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# D-band RF Architecture for Beyond 5G Wireless Networks: Specifications, Challenges, and Key Enabling Technologies


## SHORT ABSTRACT OF PRESENTATION

The D-band (110–170 GHz) could offer unprecedented data rates to mobile devices thanks to the use of huge non-contiguous frequency bands. Indeed up to 32 GHz band can be aggregated, allowing > 100 Gbps wireless data rate, for many short- or medium-range applications. Moreover, the most advanced BiCMOS technology (B55x) is pushing forward its maximum operating frequencies (ft/fmax), bridging the gap between pure SiGe and III-V technologies.

This mirage tends to vanish when trying to design transceivers and antennas at such frequencies, tackling big propagation (e.g. 96 dB at 10 m at 150 GHz) and implementation losses. If antenna array and beamforming scheme are suitable to provide antenna directivity, system gain and agility to transceiver at millimeter waves (mmWaves), the approach faces major issues when the frequency is so high. First the half-wavelength antenna pitch (~1 mm) imposes difficult constrains on the transceiver chip size, package assembly, antenna feeding routing, scalability, and heat dissipation. Next, the design of the RF phase shifters at D-band and over such wide bandwidth leads to awkward RF impairments, important losses, and huge power consumption.

In this context, this work focuses on the system definition and circuit specification on the "Future-G transceiver" demonstrator of the SHIFT project. After an analysis of the system requirement, we explore the architectural and technological options for the design of D-band transceivers and propose few key-enabling technologies for wireless access and backhauling, focusing on scalable and reconfigurable antenna schemes.

Channel aggregation and multi-tone frequency synthesis are first proposed to tackle the disseminated bands and bandwidth issues. Next, at the transmitter side, we describe a heterogeneous integration of a BiCMOS transmitter chip with III-V power amplifiers, and the beamforming antennas onto an RF interposer package to increase the radiation power. At the receiver side, a BiCMOS chip is optimized to reduce its noise figure and implementation losses, by the use of "in-local oscillators" phase shifters. Indeed, the transceiver local oscillators (Los) embed frequency multipliers (from a common frequency reference), raw delay-line phase shifters, and fine phase shifters based on an innovative injection locked oscillator (ILO) architecture. The ILO varactor is finely tuned to realize the desired phase shift according the Adler's theory. This approach reduces the losses in the RF path, provides versatility in the choice of the carrier frequency, and generates very low phase noise, allowing the transmission of higher order modulation schemes.

## KEYWORDS

D-band, analog beamforming, LO phase shifters, injection locked oscillators

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## BIOGRAPHY

**Cedric Dehos**, born in 1980, joined CEA Leti, Grenoble, France, in 2003 after graduation from ESIEE Paris (Dipl.-Ing. and M.Sc. degrees) in telecommunication and signal processing. Since then, he has been involved in system-level design of complex RF and digital base band circuits including RF behavioral modeling, architecture design and specification, system simulation, and base band signal processing. His main topics of interest included ultra-wide band systems, digital compensation of RF impairments, and antenna beamforming. Since 2006, he has been involved in various mmWaves developments in CMOS or BICMOS technologies, including 24/79 GHz short range radars, 60GHz WiGig. In 2011, he led Leti mmw designs and began moving the developments towards 5G small cells, promoting the use of mmw bands for 5G, and towards short-range chip-to-chip communications and contactless connectors. More recently, he proposes architecture for channel aggregation in D-band, targeting >100 Gbps wireless communication. He has been involved in many collaborative projects funded by European Commission, as well as in many industrial bilateral projects with transfer of technology. He is also active in the promotion of mmw wireless technologies for particle physics with CERN.