From elections to rocket launches:

CasparCG

— how a small software is changing live productions

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SVT

CasparCG – the in-house software at Swedish broadcaster, SVT – began in 2006 with the frustrations of producing live election graphics. Today, it has permeated most parts of the public service broadcaster's five HD channels and web offerings. You can look at almost any show and (if you are in-the-know) be able to recognize up to ten pieces that are being played by various CasparCG machines, from multiple studio screens to lower-thirds and channel bugs and promos.

CasparCG is currently being used or evaluated at a number of EBU broadcasters, including SVT, the BBC, DR, NRK and VRT.

"Graphics and video play-out shouldn't limit your production or kill your budget" says Niklas Woll-heim, responsible for the revamped studio design of Sweden's three largest news programmes. That might sound like an obvious statement, but when you are pricing the equipment needed to upgrade 15 live shows a day to HD, the choice wasn't a difficult one. *"The only limitation to the re-design we accepted was keeping the cost to a minimum."*

With an 8-meter LED screen and a 102-inch plasma display to fill, plus all the on-air graphics, at least eight fill+key HD outputs were needed. *"With a traditional graphics system, just the licence cost alone would have made the move to the new format several orders of magnitude more costly"* says Mikael Lindberg, technical manager for the new 1080p50 studios at SVT.

The humble beginnings of the in-house software *CasparCG* began in 2006 with the frustrations of producing live election graphics. After a near-fatal crisis during the 2002 Swedish elections broad-cast (when a big team of contractors – from a well known vendor – over-spent and under-delivered), the graphics team were willing to do anything to avoid a near-disaster the next time round.

It wasn't just the expensive hardware and licences that frustrated SVT's Olle Soprani – who can best be described as a **tinkerer in residence**. *"In the four years between the elections, desktop PCs had gone from glorified typewriters to graphical workstations. Combined with the explosion in web tech-nologies, the time was ripe for re-inventing broadcast graphics"* says Olle Soprani from his desk in the rural town of Växjö, deep in the forests of southern Sweden. *"I think it helped that my team is an hour's flight from the capital and the head office of SVT; we could think outside the broadcast box!"*

On that election evening in September 2006, all the real-time graphics in the 7-hour broadcast were played out by a combination of ordinary PC hardware, SDI video cards and a whole lot of code. The rebel project was dubbed **Caspar Character Generator** after Olle Soprani's son and was an instant success.

Fast forward six years to today's SVT broadcasts, and you'll find that CasparCG has permeated most parts of the Swedish public service broadcaster's five HD channels and web offerings. Today,

you can look at almost any show and (if you are in-the-know) be able to recognize up to 10 pieces that are being played by various CasparCG machines, from multiple studio screens to lower-thirds and channel bugs and promos. When the news programmes replaced their old Chyron and vizRT machines in 2008, the sports and OB departments quickly followed and adopted CasparCG for their new HD needs. SVT's channel branding switched to CasparCG in 2010 as the HD broadcasts increased, and by then it was already being used as the main ingredient in most of SVT's programming.

Up to 16 simultaneous HD-SDI fill+key video and graphics outputs from CasparCG machines are available in the newly-built 1080p50 studios at SVT in Stockholm. To the left; the 8 m LED screen for the show Aktuellt *(photo by Carl-Johan Söder)*

Features overview

While the description "graphics and video playout software" sounds very general and not very exiting, let's look at some of the basic capabilities of CasparCG. First off, you can have multiple inputs and multiple outputs on the same machine, and all content (video, images and dynamic Flash templates) are all stacked as layers. Every content layer can be freely animated with properties such as *position*, *scale*, *opacity*, and even re-ordered while playing. In addition, every layer can use *blend modes* (just like in Adobe *Photoshop*) and also have a number of real-time filters applied to it, such as *de-interlacing*, *blur* and *sharpen*. You can even change the *brightness*, *contrast* and *gamma* of every layer in real-time!

Embedded alpha channels are automatically used, but you can also use any layer to generate the alpha channel for any other layer. This is great for using dynamic data (such as text) to cut holes in videos, or when you are using video codecs such as *H.264* which doesn't support alpha channels.

Interlacing and varying frame rates are often a production problem, but CasparCG can play and output both NTSC and PAL formats for SD and HD, either progressive or interlaced. It even does automatic (or manual) de-interlacing of video before any position and scale animations are carried out, and then re-interlaces it correctly for output.

For output you can choose three options; recording to local disks, display on local computer screens or to 3rd-party SDI/HDMI video cards from *Bluefish Technologies* and *Blackmagic Design*. The standard hardware configuration at SVT is an *HP Z400* workstation with an *Nvidia Quadro 2000* graphics card and two *DeckLink HD Extreme 3D* SDI cards, giving each machine two fill and two key HD-SDI outputs.

With SDI cards from *Blackmagic Design*, you can also use SDI and HDMI video inputs, making it possible to use CasparCG to overlay graphics/video on top of live video and output, without the need for a downstream keyer. Many CasparCG users are not only using the software for dynamic

Abbreviations			
CPU	Central Processing Unit	**HDMI**	High-Definition Multimedia Interface
GPI	General Purpose Interface	**OB**	Outside Broadcast
GPU	Graphics Processing Unit	**OSC**	Open Sound Control
GUI	Graphical User Interface	**SDI**	Serial Digital Interface

graphics and video playback, but also as a disk recorder to save multiple video streams to the same machine. At SVT this recording functionality is used to add subtitles and other graphic overlays to already-recorded material by reading DVCPRO HD files and then inserting the overlays at the appropriate times, based on timecode, and writing back to disk.

Customize every aspect, down to the source code

The ability to customize the tool to fit the problem is something that has been invaluable for game shows. When the British game show *Fifteen to One* was brought to Sweden in 2008, CasparCG played an integral part in being able to record 25 half-hour shows per week. The show format dictated an intricate scoring system involving 230 V light bulbs and fast-paced questions – visible not only to the viewer at home, but also on large screens in the studio (including special judge/host screens with both questions and answers.) Using the modularity and openness of CasparCG, we were able to interface not only with both physical buttons, lights, screens and dimmer packs; but also deliver keyed broadcast graphics and audio cues directly to the vision mixer.

Five simultaneous HD-SDI outputs from Caspar-CG is at the heart of making it possible to record 2.5 hours of the game show Vem Vet Mest (Fifteen to One) (*photo by Jonas Hummelstrand)*

Everything was controlled from a single laptop running custom-built controller software that interfaced with all CasparCG play-out servers, the database with questions, the judges' buttons, the light bulbs and all the 15 contestant stands with buttons and screens. With over 700 shows aired this far, the now HD-upgraded game show just keeps on going and going...

In 2010, the in-house tool *CasparCG* was released to the public as a free download. While SVT wasn't the first public service broadcaster to release open source tools, it was quite a large step for SVT. After careful deliberation with lawyers, the managing director Eva Hamilton gave it a green light and CasparCG 1.8 was made available for download just in time for the NAB trade show. To say it "made a splash" would certainly be far from the truth and, to this day, you are constantly met with scepticism in the broadcast world as soon as you say that something is free.

Performance trumps ease-of-use

With the extensive use of the open source CasparCG software at SVT, and in worldwide productions ranging from Lichtenstein's parliamentary debates to the broadcasts from the Rome and Milan marathons, you would think that we would have conquered the world by now. However, the biggest uptake has been in smaller facilities that have someone a bit more technically oriented than your normal graphics designer.

A commercial play-out system naturally has to focus on getting as many users as possible, by making it really easy to get started. The small team of CasparCG developers at SVT have instead focused on making the play-out software as flexible and powerful as possible. *"Making the play-out part fast and rock-solid, that's our focus"* says Peter Karlsson, in-house developer, adding: *"Creating generic interfaces with buttons and ' stuff ' has never been a priority"*. In the hundreds of SVT productions where CasparCG has delivered graphics and/or video play-out, the developers have slapped together a custom software controller to suit the particular aspects of a particular show.

As more and more users have discovered CasparCG, they have created their own applications for controlling the play-out, and the ingenuity has been remarkable: from election *iPad* touch interfaces

and ice hockey controllers on *Android* phones, to web browser UIs for baseball games and *MIDI*-controlled physical buttons that control playback. The simple network protocol allows you to send and receive commands from almost any platform and device.

The focus on performance rather than a *ready-out-of-the-box* experience is common in open source software and, at the moment, CasparCG isn't the world's easiest software to get started with. The lack of shiny user interfaces in open source software is often frowned upon by inexperienced users, but those that manage more complex workflows find it easy to integrate and use it for everything from arena shows to rocket launches into space. We are hoping to have a number of workflow improvements in place in the beginning of 2013, with streamlined ways to create dynamic graphics templates, plus a cross-platform client software for controlling all the power features of the CasparCG Server.

The on-screen presenters used a custom-made iPad app during the 2010 Swedish elections, to be able to see which exit poll graphics were ready, and then instantly display them on air with a simple touch.
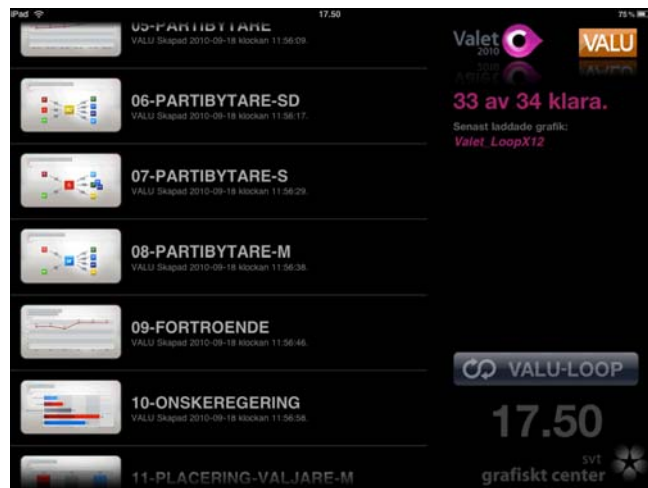
Eurovision Song Contest

The Swedish finals of the *Eurovision Song Contest* is one of the most popular shows that SVT broadcasts, and the graphics play-out has for many years been handled by a local contractor. However, for the six national broadcasts in 2013, this prestigious project will be handled in-house with the aid of CasparCG. For this specific purpose, a couple of new features will be added, such as *GPI triggering* directly from the vision mixer, something that has previously

SpaceX uses CasparCG for some of their graphics and video playback during the live broadcasts of their space missions to the ISS *(photo courtesy of SpaceX)*

been done via middleware. The idea is that a graphics operator oversees the automatic updating of the dynamic data, and the actual triggering of the graphics play-out is then done with a macro from the vision mixer.

Since the international *ESC* finals are also being broadcast from Sweden, there is a possibility that CasparCG might be used for the international broadcast as well, but a final decision had not been made at the time of writing.

Channel branding and trailer play-out

When the play-out of all of SVT's shows went to digital-from-disk in 2008, the channel branding system was rebuild around an updated in-house-built planning software coupled with an automation system from *Pebble Beach* and video/audio servers from *Omneon*. To be able to show dynamic data such as line-ups and next signs, the choice was made to replace the *vizRT* graphics system with CasparCG for text rendering. When all channels went HD in 2010, the hardware was upgraded and CasparCG was used for some additional video elements as well. In 2012 all the video idents and bumpers in one of the channels started to be played out by CasparCG, and the internal goal is to move more and more of the channel branding and trailer play-out to this platform.

One interesting use of the real-time capabilities is how CasparCG now handles the live *End Credit Squeeze* show at SVT by feeding the SDI input into a *DeckLink HD Extreme 3D* card and then scaling

that video while simultaneously overlaying images/videos and pre-recorded voice-over with dynamic text, describing the upcoming shows.

Another unorthodox use of CasparCG is how all the idents of the children's channel *Barnkan-alen* now have dynamic lengths so that they can be anywhere from 4 to 15 seconds, depending on how much time has to be filled. This is achieved by playing the video and the audio separated, and shortening the video both at the start and the end, while always doing a fade-up audio mix at the appropriate time so the music can be played to the end.
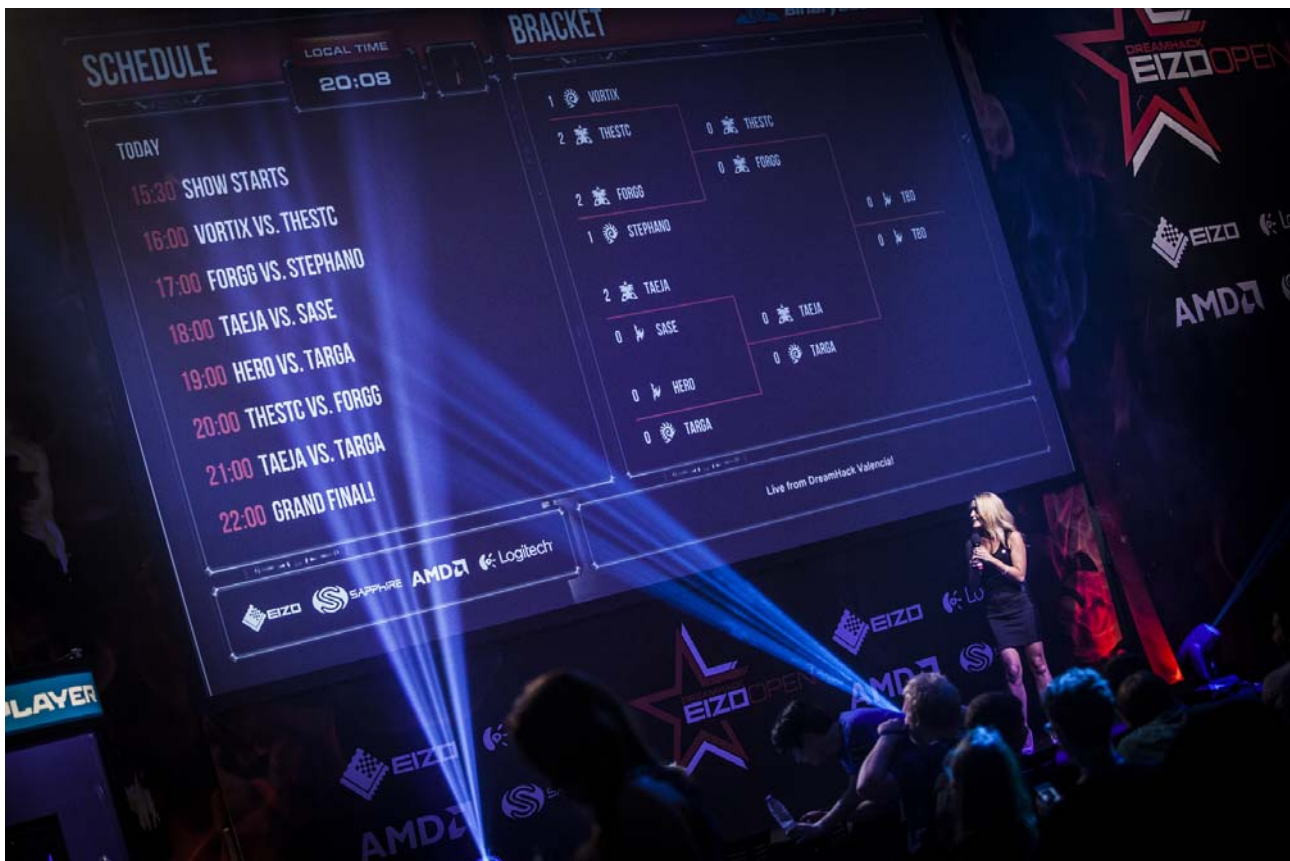

Four graphics operators in the OB truck during the last Swedish election, manning the multiple graphics outputs for real-time election data output by CasparCG *(photo by Jonas Hummelstrand)*

Brave New Broadcast

Some might hesitate to call it a sport, but the "esport" tournaments that are held regularly by *Dream-hack* are drawing respectable viewer numbers, with peaks of 150,000 concurrent streaming viewers. The September 2012 event was streamed live over two days for a total of 24 hours. With three Cas-parCG machines, the production aired leader boards, and overlaid graphics in three simultaneous languages at 720p60.

"It was the best production we've ever done; sold out and with incredible viewing numbers. We are happy – CasparCG performed royally!" says technical producer Jonas Bengtson.

For more traditional sports, like football or the Olympics, all the national Swedish broadcasts by SVT have used CasparCG for both graphic overlays and match clocks, but also for Facebook and Twitter

One of several 12-hour live web broadcasts from the Starcraft II World Championship Series by Dream-hack.tv *(photo by Helena Kristiansson)*

Jonas Hummelstrand is a broadcast designer at SVT, Swedish Broadcasting Corporation, and Community Manager for CasparCG.com. His waking hours are divided between creating motion graphics and doing visual effects for in-house productions such as the sci-fi drama series "Real Humans" (which has been sold to a number of foreign markets.) Having had extensive experience in wrangling real-time broadcast graphics systems, the development of the in-house system CasparCG and the subsequent public release has had a huge impact on the capabilities of what he can now create for SVT's productions.

Mr Hummelstrand started out as a news photographer and moved into desktop publishing in the early 1990s, followed by a move to web publishing in 1995. The last nine years have been spent in broadcasting, with a few side projects such as co-creating the iPad publishing platform used for the Cinefex app.

commentaries and studio graphics. All the templates and the controller client that were developed for the 2010 *FIFA Football World Championships* are available as free downloads from the *CasparCG.com* website. Many users have modified these to fit baseball, ice-hockey and many other sports and scoring systems.

Upcoming features

With over 60 machines in 24/7 operation at SVT, the current version of CasparCG is so integral to the production that an upgrade has to be made carefully. In development at the moment is the new version 2.1 which will feature even better performance and be fully 64-bit. In addition to today's support for Nvidia cards, version 2.1 will add support for ATI cards and also add a "CPU fallback mode" for use on lesser-powered machines, such as laptops.

Simpler configuration via a GUI is another improvement that has been on the wish list, as well as an easier graphics workflow from standard products such as *Adobe After Effects* and a custom controller palette for direct output from within *Adobe Photoshop*. Another nice content feature is the ability to automatically scroll large images with alpha, a feature specifically designed to make it easier to output credit scrolls and similar data.

With GPI triggering and the possibility to monitor performance and stats of any number of CasparCG machines via the *OSC* protocol, large-scale integration into production workflows will be even easier.

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