

Playing the game... on Linux

SEGA

Seeking a little R&R, Simon Goodwin discovers the twin joys of Sonic and Sega on Linux.

Sega has released some of the most successful electronic games for arcades and home consoles. It has also produced computers and software for other systems. This month's emulation column reviews eight Linux-friendly emulators for Sega systems.

Sega is short for Service Games, a company set up in Japan by American David Rosen in the 1950s. After a decade marketing other people's amusements, Rosen bought a jukebox factory, set up his own production line, and had a hit with a non-computer novelty called *Periscope*.

As computer games caught on in the seventies, Sega produced cartridges for simple home consoles like the Colecovision and VCS and coin-op titles for Atari arcade hardware. Early hits included seminal smooth-scrollers *Frogger* and *Zaxxon*.

Hardware hits

By 1982 Sega sales topped \$200 million worldwide and the company started to produce its own hardware, including Astron Belt, the first arcade game with laser-disc graphics, and the SG1000 home console.

In 1986 they began to colonise living-rooms worldwide with the release of the Master System, developed from consoles sold only in Japan.

The Master System followed the business model pioneered by Atari's VCS and initiated by Nintendo, with cheap 8bit hardware configured by plug-in cartridge games, but it had superior graphics, more memory and a faster processor. It sold millions of units, especially in Europe

where it was aggressively marketed by Virgin, but Nintendo trounced Sega in the USA.

A portable version, the Game Gear, failed to match the sales of Nintendo's Game Boy. The Game Gear boasted a colour screen, with fewer pixels but more colours than the Master System, but the monochrome Nintendo was cheaper

and had much longer battery life. A common factor in all these systems was the 8bit Z80 processor.

Meanwhile Sega developed far more powerful systems for amusement arcades, literally coining it with titles like combat flight simulator *After Burner*, the beat'em-up *Shinobi* and *Out Run* racing. In 1990 this experience helped them launch the 16bit MegaDrive. 32X and CD add-ons followed, but did not sell enough to lift the platform to a new level.

Nintendo and Sega battled it out through the nineties - we'll look at Nintendo emulators in a future column - but their duopoly was eclipsed in 1995 when Sony's CD-based Playstation arrived. Games for the Playstation could be produced much more quickly and cheaply, and the Sony hardware had 3D capabilities that 16 bit consoles could not match.

Hardware slips

Sega's rushed response, the Saturn, had a superficially attractive specification: multiple 32 bit RISC processors, augmented by a 68000 and Yamaha DSP for samples and synthesised sound. The hi-res 24bit colour graphics offered unlimited sprites, half a million 3D polygons a second and powerful rotation, scaling and scrolling. But this kludge proved extremely hard to program, and few games lived up to its potential.

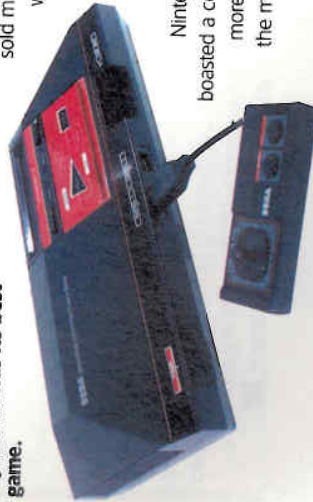
The follow-up Dreamcast, based on off-the-shelf PC chips, failed to set the world alight; production ran from 1998 until it was discontinued this year, just as really good games for it started to appear. Sega has now retrenched as a software company, after its 20 year consumer hardware

adventure. But they have left a legacy of emulators for their console, computer and arcade systems, including some excellent Linux programs.



Play with dolphins in non-violent Genesis hit *Ecco*.

The MasterSystem: *PsychoFox* was its best game.



Hardware pics courtesy Edge magazine

www.linuxformat.co.uk

8-BIT SEGAS

MasterGear

Marat Fayzullin's *MasterGear* is the easiest Sega emulator to get working. It only runs programs for the 8bit Sega consoles and computers, but supports Game Gear as well as Master System ROMs - in total about 800 titles. Marat is prolific, with NES, Game Boy, Coleco and MSX emulators also to his credit.

The Z80 engine at the heart of most of these is used in other emulators, and *MasterGear* capitalises on the similarity of sound and graphics chips in eight bit Sega, Coleco and MSX systems. These are all based on Texas Instruments Video Display circuits; 8bit Segas also incorporate sound on their video chip mask.

Master System cartridges are usually 128K or 256K long and are dominated by graphics assembled from eight by eight pixel blocks. Sprites use the same format and move over the top of two independently scrolling playfields. Three square waves plus noise contribute a typically buzzy 8bit audio accompaniment.

Games tend to be superior to their home-computer counterparts, as cartridges allow more space without concomitant loading delays, and more effort tends to go into the development of each title. What they lack in audio-visual finesse, by modern standards, they often make up in gameplay.

MasterGear has 32K of good documentation in HTML. The code is very portable, running on Amiga, Macintosh and many Unix flavours as well as Microsoft DOS, CE and Windows systems - commercial versions - but it's distributed as a binary, rather than source, which worked at once on X86 Red Hat 6.2 and Debian 2.2.

MasterGear is reckoned to run about 98 per cent of real Sega 8bit software, with standard beeps plus optional FM and MIDI sounds. It uses an X window on Linux, with command line options for screen sync and scaling. It runs well on most modern Linux systems if started with:

```
./mg -uperiod 1 -sync 60 <rom>
```

'-uperiod' makes it update every frame and '-sync' limits speed. There are runtime key-presses for joystick autofire, state saving, and audio volume, file logging and channel switching.

SMS Plus

The other Sega Master System emulator is *SMS Plus*, which was written for MSDOS and the MIPS-powered Sony Playstation, but also has a crude Linux port, available under GPL. The documentation doesn't even mention Linux and the source is a pig to compile as it has unresolved MSDOS dependencies and needs Allegro and bleeding-edge libraries that have not yet found a place in standard distros.

Sega Emulators for Linux

- 68K, XGenEm - Sega Genesis and MegaDrive consoles
- SH2, SEMU - Sega Saturn arcade-based console emulator
- 68K, System16, emulates Sega custom arcade hardware
- 68K, DGen - Sega MegaDrive emulator with good sound
- 68K, Generator - emulates Sega Genesis/MegaDrive
- Z80, MasterGear - portable Sega MasterSystem/GameGear
- 68K, GenUx, barely-started Genesis emulator for Unix
- Z80, SMSPlus, MasterSystem port from MSDOS and PSX

Display settings for the old TCL/TK Generator.

I got the precompiled binary working on Debian 2.2 after about a week of multi-megabyte downloads and much sifting through alien packages. The files I found necessary are on the LXF CD, including a

screenshot of Allegro and xshared.rpm, which contains libXxf86dga and libXxf86vm; Debian do not support these as 'so' shared libraries because their API is not yet settled.

SMS Plus has a small but smooth display in an X window, and basic but effective function-key controls. The documentation transposes the effect of F9 and F11 and does not mention F12, the 'sprite limiting' toggle. It lists potentially interesting display size and sound command-line options, but attempts to use those crash the emulator with segmentation faults.

Sound can be logged to a file, but not played live. *SMS Plus* can save its state in ten slots, and PCX screen snapshots. The latter feature is the only one that *MasterGear* lacks, and XV, *KSnapshot* and *GIMP* make that superfluous. Until the dependencies, sound and command line switches are fixed, *SMS Plus* won't give *MasterGear* much competition.

16 BIT SEGA CONSOLES

Genesis emulators

There are four Linux emulators for the Sega MegaDrive (Genesis). Of these, GenUx can swiftly be eliminated - it has barely been started, and though you can compile and run the program it doesn't do anything. Examination of the source suggests that most of the code, and even the CPU emulation, has been left as an exercise for would-be users.

DGen, *Generator* and *XGenEm* are more promising, though you'll need more than just the emulator archive and a standard Linux system to get them working. *XGenEm* and *DGen* opt for LibSDL, the Simple Direct Media Layer library, to tame the Linux sound and screen. This makes them portable to non-PC architectures without much trouble. The current SDL is on the CD.

The *XGenEm* binary release relies on the obsolete SDL_LockSO and will not start on a modern Linux 2.2 or later system. I tracked down the author, Markus Gietzen, now development director at a German biometrics company, who explained:

"I haven't worked on *XGenEm* for ages. You ran probably into trouble with the shared libraries that *XGenEm* used. To make it short: it's discontinued. I have no time to continue (it was just a quick and dirty port of my MS-DOS version) but I think that *DGen* seems to be quite good (from



On the CD



Resources

The LXF CD includes emulators and public-domain games that you can use to check that they work. Genuine ROM images are harder to come by, because of a purge on copyright-infringing Internet sites initiated by Sega last year. Most Sega ROM links that search engines cite are long gone, so use 'advanced search' options to sift out only the latest sites, if you can't transfer code from cartridges to Linux any other way. For the latest Sega emulator support, check these links:

Cartridge copying:
<http://seewww.spfl.ch/~felber/10-56>
 DGen home: <http://www.pknet.com/~joe>
 Generator home:
<http://www.squish.net/generator>
 GenUx/XGenEm:
<http://www.emucamp.com/emus/genesis.html>
 MasterSystem specs:
<http://cgfm2.emuviews.com>
 MasterGear home:
<http://www.komkon.org/fms/MG>
 Sega Arcade emulation:
<http://www.system16.com/sega>
 Samu Saturn emulator:
<http://www.zophar.net/unix>
 SMS Plus Linux port:
<http://www.emulinks.de/emus>



MasterGear also emulates the SC3000 computer.



SMS Plus overlays frame rates - here 83 Hz - and messages on its little X window.



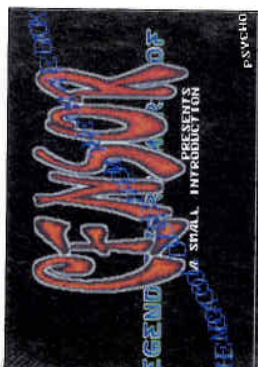
Generator's SVGAlib display, with on-screen help.



Linux can deliver Sega System 16 coin-op graphics.



The MasterGear demo game is a simple maze explorer, but a good way to check sound and graphics work at the right speed.



The Censor demo proves you've got Generator set up right.



Those pesky hedgehogs get everywhere...

« what I heard) and therefore there seems to be no need of new versions of XGenEm anymore." Sound in XGenEm is described as 'experimental' and only supports the buzzy PSG, not the FM sound chip. Documents suggest there are many programs it can't run. It lacks graphics scaling, but its vintage means that it's not a CPU hog – the author claims only 30% load on a 300MHz AMD K6-2, so it may still be worth trying on an old system. So that just leaves DGen and Generator, the pick of the bunch.

MegaDrive 1&2: Almost everybody had one.

Other menu options in the X version allow ROM file selection with a Metasploit-style requester, information about the current ROM, stop and start, and nine options to switch the layers of the display around. The screen can be normal size or doubled in both dimensions, with optional smoothing which doesn't seem to do much except chew up CPU time.

Scrolling games tended to have a wide and empty right border, with uneven width unless the 'complex (slow) VDP' option was selected. Generator 0.15 can display every frame, or one in two-five. On a K6/2-500 I had to drop back to one in three (20Hz updates) or the sound was very choppy, but this may depend on your sound card and driver.

Sound was not documented and lacked setup options. I found it more likely to stutter than DGen when playing in an X window. When expanded to a VGA-like double-size, without smoothing, Sonic 2 was glitchy even at 12Hz on my system. At the original 60Hz Sonic was a distinctly sluggish hedgehog. Menus took several seconds to respond, and the sound had harsh Dalek overtones, though some of that stemmed from the interim SoundBlaster Live! driver I was using.

Sonic 2 was still pretty playable in the original resolution at 30 Hertz, albeit rather small on my monitor, with passable sound. As you might expect from an academic project in 68K emulation, Generator 0.15 has a plethora of options to delve into Genesis RAM, though not to the Z80 sound processor. Some appear in the launch console window, some in windows of their own – the 68K code and registers use TCL/TK and VDP data appears in the console. Both 'profile' menu options give a TCL/TK error message. You can select logs in six levels of verbosity, but anything past the third 'normal' level is likely to stall the emulator with zillions of messages.

ReGeneration

The great news is that if you have a VESA-compatible display you can run an update that fixes all these criticisms, and is being actively and enthusiastically developed. Recent effort has focused on compatibility with more ROMs, and making it work smoothly on typical PC-based Linux installations. Generator 0.22 favours the controversial SVGAlib, which bypasses X and enables programs to poke the video memory buffer that IBM slotted into what is extravagantly described as PC architecture. This limits use to a subset of video cards for IBM clones.

The author, James Ponder, offered me loads of help, especially with SVGAlib. Our interest provoked him into writing much better documentation and releasing a major update that had been lurking on his hard drive for years, then piling on extra features. It now merits a version number around 0.9, rather than 0.22.

Generator now uses a dedicated graphics console, with a crisp full-screen display or a window centred amongst status and control information. You can save the whole screen, or just the game, in raw format, ready for conversion with NetPBM tools: `rawtoppm SONIC2Jss1 640 480 >a.ppm` `ppmtopgm a.ppm >sonic2j1.png`

The first command converts a raw 24bit full-screen grab into a portable pixmap which GIMP can load. The numbers are screen dimensions, not stored in a raw file but displayed by Generator when the snapshot is saved.

The second packs that into a Portable Net Graphics file. You can eliminate the temporary file a ppm by linking both commands with a pipe '|' on one line.

The new Generator has lots of extra command-line options and produces very impressive results. The only game it won't run that the older version will is Ecco the Dolphin, and given James's new-found enthusiasm I'm sure he'll soon implement this, and other ideas LXF readers may pass on.

Comparisons

Of the half-dozen ROMs I tried, the only game DGen rejected which Generator handled was Sonic 2, which for many may be reason in itself to use Generator. DGen got stuck after introducing the stars Sonic and Tails, and never put up the game display. Both stalled on the obscure Japanese ROM *Mazin Saga*, but ran the rest and several PD demos.

DGen and Generator are both impressive, with individual strengths. The versions of Generator are complementary: 0.22 has the edge for gameplay while 0.15 offers more generic emulation insights.

DGen can record and replay demo sequences, and supports a Linux joystick. It also has options to adjust CPU load, though the man page was absent from the RPM package. Like XGenEm, it supports Game Genie cheats. There's scope for an emulator combining the best features of all these, but as they're free it's worth trying them all and making your own choice.

GameGear: 8bit power in the palm of your (big) hands.



LATER SEGA SYSTEMS

System16

System16 is not a console emulator, but emulates the hardware and runs the software from real Sega coin-operated arcade cabinets. System16 used custom video hardware for Atari-style sprites and colour effects, with a 68000 main processor and a Z80 sound controller.

The peripherals in each cabinet varied depending on the demands of each game, and could include several FM sound chips capable of synthesis and sample replay. The emulator does a good job of graphics, as long as your system can handle SVGAlib, but sound support still needs a lot of work.

To get hold of the original cabinets, or the ROMs they use, check 'Gaming Eqpt' firms in Yellow Pages; then you'll be legally entitled to use the ROM images in the emulator. Working hardware may cost hundreds of pounds, as many of these games still draw cash in chip shops and arcades. Firms that maintain and refurbish them often scrap boards with the vital ROMs on, and those are your cheapest option if you're turned on by the idea of legal Sega arcade emulation.

Capabilities

Unless you've got plenty of space for an upright arcade cabinet, or even more for one of the sit-down moving variety, this emulator might still appeal for desk or laptop use. About half the

20-odd games made for System16 work well, including *Shinobi* and *Altered Beast*, and the emulator can also run ROMs from the later System18 like *Alien Storm* and *Shadow Dancer*.

The chips are usually socketed 28 pin 27xxx series EPROMs, which almost any PROM programmer can read – even my vintage QL with QEP-3 – but ready-transferred collections are available on the 'net. These are normally ZIP archives containing a couple of megabytes of code, in more than a dozen files, corresponding to chips in the original cabinet.

Often such collections are made on PCs, with filenames in capitals. This creates problems in Linux: when the emulator calls for 'ic99.bin' a file MSDOS has packed into 'IC99.BIN' does not match. So I've put shell scripts to rename the *Outrun* and *Space Harrier* files on the LXF CD.

Given a reasonably quick Linux box – say, a 300MHz Pentium or faster – System16 can emulate Sega classics like *Hang On*, *Space Harrier* and *Outrun*, which used two 68000 processors, five layers of background graphics and up to 128 dynamically scaled sprites; you'll flinch when those programs start throwing stuff at you!

Text-mode setup menus, accessed with F1, let you configure the control keys and emulate the DIP switches inside the original cabinet. These set scoring, timing and difficulty levels, as arcade owners would once a new game attracted expert players, and other interesting options on a per-game basis. There are also ten slots to save and restore the state of games in play.

Limitations

The SVGAlib dependency stops this emulator running on non-Wintel systems. I used the VESA setting in `/etc/vga/vga1ib.conf`, aimed at 'well behaved VESA BIOSes'. That satisfied a Matrox G400, which was not listed among the directly supported cards. As with Generator for SVGA, it's probably the best bet even if your card supposedly has custom support in SVGAlib, as you need not copy 'modelines' from your XF86 configuration to get it to work.

I also tried the more generic VGA, as the emulator can use a 640 x 480 pixel display, centred rather than zoomed to twice the normal dimensions, but that didn't work. I guess System16 wants direct rather than palette colours. It also favours the Pentium-specific instruction RTSC for timing, though you can disable that, and an AMD K6-2/500 did not balk at this Intel presumption.

Assuming you can find the ROMs and a suitable PC, the only flaw of System16 is the limited sound emulation. *Outrun* and *Space Harrier* look and move beautifully, but without the original bleeps a lot of the fun is missing. 

ArCADE-style scroller *Tiger*, known as *Twin Cobra* outside Japan.



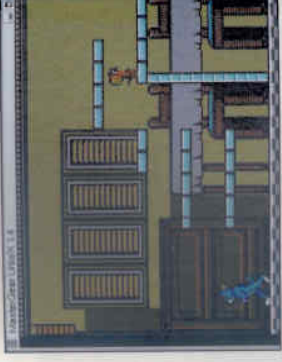
F1 smooths out the Grand Prix circuit at Monza.



SMS Plus will run away on a K6/500 without Vsync or speed limiting.



Pacmania puts a 3D slant on Toru Iwatani's *PacMan*.



Jerry has the edge in this cartoon contest.