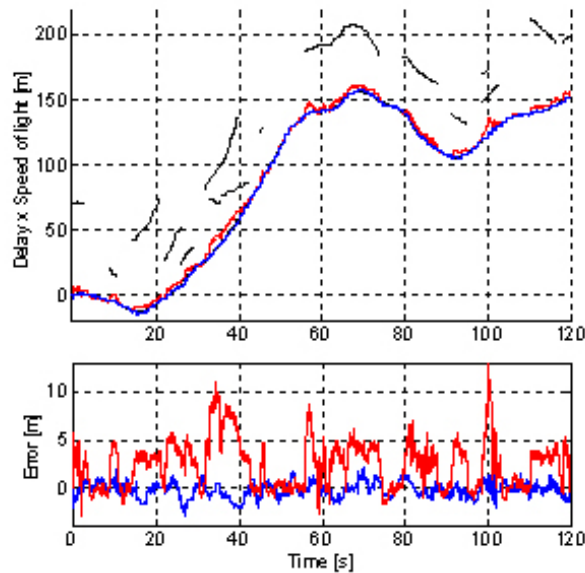


Multipath Mitigation

Above channel models are used in computer simulations in order to validate the performance of new multipath mitigation algorithms. Multipath mitigation has become an important activity at the Institute. We follow a very promising approach based on sequential Bayesian estimation. Its implementation by particle filtering methods allows us to achieve an excellent performance complexity tradeoff. Our approach incorporates the estimation of the number of echoes, their delays and complex signal amplitude.



Typical urban multipath scenario. Upper part: The black segments visualize the LOS path (hidden below the blue curve) and signal echoes, the red curve shows the LOS estimate of an advanced state-of-the-art receiver (narrow correlator with 0.1 chip spacing), the blue curve shows the LOS estimation result for the DLR receiver. The bias between LOS estimation and LOS path directly translates into the user equivalent range error which for this channel reaches 10m in case of the advanced state-of-the-art receiver and reduces considerably when the DLR algorithms are applied.

DLR at a glance

DLR is Germany's national research center for aeronautics and space. Its extensive research and development work in Aeronautics, Space, Transportation and Energy is integrated into national and international cooperative ventures. As Germany's space agency, DLR has been given responsibility for the forward planning and the implementation of the German space program by the German federal government as well as for the international representation of German interests. Furthermore, Germany's largest project-management agency is also part of DLR.

Approximately 5,700 people are employed at thirteen locations in Germany: Koeln (headquarters), Berlin, Bonn, Braunschweig, Bremen, Goettingen, Hamburg, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Stuttgart, Trauen and Weilheim. DLR also operates offices in Brussels, Paris, and Washington D.C.



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Information



Channel Modelling for Radio Navigation



Channel Modelling for Radio Navigation

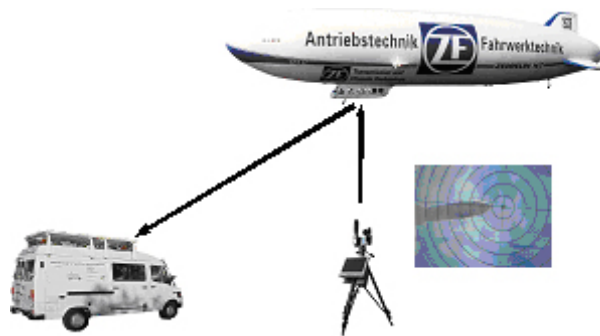
A satellite navigation receiver estimates the propagation time of the signals on their way from the satellite to the receiver. These estimates are further processed in order to provide an estimate of the user's position. The same principle is also applied for mobile radio based localisation.

In order to precisely estimate the propagation time the signals should propagate distortion-free and under line-of-sight (LOS) conditions. However, such ideal propagation conditions are almost fulfilled under practically no circumstances: multipath reception is an omnipresent phenomenon in almost all environments and LOS is not always experienced.

In satellite navigation multipath propagation is caused by the presence of numerous reflectors in the nearby vicinity of the receiver. Thus, undesirable signal echoes arrive at the receiver shortly after the reception of the direct LOS signal. They may prevent the receiver from precisely estimating the propagation time of the LOS signal. The determination of the user's position is even more difficult when signal echoes arrive at the receiver with strong signal power. Moreover, in urban canyons and indoor environments the LOS path may not even be available. Such situations are very challenging to cope with and require effective multipath mitigation algorithms. In turn, the development of these algorithms requires exact knowledge of the propagation behaviour. This knowledge has been obtained in the framework of various DLR measurement campaigns. The measurement results are the basis for accurate channel models. They are used in computer simulations to assess the performance of advanced satellite navigation receivers.

Measurement Campaigns

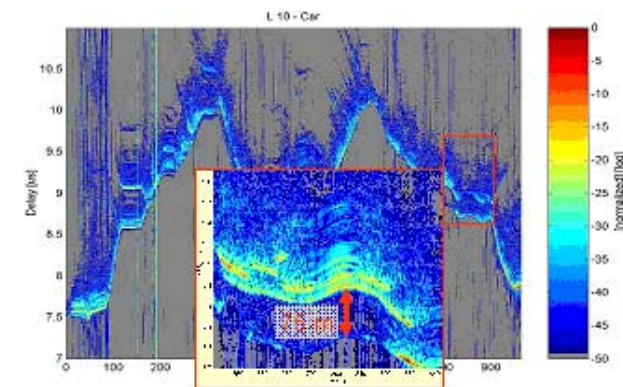
The Institute of Communications and Navigation of DLR has carried out measurement campaigns for aeronautical applications focussing on final approach and landing and for land-mobile scenarios, such as urban, suburban and rural environments for car and pedestrian users. Recent measurements have been carried out by the Institute to assess both the satellite-to-indoor environment and the mobile terrestrial propagation conditions at L and C band. The set-up of the land-mobile measurement campaigns is shown in the Figure.



Set-up of DLR's land-mobile propagation measurement campaign for urban, suburban and rural environments. The transmitter was located in a Zeppelin, thus emulating a navigation satellite. The receiver is onboard the DLR measurement van. A positioning station is used to allow the pilots to maintain their target position for each measurement sequence.

Channel Modelling

DLR's channel modelling activities resulted in the standardisation of the aeronautical satellite navigation channel model within ITU-R P.682-2 "Multipath model for aeronautical during approach over land and landing". This model describes the multipath behaviour for a satellite navigation receiver onboard an aircraft. The model follows a classical tapped-delay line approach taking into account different flight levels, aircraft speed and sink rate and reflections from both the aircraft and the ground.



Multipath reception for a typical urban environment. The figure shows a 10 minutes snapshot of the channel impulse response revealing severe echoes with varying delays and substantial received power. It also shows a situation with a severely shadowed LOS path and diffracted signal paths with strong received power. A conventional receiver experiences a corresponding bias of 75m.

The measurement campaign for the mobile terrestrial channel shall complement existing channel models by parameters describing line-of-sight characteristics and absolute delay of received signal components. For indoor reception we envisage the development of a new channel model.