Solution Brief

Radar testing using low latency digital approach

Radar technology is used heavily in military applications, commercial aviation applications, and is increasingly being used in automotive applications for collision avoidance, driver assistance, and autonomous driving.

For R&D or factory automated tests, VadaTech provides modular solutions for high-speed data processing based on low-latency digitizer and data converter.

The demonstration of a system tested for automotive radar sensor testing performed jointly between VadaTech and Keysight teams is illustrated in this solution brief.

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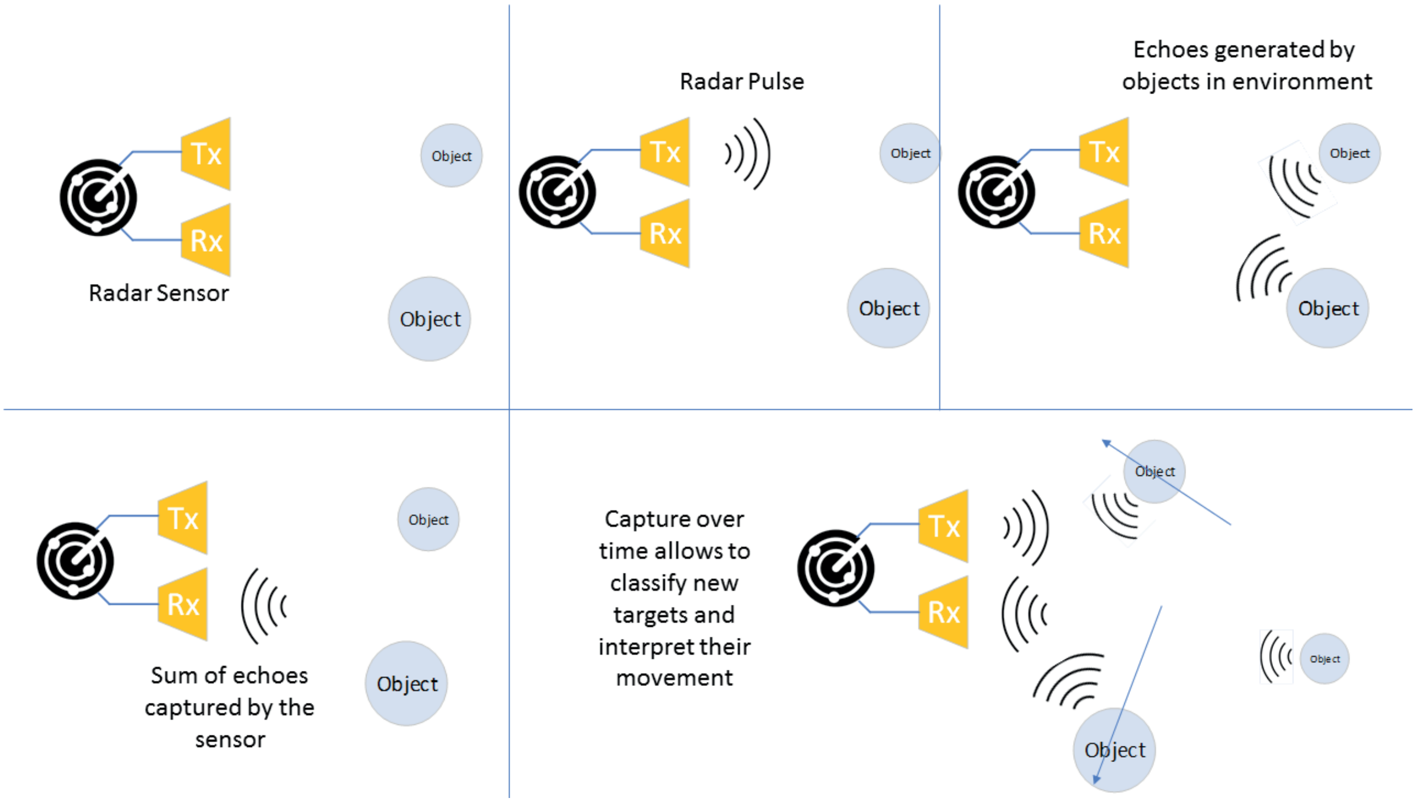
Simulated Radar Echoes for Stable Test Environment



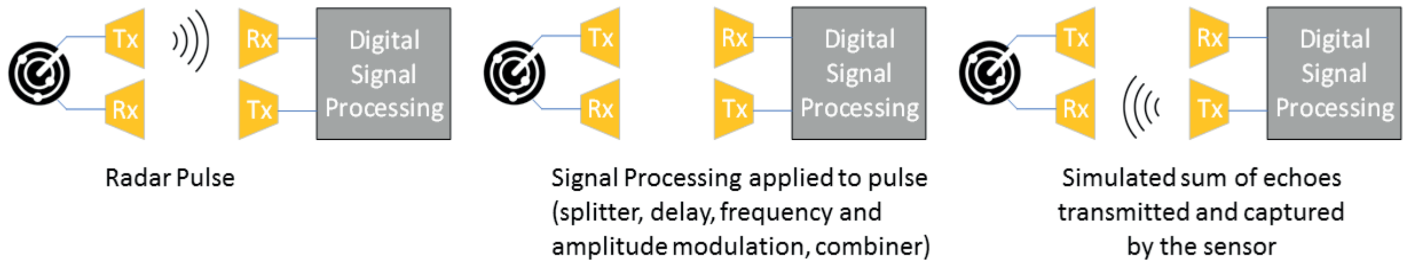
Radar sensors detect targets, associated speed and distance relatively to the radar by sending out a radar pulse over the air and interpreting the echoes generated by the targets present. There will be multiple target echoes with arbitrary delays, multiple echoes from the same target with different time of arrival caused by multi-path, and all kinds of Doppler Effect-related clutter and frequency shifts due to either the transmitter and/or the target's relative speeds. The instantaneous amplitude and phase for a given echo will be also controlled by the target's shape and size. This can be interpreted and targets can be classified accordingly by the radar and associated algorithms (illustrated above). Let's assume that the target is able to actually capture the pulse, this capture can trigger awareness that it's being targeted by a radar. If the target can in addition modify the echo with a different signature and retransmit quickly enough to the radar sensor, then the radar will interpret the target "modified echo" instead of the intrinsic echo of the target.

To create a test environment without actually moving all sorts of targets around the radar sensors the above technics can be used to modify the radar pulse according to some parameters which are going to be interpreted as a selected type of moving targets (illustrated next page).

For example (with simplification) the distance between the object and the radar sensor is simulated by delaying the echo, speed is simulated by shifting the frequency, and size is simulated by attenuating the signal.

Demonstration with Keysight for Automotive

VadaTech and Keysight teams have worked jointly to demonstrate the ability to develop such radar test system with Commercial Off The Shelf (COTS) open standard products. A simplified diagram of the setup is shown below:



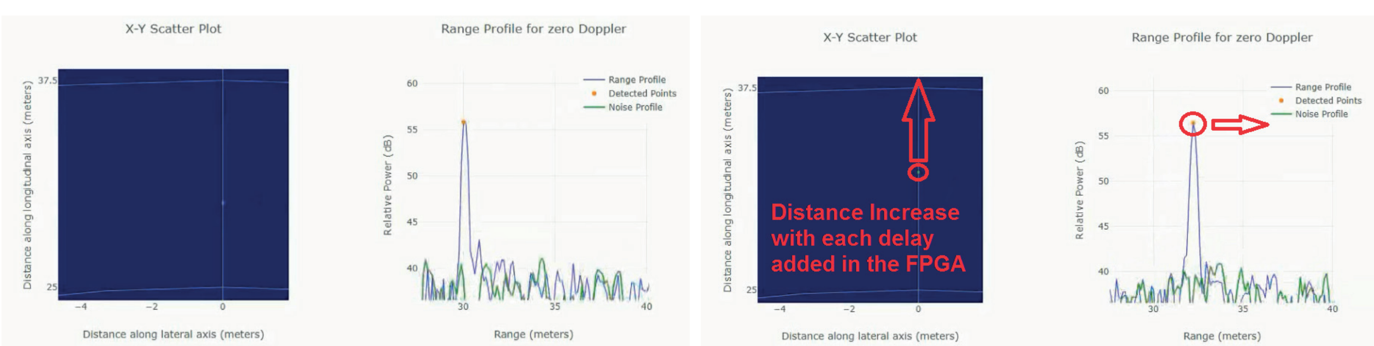
Signal is captured and down converted by the mmWave up/ down remote head with Keysight N5173B as an example. Signal is digitized by the high-speed ADC and samples are sent with low latency to the Xilinx FPGA for processing. Modified signal is then converted by the low latency DAC and upconverted by the mmWave remote head for transmission to the radar sensor.

Fixed High-Speed and Low Latency Digitizer (ADC) and Converter(DAC) with FPGA Digital Signal Processing

Fixed Transceivers w/ Antennas And Digital Down Convertor (Radio Frequencies Band to Intermediate Frequency Band)

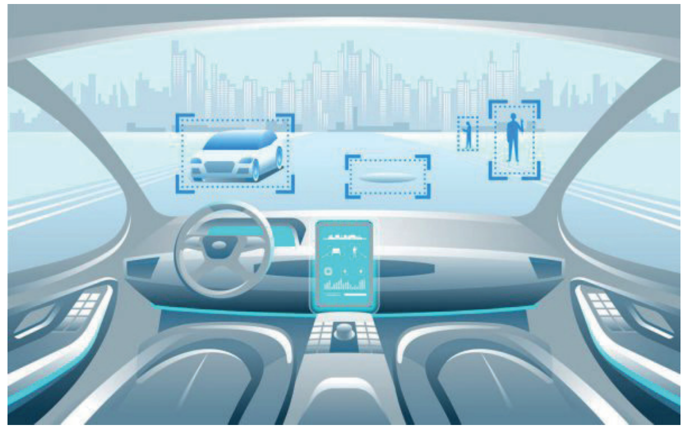
Fixed Radar Sensor

We see on the Radar Sensor GUI that the profile of the signal received after data processing correlates with a distance increasing each time we add some delay to the loopback signal (delay applied in the VPX570 FPGA):



Hardware: MOSA for both Commercial and MIL/Aero

VadaTech products are compliant to VITA and PICMG open standard architectures driven by the DoD's Open Systems Architecture (OSA) – formerly called the modular open system approach (MOSA), commercial-off-the-shelf (COTS) directives and the need to reduce size, weight, power and cost (SWaP-C).



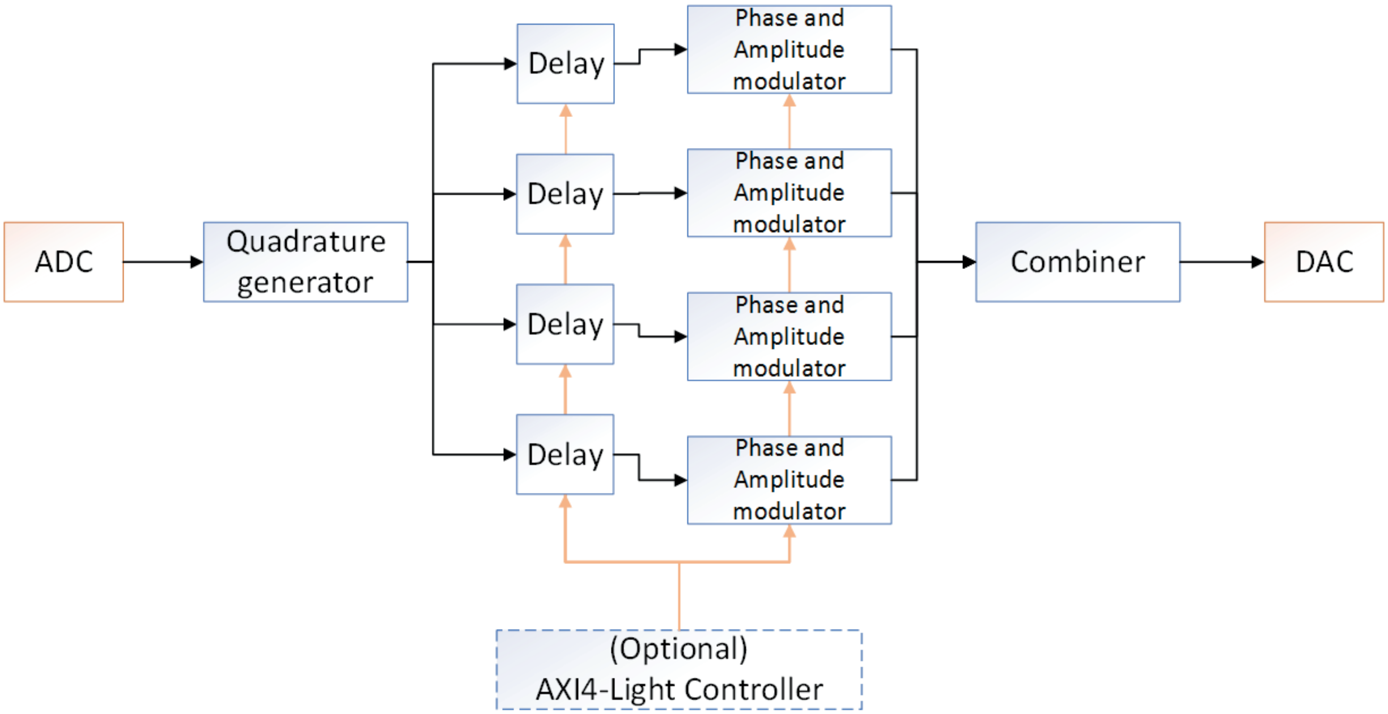
The VPX570 module (shown below) is available with different grade of ruggedization and the modular approach as well as VadaTech products offering provides the ability to scale the solution with additional converter channels, processing power and control I/O. The rackmount VTX955 1U chassis shown in the test bench below provides power, network interface and cooling.

Software: Multi-Path Modulator for VPX570

The MPM_VPX570 Multi-Path Modulator Software package from VadaTech was developed for a specific customer to support them with an intermediate level reference design in between the base hardware built-in test and their end-application. This MPM_VPX570 provides additional FPGA image and source code for the VPX570, intended to accelerate the development of a customer's end application. The end-application supported in the demonstration with Keysight was completely different than the one which had generated the original request for MPM_VPX570. For Keysight demonstration, VadaTech has still based the demonstration on the MPM_VPX570 and modified it slightly to remove or tweak the existing functions blocks. This saved time and proved the MPM_VPX570 suitable accelerator package for different types of end-use.

Data Processing in the FPGA

In the diagram of the MPM_VPX570 below we can see the digital loopback functions implemented in the VPX570 Xilinx FPGA. The advantages of the digital approach are a higher flexibility in data processing with for example greater maximum delay, letting you simulate objects at a great distance and can maintain the specified distance with higher precision than in an analog approach.



Above we can see that the pulse converted by the ADC is transformed into a complex input and split across a defined number of paths. Each path will be processed with different parameters to represent a different target.

Each path has its own independent delay block to simulate different distance to the radar sensor as well as different phase and amplitude modulator.

The combiner sums the paths and output to the converter for transmission of the simulated echoed environment back to the radar sensor.

For more details on the VPX570 and the MPM_VPX570 please visit www.vadatech.com or click on the links below to access to datasheets and videos:

[VPX570 product page]
[MPM_VPX570 product page]
[Introduction video to MPM_VPX570]

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