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I am specializing in the domain of high-performance and heterogeneous computing, computer architectures, and parallel algorithms. On a technical side, I have experience in performance analysis and optimization, parallel programming, low-latency communication, and cloud platforms. Working at Institute of Data Processing and Electronics (IPE) at KIT, I apply these technologies to build software instrumentation for distributed data acquisition and control systems.

I built and are currently maintaining a highly-available cloud platform for KATRIN (KArlsruhe TRItium Neutrino) data acquisition and slow-control systems [1], [2]. Parts of the system are adapted to support ASEC (Aragats Space Environmental Center) and SEVAN (Space Environmental Viewing and Analysis Network) particle detector networks in Armenia to study thunderstorm phenomena [3], [4]. I led a software work package of the UFO (Ultra Fast tOmography) project aimed to build a novel instrumentation for high-speed synchrotron imaging with online reconstruction and image-based feedback loop [5]. We developed a control system integrating the beam line devices with a GPU-based image-processing cluster and steering the data from the cameras until the storage [6]. IPE is actively designing novel electronics for multiple collaborations [7], [8]. Our group is looking for a hybrid solutions coupling the high-speed electronics with fast, but flexible software running on GPUs and other parallel accelerators [9]. For instance, recently we have performed a case-study aimed to evaluate the possibility of building the next generation of CMS track trigger using GPUs with round-trip latency below 6 us [10].

It is a challenging task to design an efficient computing system. Well designed data flow, a hierarchy of intelligent caches, and efficient parallel algorithms can drastically reduce required investments. Throughout all projects, we take a holistic approach to understand project requirements, identify bottlenecks, and optimize performance-critical components. To get an in-depth understanding of available parallel architectures, I have systematically applied micro-benchmarking techniques. It allowed to find multiple undocumented properties of the available hardware and to develop a range of techniques to balance the load between different computational and memory units achieving higher hardware utilization [11]. We have developed a pipelined image processing framework and contributed parallel algorithms addressing various hardware platforms including IBM Power, Intel Xeon Phi, and multiple GPU architectures [12]–[16]. To enable interactive remote visualization of large tomographic volumes, we develop a web-based visualization framework combining client- and server-side rendering techniques [17]. Because of the client-side component, high interactivity is achieved with only small investments in the data center hardware. On the other hand, the server-side component allows to improve quality on demand and makes visualization possible also for slow hand-held devices.

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