Telecom Platform at IEMN / IRCICA

Real-Time Open Multiuser RF Communication Test-Bench with Controlled Channel

One of the flagship projects of IEMN / IRCICA is focused on energetically autonomous Wireless Sensor Networks (WSN). The most of WSN transmit the data in the Industrial, Scientific and Medical (ISM) bands. The most popular 2.4 GHz ISM band accessible worldwide become overloaded due to the presence of different technologies as Wifi, Bluetooth or ZigBee. The fact of sharing the medium generates interferences between signals. Interference is a big issue for WSN that impacts both critical aspects: Quality of Service (QoS) and energy efficiency. To properly study the effects of the RF channel, a real-time open RF test-bench platform located in the IRCICA laboratory (Université Lille1) has been developed. This test-bench provides to the users the possibility to develop and test hardware and software solutions in **real-time** in the field of Digital Signal Processing, MAC-layer algorithms or Source and Channel coding in a **controlled environment**. With this platform, we are able to measure the impact of RF channel, interference and collisions between the nodes on the QoS. Moreover, we can evaluate the dependency between QoS and energy consumption of the devices.

Several professional instruments in RF communications have been integrated in the test-bench. The heart of the test-bench is a PXB N5106A Baseband Generator and Channel Emulator from Agilent Technologies. With this advanced tool, the user can emulate a channel for digital communications with different conditions. We can choose among multiple presets of configurations (e.g. communication between base station and fixed or mobile user for different technologies) or define its own configuration setup. We are able to widely modify a large set of parameters as the fading distribution (Rician, Rayleigh…) or the speed between the transceivers (e.g. device moving in a train at 300 km/h). Other instruments connected to the PXB extend the variety of end point devices by giving the possibility of using real RF sources. An ESG Vector Signal Generator is used as an advanced RF modulator and a high-end PXA Signal Analyzer is used as a RF demodulator. This setup allows to study an end-to-end full RF communication system.

In the case depicted below, we evaluate the communication between two commercially available 2.4 GHz transceivers (TelosB). The transmitter is connected to the first PXA which converts the RF signal to digital baseband information. This information feeds the PXB that can modify it, according to the chosen emulated channel model. The transformed baseband I and Q signals pass towards the ESG (RF modulator) which converts them back to RF signal and allows to choose the carrier frequency between 250 kHz and 6 GHz. The signal is finally demodulated by the receiver (Telos B).

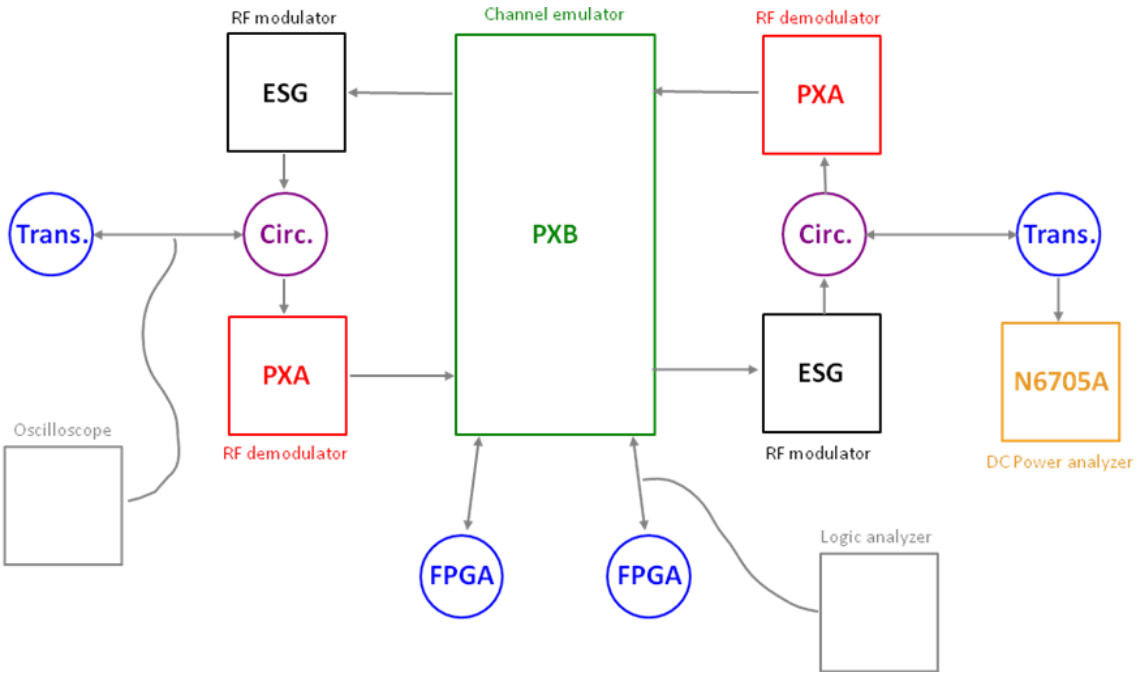
A **bidirectional** communication is enabled by adding another pair of PXA and ESG for the return way of the information. Two circulators are included to separate up and down communication links.

This test-bench provides the possibility to emulate the RF medium shared between different technologies. For that, we can implement a specific user defined technology in FPGAs with a large degree of freedom. These FPGAs are attached to the test-bench and contributes to the multiuser aspect of the platform. Signals from both type of devices, TelosB transceivers and FPGAs, share the same channel in PXB, as in real life.

In addition, energy measurements in the devices can be made using an N6705A DC Power Analyzer. We can verify the relation between the QoS and the energy consumption. Finally, a logical analyzer and an oscilloscope are connected to the system to act as a debugger.

Thanks to this test-bench we can obtain interesting results. We can have a global vision on the performance of the communication system by analyzing its different characteristics: QoS (BER, PER, number of packet retransmissions due to the interference), EVM, energy efficiency of the components.

Schematic of the test-bench



View of the test-bench