Optoelectronic solutions for remote sensing and optical wireless communications

Acreo has experience in the design and development of optical fiber communication systems, including laser transmitters, optical receivers, specialty fibers and optical fiber amplifiers. Acreo is currently conducting research on the next-generation systems employing advanced modulation formats and coherent optical signal detection techniques for achieving up to 1Tbps transmission rate at each wavelength channel.

The large investments have been made in the development and production of components for the telecommunications market. Today, a large number of cost-optimized and high performing optoelectronic components are available.

High performing components together with know-how from the fiber optic communication can be applied to other areas where the optical system characteristics such as high power, signal stability, accurate modulation, advanced noise characteristics and signal processing is central. Based on many years of experience within telecommunications Acreo offers development of Optoelectronic Solutions in application areas such as e.g. remote optical sensing employing coherent LIDARS, laser-based distance measurement systems, and optical wireless or free-space communications.

Laser sources for optical remote sensing

The development of cost-effective, compact and reliable laser pulse sources for remote optical sensing applications is requested from many segments of industry to mention such important cases as optical positioning and ranging, remote 3-D imaging or scanning, and distant measurements of velocity (of moving objects, wind, aerosols, etc.).

In this context the knowledge and the technology that have been gained in the field of optical fiber communications over several decades can be efficiently utilized. It has been proven that off-the-shelf telecom components such as transmitter lasers and optical receivers, optical fiber amplifiers and their basic components represent an effective tool-box for designing high-performance all-fiber systems for LIDAR and remote sensing applications. All-fiber systems that are based on mature telecom components have many advantages. They are operating at the eye-safe wavelength. They are stable under vibration, shocks, and temperature variations. They are characterized by long lifetime and require very low, if any, maintenance. In addition, the system outline is very flexible. Thus, all-fiber systems are expected to become a choice for many practical applications.

New perspectives for optical wireless communications

In recent years we have seen a growing international interest in research and development in optical wireless communication systems. Traditionally, the optical wireless communication technology that is often called free-space optics technology relies on high power lasers for medium to long range applications. Free-space optics technology has been around for decades, but price and physical size have prevented the technology from being used for mass market deployment.

Over the last years we have seen remarkable advances in semiconductor sources such as light emitting diodes and lasers in infrared, visible and ultraviolet wavelengths, multi-array light sources and detectors, tracking and steering. These advances provide huge potentials for short to medium range optical wireless communication applications at a low power and a low cost.

Optical wireless communication technology uses completely different parts of the electromagnetic spectrum to regular radio-based wireless communications technologies. It doesn’t have the problem of limited spectrum available for data transmission and other disadvantages related to the physical properties of radio waves. Optical wireless systems may use components that are similar to those used

in fiber optical systems and may provide same high data rates as fiber but without the cost associated with fiber deployment. Different from radio waves radiating in all directions and penetrating through walls, optical signals can be easily localized in spots or even focused making it nearly impossible to intercept. This feature manifests in a number of advantages. Optical wireless products do not require any license for operation worldwide. Nonintrusive optical wireless solutions can be used in locations where radio wave pollution is prohibited, e.g. in hospitals, aircrafts and industrial facilities. In majority of application scenarios using optical signals does not cause any health concerns.

The interest to optical wireless communication is empowered by quickly developing infrastructure of light sources that are intended for applications other than data communications but having attractive modulation bandwidth capabilities. One example is the future light illumination infrastructure. The light emitting diodes that are replacing today the old-fashion light illumination bulbs are going to be available practically everywhere and be utilized for high-speed data communication. In the view of such perspectives, the future potentials of the optical wireless communications are beyond what is thinkable today.

Previous experience:

- Development and performance characterization of optoelectronic components and subsystems for optical fiber communications: Erbium-doped fiber amplifiers (EDFA), Raman amplifiers, laser signal sources, modulation formats, laser phase noise, etc.
- Kilowatt-peak-power Master Oscillator Power Amplifier (MOPA) laser source for distance measurement system. Cost-effective design based on components developed for optical fiber communications, optimized for achieving very stable laser pulses with high peak powers.
- Laser phase noise characterization and impact on the performance of high-speed optical fiber communication systems based on optical coherent receivers with digital signal processing.
- Development of advanced modulation format for optical wireless communication systems.
- Development of compact low-cost free-space optical (FSO) communication system for access networks. Custom design of small form factor transceivers, laser beam tracking and self-alignment solutions for compact FSO terminals.