Kernel driver dell-smm-hwmon

Description

On many Dell laptops the System Management Mode (SMM) BIOS can be queried for the status of fans and temperature sensors. Userspace utilities like `sensors` can be used to return the readings. The userspace suite i8kutils can also be used to read the sensors and automatically adjust fan speed (please notice that it currently uses the deprecated `/proc/i8k` interface).

`sysfs` interface

Temperature sensors and fans can be queried and set via the standard `hwmon` interface on `sysfs`, under the directory `/sys/class/hwmon/hwmonX` for some value of `X` (search for the `X` such that `/sys/class/hwmon/hwmonX/name` has content `dell_smm`). A number of other attributes can be read or written:

Name	Perm	Description
fan[1-3]_input	RO	Fan speed in RPM.
fan[1-3]_label	RO	Fan label.
fan[1-3]_min	RO	Minimal Fan speed in RPM
fan[1-3]_max	RO	Maximal Fan speed in RPM
fan[1-3]_target	RO	Expected Fan speed in RPM
pwm[1-3]	RW	Control the fan PWM duty-cycle.
pwm1_enable	WO	Enable or disable automatic BIOS fan control (not supported on all laptops, see below for details).
temp[1-10]_input	RO	Temperature reading in milli-degrees Celsius.
temp[1-10]_label	RO	Temperature sensor label.

Disabling automatic BIOS fan control

On some laptops the BIOS automatically sets fan speed every few seconds. Therefore the fan speed set by mean of this driver is quickly overwritten.

There is experimental support for disabling automatic BIOS fan control, at least on laptops where the corresponding SMM command is known, by writing the value `1` in the attribute `pwm1_enable` (writing `2` enables automatic BIOS control again). Even if you have more than one fan, all of them are set to either enabled or disabled automatic fan control at the same time and, notwithstanding the name, `pwm1_enable` sets automatic control for all fans.

If `pwm1_enable` is not available, then it means that SMM codes for enabling and disabling automatic BIOS fan control are not whitelisted for your hardware. It is possible that codes that work for other laptops actually work for yours as well, or that you have to discover new codes.

Check the list `i8k_whitelist_fan_control` in file `drivers/hwmon/dell-smm-hwmon.c` in the kernel tree: as a first attempt you can try to add your machine and use an already-known code pair. If, after recompiling the kernel, you see that `pwm1_enable` is present and works (i.e., you can manually control the fan speed), then please submit your finding as a kernel patch, so that other users can benefit from it. Please see :ref:`Documentation/process/submitting-patches.rst <submittingpatches>` for information on submitting patches.

> **System Message: ERROR/3 (`D:\onboarding-resources\sample-onboarding-resources\linux-master\Documentation\hwmon\(linux-master)(Documentation)(hwmon)dell-smm-hwmon.rst`, line 70); *backlink***
>
> Unknown interpreted text role "ref".

If no known code works on your machine, you need to resort to do some probing, because unfortunately Dell does not publish datasheets for its SMM. You can experiment with the code in this repository to probe the BIOS on your machine and discover the appropriate codes.

Again, when you find new codes, we'd be happy to have your patches!

Module parameters

- force:bool
  Force loading without checking for supported models. (default: 0)

- ignore_dmi:bool
  Continue probing hardware even if DMI data does not match. (default: 0)
- restricted:bool
  Allow fan control only to processes with the `CAP_SYS_ADMIN` capability set or processes run as root when using the legacy `/proc/i8k` interface. In this case normal users will be able to read temperature and fan status but not to control the fan. If your notebook is shared with other users and you don't trust them you may want to use this option. (default: 1, only available with `CONFIG_I8K`)
- power_status:bool
  Report AC status in `/proc/i8k`. (default: 0, only available with `CONFIG_I8K`)
- fan_mult:uint
  Factor to multiply fan speed with. (default: autodetect)
- fan_max:uint
  Maximum configurable fan speed. (default: autodetect)

Legacy `/proc` interface

> **Warning**
>
> This interface is obsolete and deprecated and should not used in new applications. This interface is only available when kernel is compiled with option `CONFIG_I8K`.

The information provided by the kernel driver can be accessed by simply reading the `/proc/i8k` file. For example:

```
$ cat /proc/i8k
1.0 A17 2J59L02 52 2 1 8040 6420 1 2
```

The fields read from `/proc/i8k` are:

```
1.0 A17 2J59L02 52 2 1 8040 6420 1 2
|   |   |       |  | | |    |    | |
|   |   |       |  | | |    |    | +------- 10. buttons status
|   |   |       |  | | |    |    +--------- 9.  AC status
|   |   |       |  | | |    +-------------- 8.  fan0 RPM
|   |   |       |  | | +------------------- 7.  fan1 RPM
|   |   |       |  | +--------------------- 6.  fan0 status
|   |   |       |  +----------------------- 5.  fan1 status
|   |   |       +-------------------------- 4.  temp0 reading (Celsius)
|   |   +---------------------------------- 3.  Dell service tag (later known as 'serial number')
|   +-------------------------------------- 2.  BIOS version
+------------------------------------------ 1.  /proc/i8k format version
```

A negative value, for example -22, indicates that the BIOS doesn't return the corresponding information. This is normal on some models/BIOSes.

For performance reasons the `/proc/i8k` doesn't report by default the AC status since this SMM call takes a long time to execute and is not really needed. If you want to see the ac status in `/proc/i8k` you must explictitly enable this option by passing the `power_status=1` parameter to insmod. If AC status is not available -1 is printed instead.

The driver provides also an ioctl interface which can be used to obtain the same information and to control the fan status. The ioctl interface can be accessed from C programs or from shell using the i8kctl utility. See the source file of `i8kutils` for more information on how to use the ioctl interface.

SMM Interface

> **Warning**
>
> The SMM interface was reverse-engineered by trial-and-error since Dell did not provide any Documentation, please keep that in mind.

The driver uses the SMM interface to send commands to the system BIOS. This interface is normally used by Dell's 32-bit diagnostic program or on newer notebook models by the buildin BIOS diagnostics. The SMM is triggered by writing to the special ioports `0xb2` and `0x84`, and may cause short hangs when the BIOS code is taking too long to execute.

The SMM handler inside the system BIOS looks at the contents of the `eax`, `ebx`, `ecx`, `edx`, `esi` and `edi` registers. Each register has a special purpose:

Register	Purpose
eax	Holds the command code before SMM, holds the first result after SMM.

Register	Purpose
ebx	Holds the arguments.
ecx	Unknown, set to 0.
edx	Holds the second result after SMM.
esi	Unknown, set to 0.
edi	Unknown, set to 0.

The SMM handler can signal a failure by either:

- setting the lower sixteen bits of `eax` to `0xffff`
- not modifying `eax` at all
- setting the carry flag

SMM command codes

Command Code	Command Name	Description
`0x0025`	Get Fn key status	Returns the Fn key pressed after SMM: • 9th bit in `eax` indicates Volume up • 10th bit in `eax` indicates Volume down • both bits indicate Volume mute
`0xa069`	Get power status	Returns current power status after SMM: • 1st bit in `eax` indicates Battery connected • 3th bit in `eax` indicates AC connected
`0x00a3`	Get fan state	Returns current fan state after SMM: • 1st byte in `eax` holds the current fan state (0 - 2 or 3)
`0x01a3`	Set fan state	Sets the fan speed: • 1st byte in `ebx` holds the fan number • 2nd byte in `ebx` holds the desired fan state (0 - 2 or 3)
`0x02a3`	Get fan speed	Returns the current fan speed in RPM: • 1st byte in `ebx` holds the fan number • 1st word in `eax` holds the current fan speed in RPM (after SMM)

`0x03a3`	Get fan type	Returns the fan type:
		• 1st byte in `ebx` holds the fan number
		• 1st byte in `eax` holds the fan type (after SMM):
		  ◦ 5th bit indicates docking fan
		  ◦ 1 indicates Processor fan
		  ◦ 2 indicates Motherboard fan
		  ◦ 3 indicates Video fan
		  ◦ 4 indicates Power supply fan
		  ◦ 5 indicates Chipset fan
		  ◦ 6 indicates other fan type

`0x04a3`	Get nominal fan speed	Returns the nominal RPM in each fan state: • 1st byte in `ebx` holds the fan number • 2nd byte in `ebx` holds the fan state in question (0 - 2 or 3) • 1st word in `eax` holds the nominal fan speed in RPM (after SMM)
`0x05a3`	Get fan speed tolerance	Returns the speed tolerance for each fan state: • 1st byte in `ebx` holds the fan number • 2nd byte in `ebx` holds the fan state in question (0 - 2 or 3) • 1st byte in `eax` returns the speed tolerance
`0x10a3`	Get sensor temperature	Returns the measured temperature: • 1st byte in `ebx` holds the sensor number • 1st byte in `eax` holds the measured temperature (after SMM)

Command Code	Command Name	Description

`0x11a3`	Get sensor type	Returns the sensor type:
		• 1st byte in `ebx` holds the sensor number
		• 1st byte in `eax` holds the temperature type (after SMM):
		  ◦ 1 indicates CPU sensor
		  ◦ 2 indicates GPU sensor
		  ◦ 3 indicates SODIMM sensor
		  ◦ 4 indicates other sensor type
		  ◦ 5 indicates Ambient sensor
		  ◦ 6 indicates other sensor type

`0xfea3`	Get SMM signature	Returns Dell signature if interface is supported (after SMM): • `eax` holds 1145651527 (0x44494147 or "DIAG") • `edx` holds 1145392204 (0x44454c4c or "DELL")
`0xffa3`	Get SMM signature	Same as `0xfea3`, check both.

There are additional commands for enabling (`0x31a3` or `0x35a3`) and disabling (`0x30a3` or `0x34a3`) automatic fan speed control. The commands are however causing severe sideeffects on many machines, so they are not used by default.

On several machines (Inspiron 3505, Precision 490, Vostro 1720, ...), the fans supports a 4th "magic" state, which signals the BIOS that automatic fan control should be enabled for a specific fan. However there are also some machines who do support a 4th regular fan state too, but in case of the "magic" state, the nominal RPM reported for this state is a placeholder value, which however is not always detectable.

Firmware Bugs

The SMM calls can behave erratic on some machines:

Firmware Bug	Affected Machines
Reading of fan states return spurious errors.	Precision 490
Reading of fan types causes erratic fan behaviour.	Studio XPS 8000 Studio XPS 8100 Inspiron 580
Fan-related SMM calls take too long (about 500ms).	Inspiron 7720 Vostro 3360 XPS 13 9333 XPS 15 L502X

In case you experience similar issues on your Dell machine, please submit a bugreport on bugzilla to we can apply workarounds.

Limitations

The SMM calls can take too long to execute on some machines, causing short hangs and/or audio glitches. Also the fan state needs to be restored after suspend, as well as the automatic mode settings. When reading a temperature sensor, values above 127 degrees indicate a BIOS read error or a deactivated sensor.