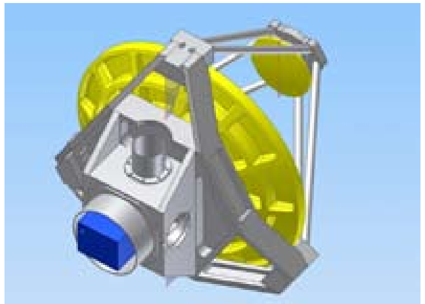
Future Challenges

The applicability of Mobile Free-Space Optical Communications for operational scenarios requires development and qualification of components and systems for the aeronautic, stratospheric, and space environment. All these fields are covered by activities of the group.

OCG is also involved in the development of Adaptive Optics for Free-Space Communications. This technology will enable near diffraction limited communication also through the turbulent atmosphere, bringing optical links near to their theoretical performance limits.



Design of a Transportable OGS Telescope (TOGS)

Aeronautic Optical Downlink Terminal

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

Optical Free-Space Communications

DLR

Laser Links for High Data Rate Communications

Prospects of Optical Free-Space Communications

Optical Free-Space Transmission is a very effective way to transmit information from point to point with lowest transmit power and at highest data rates. While systems operating at radio frequencies require comparatively high power consumption and large antenna structures, are subject to frequency regulation, and are limited in data rate, the optical technology does not have these drawbacks and can already today transmit data at up to several gigabits per second. This will lead to an extreme size and power reduction while enabling new applications which are not feasible with existing RF-technology.

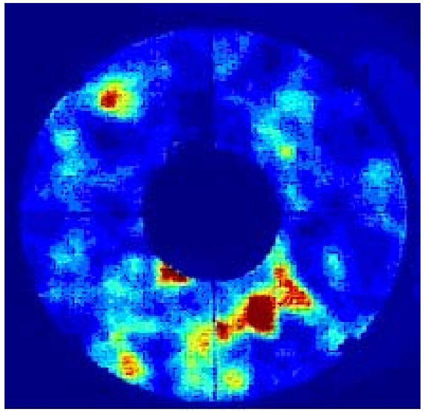
Application Scenarios for Mobile Optical Communications: From inter-satellite links to aeronautical links down to terrestrial scenarios

The main physical advantage of using optical frequencies is the drastically reduced transmitter beam divergence. This also implies one of the challenges of mobile optical links as the communication partners need to be aligned precisely to keep up the link. The Optical Free-Space Communications Group (OCG) as part of DLR's Institute of Communications and Navigation Investigates all scenarios that are feasible at the moment and in future.

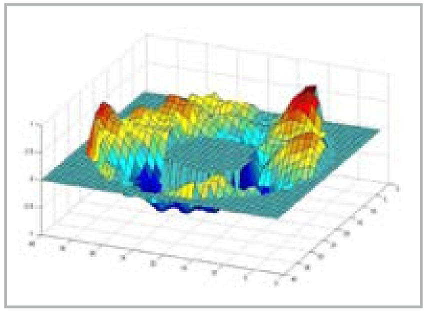
Atmospheric Effects

When performing optical links through the atmosphere, the deteriorating physical effects of the traversed air volume need to be considered. These effects are the absorption and scattering of optical signals, the attenuation by fog and clouds, and the wavefront distortion caused by thermal atmospheric Index-of-Refraction Turbulence (IRT).

The later effect is similar to the problems astronomers face when they want to use large-aperture high resolution telescopes. In optical communications, several techniques can be used to mitigate the IRT-influence.



Scintillation Pattern caused by IRT



Distorted Wavefront, measured at a 1m Telescope

Real-World Technology Evaluation

Heritage of „Firsts“

The OCG has developed and performed several firsts in the field of Optical Free-Space communications. The Free-Space Experimental Laser Terminal „FELT“ was developed for operation in the stratosphere and flew in August 2005 onboard a scientific balloon from Kiruna, Sweden. It transmitted data at 1.25Gbps from 22km altitude inside the stratosphere to a transportable optical ground station over a distance of up to 64km.

World's First Stratospheric Optical Downlink Terminal

In June 2006 the group used the OGS-OP (Optical Ground Station Oberpfaffenhofen) to perform optical data reception from the Japanese Test Satellite „OICETS“ at 600km orbit altitude. During several satellite-overflights digital data was received with uncoded bit error rates down to 2e-6. This was another „First“ on European grounds, while the partners in Tokyo performed similar trials in parallel.

OGS-OP during the first Optical Data Downlink from a Low-Earth-Orbit Satellite in Europe