#### 2800 MB/s Heterogeneous Data Processing for a 4-channel, 5.6 Gbps Wind-LIDAR-System









Physikalisch-Technische Bundesanstalt Braunschweig and Berlin National Metrology Institute



# Why using a Wind LIDAR System?

- Measuring wind speed up to 200m above ground without expensive measurement masts.
- Same accuracy as cup anemometers mounted onto meteorological masts.
- Very important for power curve characterization and wind potential analysis during planning phase of wind farms.
- Small system fits on a trailer.
- Very cost effective!



PTB LIDAR System at the test site of Deutsche WindGuard Consulting GmbH

## How does a LIDAR System work?



- > 1.55µm Laser
- AOM with 75MHz
- Reflection from
   Aerosol particles
- Receivers show
   Doppler effect

   calculation of speed
   of the particles
- Transmission delay defines height of measurement
- Bistatic system for small measurement volume and high accuracy



PTB Wind LIDAR System setup

## **Bistatic Wind LIDAR System**





Conventional LIDAR System

**Bistatic LIDAR System (PTB)** 

## **Measurement data flow**



- ▶ Lidar Receiver Data sampled with 350MSPS@16-Bit per channel
   → 2800MB/s data stream.
   (4th channel is direct downlink)
- > Data stream reduced by a mixer  $\rightarrow$  800MB/s
- FFT, Cross-correlation of the channels and some additional maths
   → below 20MB/s
- Display and store important data (statistics)



## **Used components**



- 4 channel ADC and DAC connected via 5.6Gbps per lane JESD204B (2x TI ADC16DX370, 1x TI DAC38J84)
- Mixer functionality implemented on FPGA (Xilinx Virtex-7 690T)
- Set of 3 DSPs used for FFT, Cross-correlation and additonal maths (TI TMS320C6678)
- x86 CPU running Windows used for GUI and Storage (intel 4<sup>th</sup> Generation Core i7 quad-Core)



## **Application-ready Framework**



- > Application-ready Framework provided to customer:
  - JESD204B Subclass 1 IP + API to connect ADCs and DACs to the FPGA
  - PCIe Gen.3 endpoint IP + API on the FPGA
  - PCIe API on DSPs
  - GigE & TCP/IP API on DSPs
  - GigE & TCP/IP API on x86 CPU
  - Management Software and Demo applications



#### PCIe data transfer



- $\succ$  Distributed lock-less FiFo with posted writes only ightarrow NVMe style
- Latency significantly reduced



### **MicroTCA System Concept**





- > ADC/DAC FMC module
- on FPGA carrier AMC with Freescale QorIQ (Linux)
- > Quad-DSP AMC module
- > x86 AMC module, SATA SSD carrier, Multi-Serial AMC module

## **MicroTCA System Components**





**EMCOMO** 

## Wind LIDAR MicroTCA System







- Specification of MTCA System Architecture
- Selection of appropriate MTCA components
- Modification of AMC modules and crate according MTCA.1
- Integration and Installation of MTCA System
- Development of Application-ready Framework (IP-Cores, DSP and Windows Software) by local partner Missing Link Electronics
  - Application will be developed/integrated by customer!
- User Documentation of MTCA System and Application-ready Framework

**One stop shop for Embedded Computer Systems!** 





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