STATUS, RECENT DEVELOPMENTS AND PERSPECTIVE OF TINE-POWERED VIDEO SYSTEM, RELEASE 3

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Abstract

Experience has shown that imaging software and hardware installations at accelerator facilities needs to be changed, adapted and updated on a semi-permanent basis. On this premise the component-based core architecture of Video System 3 was founded. In design and implementation, emphasis was, is, and will be put on flexibility, performance, low latency, modularity, interoperability, use of open source, ease of use as well as reuse, good documentation and multi-platform capability. In the past year, a milestone was reached as Video System 3 entered production-level at PITZ, Hasylab and PETRA III. Since then, the development path has been more strongly influenced by production-level experience and customer feedback. In this contribution, we describe the current status, layout, recent developments and perspective of the Video System. Focus will be put on integration of recording and playback of video sequences to Archive/DAQ, a standalone installation of the Video System on a notebook as well as experiences running on Windows 7-64bit. In addition, new client-side multi-platform GUI/application developments using Java are about to hit the surface. Last but not least it must be mentioned that although the implementation of Release 3 is integrated into the TINE control system [1], it is modular enough so that integration into other control systems can be considered.

OVERVIEW

The Video System explained further on originates at the Photo Injector Test Facility Zeuthen (PITZ). This is a test facility at DESY for research and development on laser driven electron sources for Free Electron Lasers (FEL) and linear colliders [2, 3]. A vital diagnostic used to observe and measure the electron beam is the Video System at PITZ. As the facility has been constantly upgraded over the last decade, the video system was enlarged and easily outgrew its initial specifications.

Based on the acceptance and extension at PITZ, the Video System has been exported over the years to PETRA at DESY and its pre-accelerators [4], EMBL Hamburg and PETRA III user beamlines at Hasylab [5], where the requirements for a Video System at these facilities admittedly were substantially different compared to PITZ. In addition, remarkably small installations have been realised as well, such as providing video stream of a high-voltage power supply display installed at a remote location.

During the years of evolvement, the Video System underwent constant extension and upgrading. Naturally, it quickly outgrew its original specifications which made any further extension or upgrading cumbersome. A redesign towards a component-based approach, where individual elements are easy to change, adapt, upgrade etc., has been completed [6]. Due to this well-defined and flexible approach, a lifetime of more than a decade is expected. This fits to lifetimes of existing and coming accelerators and other experiments close to basic physics research.

Some of the many new available features include:

- flexible image source interface, focused to AVT Prosilica and JAI Gigabit Ethernet cameras, other interfaces available, new interfaces easy to implement
- raw grayscale images up to 16 bits per pixel
- raw colour images (RGB24)
- integrated JPEG compression/decompression (grey and colour)
- focused but not limited to Gigabit Ethernet, GigE Vision, gen<i>cam cameras
- loss-less acquisition, transport and analysis
- high-bandwidth (tens of megabytes per second)
- low latency (tens of milliseconds range)
- well-defined image data type, integrated in TINE data transport
- up to 30 frames per second are easily achievable
- lightweight shared memory interconnection for video stream handover across video system components
- multicasting of video images via TINE
- interface to Matlab
- well-defined, documented and flexible XML configuration files
- integrated native Java-based universal slow control solution (puts up a pretty good show on its own)
- native components (MS Windows) are based on platform-independent source code easy to port
- client-side is native Java code

It needs to be mentioned here that the system has been kept very flexible beneath the surface. Use-cases that require more frames per second, integration of other cameras, higher resolutions or bit-depths than mentioned above can certainly be considered. If there is demand, a test installation to verify special requirements should be easy to provide.

STATUS

At the moment, the current release of the Video System has been installed and is used in production level at PITZ, Petra III (pre-accelerators, diagnostic beamline, synchrotron radiation interferometer, user-beamlines of Hasylab, …) and since April 2011 at the Relativistic Electron Gun for Atomic Exploration (REGAE) accelerator. In the past, the European Molecular Biology Laboratory (EMBL)

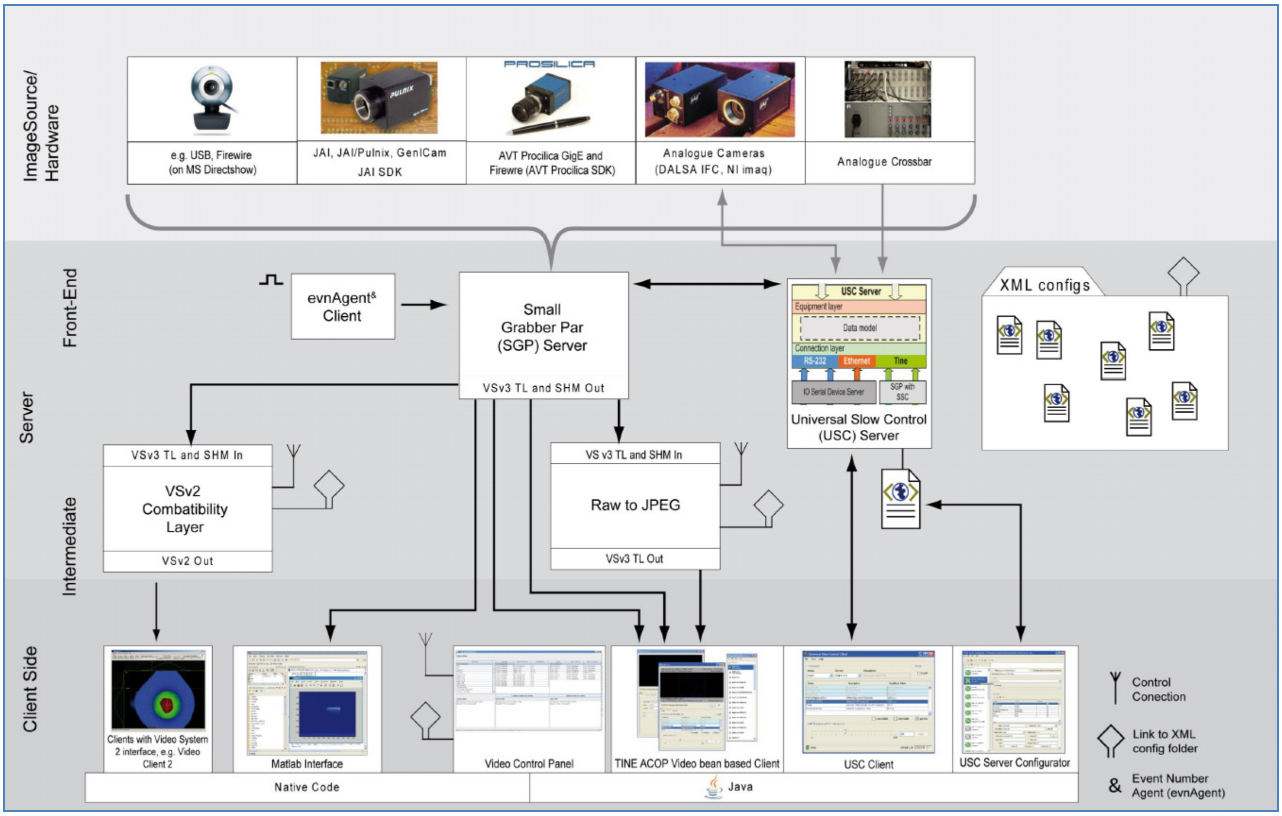

Figure 1: Simplified layout of VSv3 components and their interaction.

Hamburg has used the Video System 2 (VSv2) [7] for sample changer monitoring and control to great satisfaction. As step by step EMBL user beam-lines are commissioned at PETRA III, VSv3 components are foreseen to be installed there. The simplified layout of the VSv3 components can be seen in Fig 1.

PITZ

In the past year, PITZ has finished its current gun conditioning cycle and is currently experiencing a hardware upgrade of the accelerator. The video system is set up in a heterogeneous way. Various types of cameras (analogue JAI, digital JAI, JAI/Pulnix and Prosilica GigE) coexist next to each other, each one where its characteristic fits best. All cameras are snapshot-triggered by central timing (mainly 10 Hz) and are in general delivering frames at this rate. Legacy VSv2 technology is still used on the client side, while back-end/infrastructure has been fully upgraded to the current release level. Matlab interfaces keep growing as to satisfy demands of physicists.

PETRA III

Upgrading VSv2 legacy installations to VSv3 was one of the main tasks performed during the past year. Now as everything is VSv3-based, a Raw to JPEG component has been introduced almost anywhere to reduce video transmission usage on the controls network. For many raw video feeds to the controls network there is now an additional JPEG feed which provides the same stream, only JPEG-compressed (using compression ratios of about 1:10 to 1:50). In addition, a synchrotron radiation interferometer has been commissioned and the diagnostics beam-line has been upgraded to JAI BM141 camera. Matlab interfaces have been introduced and extended in the last months. The synchrotron radiation interferometer measurement applet is based on this.

PETRA III client-side at Hasylab

In the past year, the already existing pure VSv3 installation at client-side of Petra III has constantly been extended. Currently there are various types of Prosilica GigE cameras (about 90 pieces) running in parallel at slow non-triggered update rates. As many server processes as cameras, distributed across three server hosts running Windows XP SP3, provide control of the cameras and a standard VSv3 video interface via TINE to the control system.

REGAE

A new linear accelerator is currently being set-up at DESY. For the diagnostics of the electron bunches at REGAE [8], an installation of the Video System has been done. For initial operation phase, three cameras of JAI BM 141 have been installed at the accelerator. One server

PC is used for control and readout of these cameras. First beam images have been taken.

RECENT DEVELOPMENTS

Transition from former technology (Video System 2) to the state-of-the-art Video System is still ongoing. At PITZ, step by step important legacy client applications such as the PITZ Video Control Panel and Video Client 2 are going to be exchanged to new native Java-based applications.

Foreseen as a successor to Video Client 2, the Java Video Client application is a component-based client-side application, which encapsulates the functionality needed to provide a single high-level user interface to display video streams including image analysis (ACOP Video component) and controlling camera settings (USC component) as well as providing a consistent view of all available cameras across a VSv3 installation.

Matlab Interface

In 2010, the first interface from VSv3 to Matlab was created and used enthusiastically by the physicists, who immediately began requesting more features. Thus, as time passed, the Matlab interface grew. Using the multi-platform-available MEX-functions, one is able to get a single video image from the server, load in proprietary Video System 2 images and image sequences from file and is able to grab a sequence of video images from server. The MEX functions have been carefully designed for cross-platform compatibility and have been made available on a wide range of Matlab versions (v7 to 2011a) on Win 32, Linux and Win 64. Our aim here is again to provide the user with a wide range of tools, so that he can use his favourite working environment. As our development cycle regarding the Matlab interfaces is maturing and the physicists are providing feedback, more external functions can be expected to be implemented.

Video System on a Notebook

In the last year demand rose for having a standalone Video System installation on a notebook, where one is able to use the benefits of a known on-site video system installation for both on- and off-site use. This allows temporary local installations at any laboratory, where hands-on experience can be gained by sites interested in joining the video system collaboration For example, the Cherenkov Telescope Array (CTA) test facility to be built in Berlin is interested in having such a local installation on a notebook for first hands-on outdoor measurements on and at the dish.

Some local installations on notebooks have been used, primarily at REGAE and CTA. Each has in common a server as well as client applications which can be run on the notebook locally (see Fig 2). A local Ethernet interface is used to connect a GigE camera. As a bonus, the software was set up in such way that if a network connection to a site-network exists, video system components located therein can be accessed if necessary. As Windows XP SP3 Professional workstation-type machines are used for video server environment on site, installation on Windows XP notebook was fairly straightforward. In contrast, a CTA notebook was already equipped with Windows 7 / 64 bit. Although this was new territory, the installation and usage of native Windows (Win32) software under 7/64 was easier than expected. However, significant attention needed to be paid to the Start Menu and shortcuts, WOW64 and Networking Firewall.

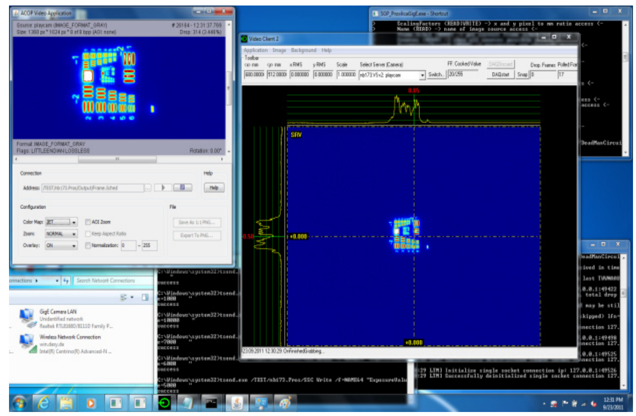

Figure 2: Video System 3 and 2 (client-side) running in parallel on a notebook using Windows 7/64 bit.

Attaching Event Numbers to Video Frames

Up to now, a neglected part of the Video System has been the integration to Archive/DAQ systems. As an important step in this direction, attaching event numbers to newly acquired video frames has been implemented (see Fig 3). An important criterion for exact correlation of a beam image at a facility using triggered acquisition like PITZ is a so-called general event number. Each shot of the accelerator gets a unique event number assigned, which in general is transported to individual controls subsystems and experiment's properties are tagged with that event number. Afterwards, the data is transferred to the DAQ system. Later on, the physicist will require the event number to collect data that belong to an individual shot of the accelerator. A lightweight solution has been developed and installed at PITZ, which makes use of multicasting the event number from a central timing source throughout the controls network. On the server level, the SGP component with the help of an 'event number Agent' component (evnAgent), tags each freshly acquired video image with the event number.

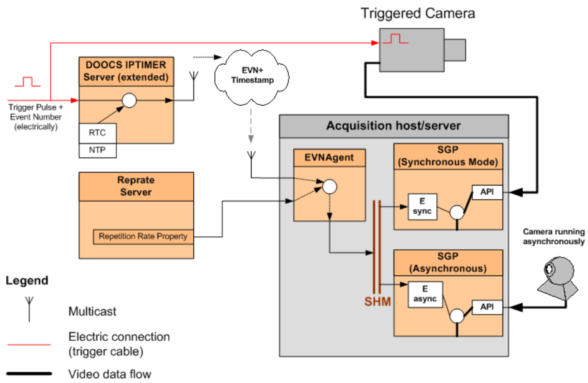

Figure 3: Distribution of Event Number.

The integration of image data into the TINE event archive system is well underway. Generic tools such as the TINE Event Archive Viewer are now able to store and retrieve video sequences, either frame-by-frame or movie style. Streaming these stored image data into specific dedicated video analysis tools will provide the physicist with the ultimate comfort in rapid browsing and searching of stored events coupled with the precision analysis found in the live video tools.

Online Documentation

The Video System website (an important element of the TINE website) has likewise matured over the past year [9]. General information, technical aspects, reference documentation, conference submissions and contact persons are now available world-wide. Readers are kindly asked to provide feedback.

PERSPECTIVE

At REGAE, integration of Andor iXon scientific detector into the Video System is currently being considered. By using a plain C-API which Andor provides to interface with the detector, a proof-of-concept application has been successfully implemented. A SGP component may be introduced later on.

A big point for PITZ in the coming year is the removal of Video System 2 support on the client side. Necessary for this is the availability of comparable tools using Video System 3 interface. Most tools will follow the paradigm of using native Java on the client side, to provide freedom of client platform for the operator. Also, effort will be spent to move legacy native measuring clients with VSv2 interface to the new release level. The Emittance Measurement Wizard (EMWiz) and Momentum and Momentum Analysis tool (MAMA) are two central applications there.

Furthermore, investigations and implementations of native releases of some Video System components on Windows 7/64 bit und possibly Linux platform, implementation of Image Source Profiles, creation and extensions of client VSv3 APIs, fine tuning of server-side to make it easier to set-up, maintain and use, are certainly worth mentioning.

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