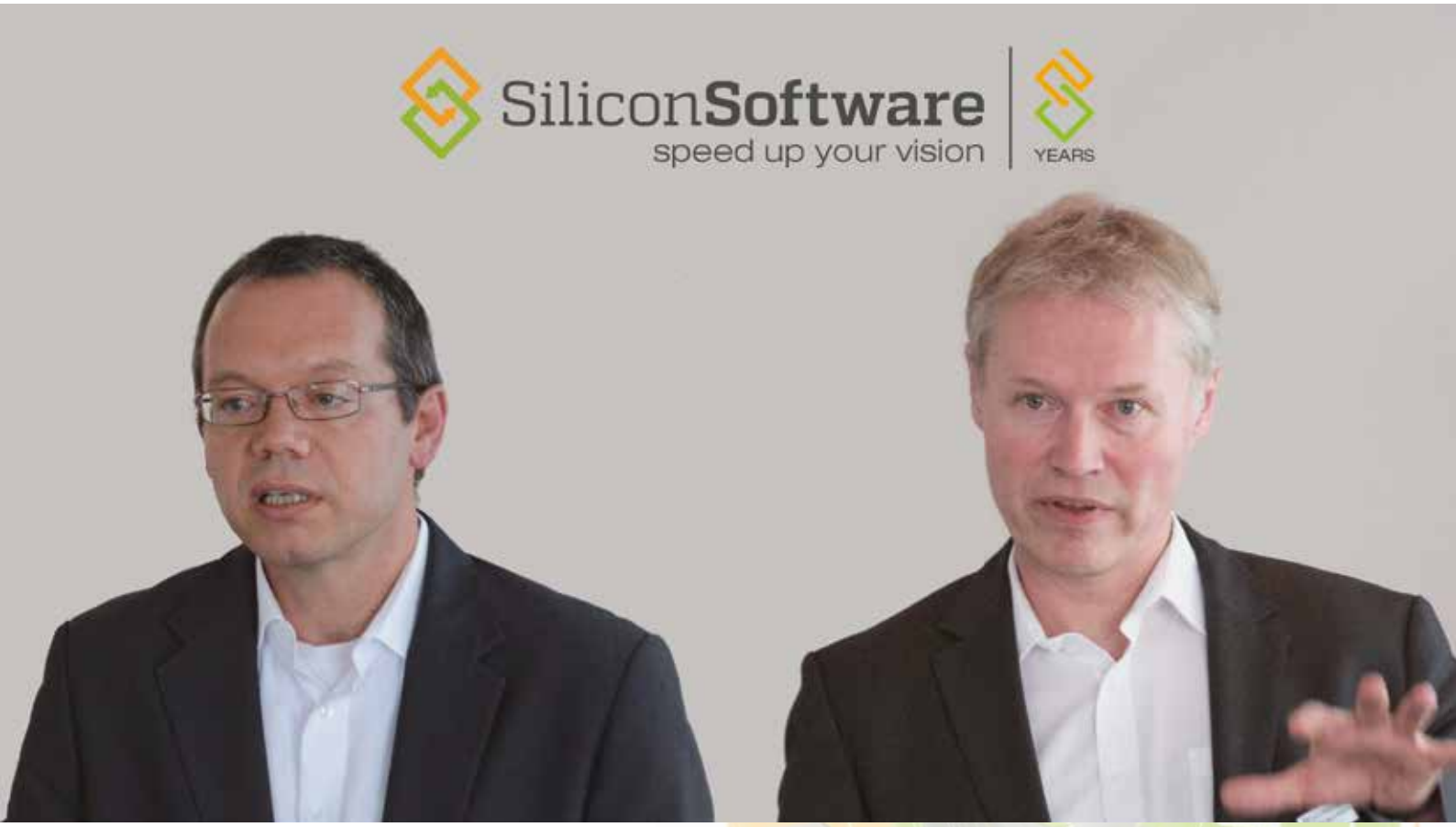
20 years of frame grabbers and graphical FPGA programming

Comprehensive solution portfolio for the vision of the future

The history of Silicon Software began 20 years ago at the world's largest particle accelerator, the Large Hadron Collider, in Cern Geneva. The detectors generated a data flood of 40 million frames/sec. In order to select approximately 10 to 100 images with physically interesting information, Dr. Klaus-Henning Noffz and Dr. Ralf Lay created their first frame grabbers and thus laid the foundation for their own company.



Silicon Software CEO Dr. Klaus-Henning Noffz (right) and Dr. Ralf Lay (left)

How began the history of Silicon Software twenty years ago?

Klaus-Henning Noffz (KHN): At the University of Mannheim, we developed the concept of a highly parallel computer for Cern, which was based on FPGA technology and was able to process the necessary image processing tasks directly in the hardware of the FPGA. However, nobody knew how to program such a multi-FPGA computer efficiently. There, too, we broke new ground and developed our own programming language. So this project

was not only the birth of our first microEnable frame grabbers series, but also the foundation for VisualApplets, our graphical development software tool for FPGA programming. Our first major customer was a manufacturer of document scanners for banks.

What was the personal highlight of the company's history so far?

Ralf Lay (RL): Over the past 20 years, there have been many highlights, but also cuts that have influenced the company's development in the long term. In 2001, we developed the microEnable III frame grabber for the Camera Link standard. For the first time, it enabled us to offer truly standardized and internationally compatible solutions and it became a building block of our growth. In 2006, we won the International Vision Award with VisualApplets and at the same time expanded our product range to include image processing software. In 2016, we released VisualApplets 3.0 with its extensions. With the introduction of VisualApplets Embedder for FPGA embedded devices, we now also address manufacturers of FPGA-based image processing devices, as well as VHDL programmers through VisualApplets Expert extension. This step further expanded our business. We see the development history for frame grabbers and image processing rather at its beginning than at its end. Therefore, we will continue to develop our vision of a modern frame grabber into the future.

The era of the frame grabbers has often been declared finished. Where do you see future applications of frame grabbers?

KHN: The field of application for dedicated frame grabbers and cameras lies in the area of machine vision interfaces and for high bandwidths. Image processing will always have requirements for the support of image sensors, drive options, short latency and image transmission rates that are of no interest to the consumer market. For this we need our own standards. These were oriented on high performance values and thus also on high-performance individual components. The frame grabber is a fixed part of the image processing system. We also see that the image processing and data control competence of a frame grabber is increasingly needed. We also see the need in areas where products such as GigE Vision, that should be frame-grabber-less, are successfully seeing new opportunities with our products. As a general rule, frame grabbers can take on additional tasks, such as preprocessing (image processing / improvement) and post-processing (image analysis) and up to the processing of signal data. In an industrial environment, frame grabbers play the role of self-controlling components with decentralized intelligence, which control the peripherals and enable individualized products since a pure camera or embedded system reaches its limits.

"We see the development history for frame grabbers and image processing rather at its beginning than at its end."

Ralf Lay, Silicon Software

Which high-end interfaces play a role?

RL: The current high-end interfaces are CoaXPress (CXP) and Camera Link HS (CLHS). A higher transfer speed has already been specified for CXP. CLHS has an electrical and optical transmission variant through which the two standards also have the default settings. In the meantime, a common

standardization approach has been used. For these standards, we, as a frame grabber manufacturer, are required to bring new products onto the market. 10GigE is technologically strong in its relation to the optical CHLS solution. The market is still growing with these camera solutions. It is more interesting with NBase-T, since here we believe that higher requirements from the GigE Vision environment will lead to an increase in this technological solution. Especially for multi-camera solutions or high-precision triggering, frame grabbers are strongly recommended. The development of USB3.1 is also interesting, especially from consumer perspective, as more and more functions are implemented in the interface technology.

adapted to these new developments, but the classic frame grabber still plays a key role in our product portfolio. VisualApplets has also changed over the years and now offers easier access and faster programming, as well as more image processing functions being implemented than ever before.

You released VisualApplets to the market in 2006. Were you too far ahead of the market's processing needs?

RL: With our vision to make FPGA technology programmable for everyone, yes we were very early on the market. For our mission to give our custom-

„Industry 4.0 will require intelligent components that perform sophisticated image processing in real-time."

Klaus-Henning Noffz, Silicon Software

Silicon Software is often seen as a pure frame grabber company, is it still true?

KHN: We are no longer a pure frame grabber manufacturer, thanks to VisualApplets we are also software manufacturer. Our company profile is currently changing through our expanding support for embedded vision. Until recently VisualApplets was bound to our frame grabbers, with the release of VisualApplets Embedder, image processing with FPGAs is now also possible within cameras and vision sensors. The concept has already been successfully implemented by major camera and sensor manufacturers Baumer and SICK. The FPGA devices are graphically programmable thanks to VisualApplets without the need for HDL programming, in order to realize real-time applications in a short development time. These can then be ported to other devices in order to accelerate market availability for an entire product line. With VisualApplets Expert, it is also possible to integrate our partners' existing and proprietary HDL libraries in VisualApplets.

Our products and tasks have now changed and

ers a tool to program the frame grabbers FPGA themselves, we came in time. The requests for programming on the frame grabbers came more frequently with the microEnable III from 2001 onwards. VisualApplets gave us the opportunity to develop our own development services, to program them faster and more efficiently, and to integrate new, inexperienced hardware engineers into application programming.

Where is VisualApplets used?

KHN: A big limitation was that VisualApplets could only be used on Silicon Software products. Since the software was always designed to be independent of the hardware, we have released an extension to VisualApplets called VisualApplets Embedder in 2016, which allows third-party companies to make their products compatible with VisualApplets. With Baumer's LX VisualApplets camera series and with SICK's use for the internal programming

of their AppSpace products, we have already won two major customers. At the moment, we are seeing a lot of demand from camera manufacturers who want to make the leap towards Smart Cameras, but also for manufacturers of special image processing boards, which are used as system accelerators.

What will be the image processing of the future in general?

RL: Machine Vision will play an important role in industrial automation. Although it has established itself today, it still is within a vertical niche. In the future, image processing will be of crucial importance through the networking of production within the framework of industry 4.0. When robots work closely with people or production produces personalized variations, you will always find Machine Vision as a dominant theme. From our point of view, we are perfectly positioned for this growth: it will require intelligent components that perform sophisticated image processing in real-time. New application areas and algorithm development under VisualApplets are also becoming important. Here, the subject of deep learning with Convolutional Neural Networks (CNN) is a main topic that enables analysis, especially in surface inspection, with more accurate results under difficult conditions.

Embedded vision is a technology that is gaining more and more popularity. Why do you think this is, and what is your company's role in the technology?

KHN: Embedded vision expands the possibilities for image processing into new areas such as autonomous driving, surveillance, transport, logistics and service robots, industries in which PC's are not suitable nor desired. Low system costs, a higher mobility, better integration and reducing the system size also supports this approach.

However, due to the complexity and heterogeneity (components from different manufacturers), it requires new concepts and technologies. For this reason the Embedded Vision Study Group, under my chairmanship, has been developing new Embedded Vision Standards (OPC UA Vision Companion Specification and Embedded GenICam) since the end of 2015 in the areas of process technology, software compatibility and integration into automation (industry 4.0, IIoT). Complimenting this is the parameterization of Vision devices and the representation of their complex functions and formats in GenICam.

Our own approach focuses on intelligent, virtually self-sufficient embedded image processing components based on FPGA technology which greatly reduces the data load on CPUs. The FPGA in a way represents the control center of embedded cameras and vision sensors, and they are particularly suited for image and signal processing, communicating with the peripherals and IT systems as well as real-time processing using VisualApplets - programmed via its graphical user interface. With the graphical FPGA programming of vision devices, it is possible to quickly equip complete product lines with partially autonomous capacity at an accelerated time to market. Through this concept, embedded vision components can achieve the comparable performance of large solutions in many embedded applications.

Deep learning and artificial intelligence is also becoming more popular. How, if at all, does your company plan to become involved in this, if they are not already?

RL: Machine learning is an important topic for us, as it provides new approaches to many new applications with clearly better results. Convolutional neural networks (CNN) are very well suited for pattern recognition by training and complex classifications via the linear combination of convolutions, e.g. to detect defects. FPGA processors are perfectly suited for CNNs due their native parallel processing architecture and by providing a single step from image acquisition to classification result. FPGAs have much lower power consumption than GPUs and are the best choice for the high amount of data to be processed in machine learning. They can also be used in embedded vision devices, leveraging machine learning in the Machine Vision environment. Machine learning has become a high priority for us: A CNN operator

within VisualApplets as well as a new frame grabber are being developed specifically adapted for this purpose. The other benefit for our partners is the use of our CNN operator functionality within their VisualAppplets Ready devices.

Now that you are celebrating your 20th anniversary, what would you like to see your company do in the next 20 years?

KHN: We would like to continue establishing VisualApplets as the market standard for FPGA programming. Since FPGA programming is made easy for everyone by the graphical user interface of VisualApplets, without needing any HDL (hardware description language) knowledge, we will further enhance our software according to user and market needs via special functionalities, e.g. for machine/deep learning and others. As we consider the future, we envision VisualApplets covering all the most important vision applications and requirements by providing task specific applets or operators and will be used by a large number of hardware and software developers as well as application engineers. We foresee VisualApplets being used in many varied FPGA based devices running versatile applications - from extremely compact ones to huge image processing systems.

The same objectives are valid for our frame grabbers. We will cover all future and relevant high-speed camera interfaces, connected via the quick configuration of the system components, so that all demanding vision applications in all industries can be addressed. The frame grabbers will be still needed and we will remain a technology pioneer for our industry.

In conclusion, expanding our hardware and software company by providing the market with concise tailor-made solutions which meet the requirements of our customers – this is my vision for the next 20 years of our company.

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