever before.

Key benefits

- Supports all five car-to-car radio channel models
- Brings real-world, car-to-car radio channels to the lab
- Lets you create reproducible receiver test cases under controlled fading conditions in car-to-car communications scenarios
- Simplifies signal generation under car-to-car fading conditions
- Allows engineers to fully focus on receiver testing

See also

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