# Power Off, Sleep and Standby

Common terms in use relating to sustainability…

…but what do we all mean when we use these terms.

A survey of engineers.
A deep discussion on each term and the results of the survey.
Further exploration leading to ACPI.
Cross mapping between terms.

# Greening of Streaming View

By the Lexicon Working Group (WG1)

## About WG1

Greening of Streaming has an objective to improve the energy efficiency of streaming ecosystems.

Working Group 1 seeks to help the industry refine the language we use, particularly as we adopt new terms, or adapt existing terms to describe sustainability related objectives. Many of our terms have evolved from broadcast engineering and business. Sometimes we use terms at cross purposes to each other, and at other times we are simply unfamiliar with the words.

In WG1 we pick words and discuss them internally, and reach out to the wider community with surveys, refine those thoughts and produce these papers. What we expect our readers to discover is that when they picked the paper up they thought they knew what the term meant, and after reading the paper they will better understand interpretations of the terms from different perspectives. They will also be left able to use the word with better context for clarity. We will conduct the working group in English, but we are making a point of asking those in our membership who speak other languages to consider that and to bring that to the discussion too.

## Power off, sleep and standby.

In this paper we explore the use of the terms

- 'Power Off'
- 'Sleep'
- 'Standby'

When planning for sustainability strategies in our sector - streaming and broadcast - we are all critically aware that the most inefficient use of energy is digital infrastructure that is powered up and 'waiting' to perform a function or task, but not actually doing anything. If you can somehow power off infrastructure down then potentially there are energy savings.

However digital media infrastructure is not usable when it is powered off. But some digital media infrastructure can be powered on and off as it is required. In practice though it really means powered from a low power state to a higher power state.

We also realised that while for a laptop owner 'sleep' is shutting the lid, to a Set-Top Box manufacturer 'sleep' is 'dimming the red light' and to a chip maker 'sleep' happens 40 million times a second…

And with 'standby' being a commonly used term we came to the conclusion that we needed to ask our industry colleagues how they used these three terms. We reached out to about 30 folks we knew.

The results were very interesting - not least because no two results were the same!

Here are a spread of inputs for each term.

**SLEEP**

I don't see this word used

1 response

This mode is "power saving" mode without shutting down the system. The main function of the system is stopped and the internal processes are slowed down or stopped if possible to consume less resources. Returning to the main function is fast.

1 response

To pause an application/device in a working state so that it may be initiated as quickly as possible once the user wants to engage with it again. Single digit seconds are expected to bring back to working state. I would expect sleep to take longer to come back to active status than standby. I would expect power consumption to be minimal, just enough to keep anything that was in active memory alive.

1 response

**STANDBY**

Suspend all the features except the one to wake up the system. Keep only mandatory checks

1 response

Ready to start in 5 seconds

1 response

Stand by: the system is always powered and its main functions work to keep its memory waiting for an interruption by its input-output devices.

1 response

**POWER OFF**

depends on equipment : - those with sperate BLC keep BMC on, - those with no BMC will shut down completely

1 response

Completly off, Needs a finger to turn it back on

1 response

Zero power consumption (or as close to zero as physically possible). The system will have to go through a full booting sequence to restart.

1 response

In full the results were well represented by wordclouds:

Sleep

# Standby

# Power Off



With a sample size this small it was obvious that we would only get an indication of where typical engineers use of these terms may range, but as we can see from simply the size of the word clouds there were a few strongly common terms in each.

System stands out strongly on all three terms. Consumption, Power and Energy appear frequently too. Restart appears strongly in power off, less so under 'sleep' and almost not at all under standby.

All sorts of conclusions could be drawn, but the point is made: while these terms are often used deterministically, bin practice, across engineering groups they appear to lack unified / clear definition.

# ACPI

Philippe and Daniele from Mainstreaming then brought the ACPI standards for these terms to the groups attention.

**Power states**  [ edit ]

**Global states**  [ edit ]

The ACPI Specification defines the following four global "Gx" states and six sleep "Sx" states for an ACPI-compliant computer system:[34][35]

| Gx | Name | Sx | Description |
|---|---|---|---|
| G0 | Working | S0 | The computer is running and the CPU executes instructions. "Awaymode" is a subset of S0, where monitor is off but background tasks are running |
| G1 | Sleeping | S0ix | Modern Standby,[36] or "Low Power S0 Idle". Partial processor SoC sleep.[37][38] Known to ARM and x86 devices. |
| | | S1 | *Power on Suspend (POS):* Processor caches are flushed, and the CPU(s) stops executing instructions. The power to the CPU(s) and RAM is maintained. Devices that do not indicate they must remain on may be powered off. |
| | | S2 | CPU powered off. Dirty cache is flushed to RAM. |
| | | S3 | Commonly referred to as *Standby, Sleep,* or *Suspend to RAM (STR)*: RAM remains powered. Fans may turn off. Requires GPU drivers on Windows. |
| | | S4 | *Hibernation* or *Suspend to Disk:* All content of the main memory is saved to non-volatile memory such as a hard drive, and the system is powered down. |
| G2 | Soft Off | S5 | G2/S5 is almost the same as G3 *Mechanical Off*, except that the power supply unit (PSU) still supplies power, at a minimum, to the power button to allow return to S0. No previous content is retained. Other components may remain powered so the computer can "wake" on input from the keyboard, clock, modem, LAN, or USB device. |
| G3 | Mechanical Off | | The computer's power has been totally removed via a mechanical switch (as on the rear of a PSU). The power cord can be removed and the system is safe for disassembly (typically, only the real-time clock continues to run using its own small battery). |

The specification also defines a *Legacy* state: the state of an operating system which does not support ACPI. In this state, the hardware and power are not managed via ACPI, effectively disabling ACPI.

https://en.wikipedia.org/wiki/ACPI#:~:text=Commonly%20referred%20to%20as%20Standby,Requires%20GPU%20drivers%20on%20Windows.&text=Hibernation%20or%20Suspend%20to%20Disk,the%20system%20is%20powered%20down.

We spend several meetings talking through these definitions and understanding the nuances.

# Final Mapping of our results to ACPI

Overall we felt that these definitions were well defined and we set about mapping our use of the terms Sleep, Standby and Power Off to these ACPI models.

After some discussion and review this is the set of tables we came up to help that mapping:

| System Status | Consumption | Wake Up Time | Interaction | Status Visibility | ACPI |
|---|---|---|---|---|---|
| **PUBLISH (Device with display: Smartphone, Tablet, SmartTV, SmartClock)** | | | | | |
| **Power On** | Full power<br>Consumption proportional to the brightness level of the display<br>Consumption proportional to the CPU load of active applications | Is On | All<br><br>The Device can never automatically go into Sleep or Stand-by status while it is playing videos, including video conferencing applications, slide shows, etc. | Display on | S0 |
| **Stand By** | To immediately stop consuming specific resources<br><br>Power line supply:<br>   In some case, App active, can start a screen saver to avoid display impression (stand-by). After a configurable time can turn-off the display and reduce power consumption (Sleep)<br><br>Battery supply:<br>   Display completely turned off<br>   Clock on with some device<br>   Reduced consumption<br>   Some Background App can still work with reduced performance and lower consumption | Stand-by to live in < 1 seconds<br><br>State actively maintened and updated<br><br>Faster than Sleep | To be able to respond to direct or indirect end user interaction<br><br>Power line supply:<br>   Remote command<br>   Touch the display or PIR sensor<br><br>Battery supply:<br>   Touch the display<br>   Move the device<br>   Receiving notifications | To be visibly inactive to an end consumer until another direct or indirect interaction occurs<br><br>Power line supply:<br>   Red LED or similar low power indicator<br>   Logo light on, configurable<br>   Clock or slideshow<br><br>Battery supply:<br>   Display completely turned off<br>   Clock on with some device | S1 - S2 |
| **Sleep** | The system would stop all activity except waiting for a "wake up" or "power ON" command.<br><br>System going to standby mode should put itself in a state where no application task are executed until a "continue" command or a new job order is received.<br><br>Power line supply:<br>   In some case, App active, can start a screen saver to avoid display impression (stand-by). After a configurable time can turn-off the display and reduce power consumption (Sleep)<br><br>Battery supply:<br>   Display completely turned off<br>   Few BackGround App can still work with reduced performance and lower consumption | Service is ready to be used on the fly<br><br>Stand-by to live < 5 sec<br><br>State Preserved | To be able to respond to direct or indirect end user interaction<br><br>Power line supply:<br>   Remote command<br>   Touch the display or PIR sensor<br><br>Battery supply:<br>   Touch the display<br>   Move the device<br>   Notification turned off | To be visibly inactive to an end consumer until another direct or indirect interaction occurs<br><br>Power line supply:<br>   Red LED or similar low power indicator<br>   Logo light on, configurable<br>   Clock or slideshow<br><br>Battery supply:<br>   Display completely turned off<br>   Clock on with some device | S3 - S4 |
| **Power OFF** | Power line supply:<br>   The Power Supply Unit still supplies power, at minimum, to receive the remote command<br>   <0,1W or <1%<br><br>Battery supply:<br>   Minimum consumption with capacity button<br>   No consumption with mechanical button<br>   Natural battery discharge | Full booting sequence to restart.<br><br>Clean system at start | Direct input must be provided to return the system to a "power on" state.<br><br>Power line supply:<br>   Remote power-on command<br>   Still wake on LAN commands<br><br>Battery supply:<br>   Mechanical or capacity<br>   Turning on the charging power supply | Power line supply:<br>   Red LED or similar low power indicator<br>   Logo light on, configurable<br><br>Battery supply:<br>   Completely turned off | S5 |
| **Mechanical Off** | None | Full booting sequence to restart.<br><br>Clean system at start | Mechanical action to Power On | Completely turned off | |

| System Status | Consumption | Wake Up Time | Interaction | Status Visibility | ACPI |
|---|---|---|---|---|---|
| | PUBLISH (Device without display: SmartSpeaker) | | | | |
| Power On | Full power<br>Consumption proportional to the sound volume | Is On | All | Usually none, one or more colored Led when interacting with a user | S0 |
| Stand By | Power line supply:<br>  Reduce consuming, no audio output<br><br>Battery supply:<br>  no device | Stand-by to live in < 1 seconds<br><br>State actively maintened and updated<br><br>Same as Sleep | To be able to respond to direct "voice" end user interaction<br><br>Power line supply:<br>  Voice command<br>  Touch the device<br><br>Battery supply:<br>  no device | None | S1 - S2 |
| Sleep | Power line supply:<br>  Reduce consuming, no audio output<br>  Microphone disable<br><br>Battery supply:<br>  no device | Stand-by to live in < 1 seconds<br><br>State actively maintened and updated<br><br>Same as Stand By | Microphone turned off<br><br>Power line supply:<br>  Turn on microphone<br><br>Battery supply:<br>  no device | None | S3 - S4 |
| Power OFF | Power line supply:<br>  None<br><br>Battery supply:<br>  no device | Full booting sequence to restart.<br><br>Clean system at start | Power switch turned off<br><br>Power line supply:<br>  Turn on power switch<br><br>Battery supply:<br>  no device | Switch in off position | S5 |
| Mechanical Off | None | Full booting sequence to restart.<br><br>Clean system at start | Mechanical action to Power On | Completely turned off<br>  Switch off<br>  Socket disconnected | |

| System Status | Consumption | Wake Up Time | Interaction | Status Visibility | ACPI |
|---|---|---|---|---|---|
| | | | PUBLISH (Device with external display - Set-Top Box: Apple TV 4k, Amazon Fire TV 4K, Chromecast with Google TV (4K) ) | | |
| **Power On** | Full power<br><br>Consumption is proportional to the CPU load of active applications or to the workload of CPU/GPU depending on the video streaming characteristics (* see below)<br><br>Usually this type of device is powered by the mains.<br>**Apple TV** has an internal power supply<br>**Amazon and Google devices** have an external power supply with USB connection. It is not possible to power them from a USB socket on the TV as it requires more power than can be supplied. | Is On | All<br><br>The Device can never automatically go into Sleep or Stand-by status while it is playing videos, including slide shows, etc.<br><br>CEC - Consumer Electronics Control<br>https://en.wikipedia.org/wiki/Consumer_Electronics_Control<br>These 3 Set-Top Boxes and others listed below support CEC technology. Among the most interesting features in this analysis are:<br>Synchronized Power On and Off: Turning on or off one device can automatically power on or off other connected devices, simplifying the management of the entire multimedia system.<br>Automatic Source Selector: CEC technology may enable the TV to automatically switch to the appropriate HDMI source when a connected device is turned on. A further aspect of this function is that the Set-Top Box is informed that it no longer has the display (TV) connected and can pause the video, activate a screen saver and/or go into Stand By. | On some devices a Led is on<br><br>Attached display on | S0 |
| **Stand By** | To immediately stop consuming specific resources See in "Device wed W $" sheet the reduced consumption.<br><br>In some case, App active, can start a screen saver to avoid external display impression (stand-by).<br>After a configurable time can turn-off the external display and reduce the global power consumption (Sleep). Only if there aren't video in streaming or other active App running<br><br>Contrary to what the user might expect, starting a Screensaver, with the exception of the blank video, involves consumption comparable to video streaming. Just think of the Apple TV Screensaver which launches the high resolution aerial view, or the photo SlideShow on other devices. | Stand-by to live in < 1 seconds<br><br>State actively maintened and updated<br><br>The Sleep and Stand by states are not well differentiated in this type of device. Depending on the device they can be defined in one or another name | To be able to respond to direct or indirect end user interaction<br><br>Remote command<br>Selecting on the attached display the HDMI input via CEC command. | On some devices a Led is on<br><br>Attached display go blank | S1 - S2 |

| System Status | PUBLISH (Device with external display - Set-Top Box: Apple TV 4k, Amazon Fire TV 4K, Chromecast with Google TV (4K) ) | | | | |
|---|---|---|---|---|---|
| | Consumption | Wake Up Time | Interaction | Status Visibility | ACPI |
| Sleep | consumption.<br><br>In some case, App active, can start a screen saver to avoid external display impression (stand-by).<br>After a configurable time can turn-off the external display and reduce the global power consumption (Sleep). Only if there aren't video in streaming or other active App running.<br><br>Some device can start a screen saver after a configurable time with the video in Pause, and successively blank the attached video. | State actively maintened and updated<br><br>The Sleep and Stand by states are not well differentiated in this type of device. Depending on the device they can be defined in one or another name. | Remote command<br>Selecting on the attached display the HDMI input via CEC command | Attached display go blank | |
| Power OFF | The Power Supply Unit still supplies power, at minimum, to receive the remote command<br>   <0,1W or <1%<br><br>Considering the consumption of the power supply in the Power Off state, the reduction in its efficiency at low consumption and presumably the greater number of hours in the Off state compared to the On condition. It should be noted that consumption and consequently costs can be significantly higher. keeping the device switched off but connected to the electrical mains. Adopting a power supply, as in the case of the Apple TV, which has a very limited power absorption with the device turned off (1/3 of the other two devices considered), involves a reduction in consumption that is more significant than the energy savings can be when switching the device from On to Sleep/Stand by for a few tens of minutes before Power Off. | Full booting sequence to restart.<br><br>Clean system at start | Direct input must be provided to return the system to a "power on" state.<br><br>Remote power-on command<br><br>Some device wake up turning on the attached TV if CEC function is enable | All off | S5 |
| Mechanical Off | None of the devices have a mechanical power off button. The power supply must be physically disconnected from the electrical mains. | Full booting sequence to restart.<br><br>Clean system at start | Plug the power supply into the electrical outlet. | Completely turned off | |

| PUBLISH (Servers - Encoders - Headend) | | | | | |
|---|---|---|---|---|---|
| **System Status** | **Consumption** | **Wake Up Time** | **Interaction** | **Status Visibility** | **ACPI** |
| **Sleep** | To immediately stop consuming specific resources<br><br>Zero signal output or system feedback other than a status light<br><br>No CPU instructions are executed except a "wake up" command treatment<br><br>Just enough to keep anything that was in active memory alive | Sleep to live in < 10 seconds<br><br>State Preserved<br><br>Longer than Stand-by<br><br>Faster than Power OFF | To be able to respond to direct or indirect end user interaction | To be visibly inactive to an end consumer until another direct or indirect interaction occurs<br><br>Status light (lower power consumption, hopefully)<br><br>To be visibly inactive to an end user until a specific, direct interaction occurs | S3 - S4 |
| **Stand By** | /CHANGE ORDER/ StandBy energy consumption is higher than in Sleep mode, because most states actively maintained<br><br>The system would stop all activity except waiting for a "wake up" or "power ON" command.<br><br>System going to standby mode should put itself in a state where no application task are executed until a "continue" command or a new job order is received.<br><br>It's a transient state before sleeping.<br><br>**HOT STANDBY**<br><br>**COLD STANDBY half way between HOT STAND BY  and SLEEP (ACPI** | **Service is ready to be used on the fly**<br><br>Stand-by to live < 1 sec<br><br>State actively maintened<br><br>**Streaming delivery ON?** | To be able to respond to direct or indirect end user interaction | To be visibly inactive to an end consumer until another direct or indirect interaction occurs | S0-S0ix |
| **Power OFF** | The Power Supply Unit still supplies power, at minimum, to allo return to Stand By.<br><br>A full reboot is required (copy from slide) | Full booting sequence to restart.<br><br>Clean system at start | Direct input must be provided to return the system to a "power on" or "standby" state.<br><br>Still wake on LAN commands. | To enter a state where it is visibly obvious to an end user that the system is not going to be responsive to any input, is not consuming resources, and is specifically not consuming power. | S5 |

# Notes on the summary spreadsheets

From the analysis carried out, it emerges that the terms "Sleep" and "Standby" are known by users, but there is a fair amount of confusion about the correct attribution of device states. This is also a consequence of the different nature of the devices. Where some states are clearly understandable, for example in a notebook, in other types of devices it is difficult to distinguish and understand the functional differences or even the very existence of different states, for example in a SmartDisplay such as the Google Nest Hub.

This difficulty in interpreting the states can also be found by analyzing documents and websites of the manufacturers of these devices, obviously excluding computers.
In many cases there are no two different Sleep and Standby status. For the same category of devices they are used alternatively to identify a state of the device which is not always correlated with an effective reduction in energy consumption. For example, in Set-Top Box devices, activating the Screensaver for a hypothetical Sleep condition does not lead to a consequent reduction in consumption.

For some devices, in particular those with an external display and powered by the mains, the annual energy consumption in the PowerOff state can be comparable if not even higher than the consumption in the On state, considering an average ratio of 4 hours On per day. This means that the timed activation of a Sleep/Stand by state tens of minutes before Power Off is not significant in terms of energy consumption, if not detrimental for example for the activation of the ScreenSaver.

For energy saving purposes, it would be more important to adopt power supplies that have very low Power Off consumption and better efficiency in the On state.
Alternatively, the adoption of USB-C ports on TVs capable of providing sufficient energy for the Set-Top Boxes, so that turning off the TV involves the complete disconnection of these devices.
A consumption of 1W/h in the PowerOff state, 7.3kW/h per year, multiplied by tens or hundreds of millions of devices leads to enormous energy waste.