RF photonic integration technology for phased array antenna systems

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Introduction

RF Photonics employs optical technology to implement the functions which are traditionally realized in RF domain, overcoming the limitations of the corresponding all-RF implementations. We are currently involved in several projects on RF Photonics applied to wireless communication systems, especially to phased array antenna design for airborne and radio astronomy applications. Photonic solutions are proposed to implement several of the desired functions. The main interest in the present research projects is the integration of the different RF photonic components on a single hybrid platform.

Optical heterodyning

In some applications, the RF signals received by the antenna elements need to be down-converted, prior to further processing. In this implementation, the mixer employs a very stable local oscillator carrier, generated by optical heterodyning of two lasers.

Integrated optical beam forming networks

The optical beamformer delays and combines the signals from the antenna elements in the optical domain to create the desired radiation pattern.

- The optical filter implements the desired SS-B 3G modulation scheme
- DBPN and filter are integrated on a single optical chip fabricated in TriPleX™ waveguide technology by LionIX BV
  - True time delay units based on optical ring resonators
  - Frequency periodic behaviour
  - Thermal tuning mechanism

In case of large number of antenna elements, multi-wavelength binary tree architectures allow to keep a low level of complexity for the beamformer

- A careful phase and amplitude matching, an IMD suppression of 40dB is obtained

Broadband analog optical links

In case of extended receiving stations (e.g. large radio telescope arrays) antenna remoting can be achieved by using a high dynamic range broadband analog optical link.