Whitepaper

Modern Standby on Dell Client PCs

With the increased demands of customers, and intelligence included in Client PCs, the need to have a long sleep period but quick access to data and resources is of paramount importance. To cater to this demand, the PC market is moving all systems from the legacy Suspend behavior to a Modern Standby where all devices are self-powered and provide a capability for near instant-on functionality, as well as periodic network updates, but maintaining long battery life while in low power.

November, 2019

Table of contents

Introduction

Client PCs are becoming increasingly important to users lives by providing functions such as network connectivity, phone usage, text and chat, TV usage, and so on, As PCs continue to become a centralized entity in our daily lives, the ability to deliver optimal power to the computer while maintaining long battery life and near-instant response time has become a critical demand of all customers. A key enabler to provide this level of long battery life and instant behavior is the introduction of Modern Standby in future computer designs.

Modern Standby is the revolutionary migration of the Windows sleep state to enable a PC's idle-system optimizations and instant-on behavior.

Dell has launched several systems over the past few years enabling the Modern Standby feature and will continue to aggressively drive optimal user behavior with internal and external partnerships.

Overview and Details of Modern Standby

Modern Standby is the next step in the evolution of low-power sleep states for Microsoft operating systems. Several instances of low-power implementations have taken place in the past with various levels of success with power and performance targets. The most prevalent is S3 suspend which places the system into the ACPI system sleep state of S3. This behavior is common over the past 20 years but provides limited performance capabilities. An inability to provide instant-on and perform operations while in S3 are historical drawbacks of this power state.

Modern Standby in Windows 10

Since Windows 10's inception, Modern Standby has been constantly refined to make it more resilient as well as address new user scenarios such as wake on voice, wake on fingerprint reader, and the ability to stream audio from your PC while in Modern Standby.

You can also support non-SSD hard drives, more selectively waking up in connected designs to reduce battery usage and making ecosystem drivers more aware of the power state.

Modes of Modern Standby

There are two main modes of Modern Standby: Connected and Disconnected Standby. These two modes allow for varying network capabilities of the system and should be evaluated independently of each other.

CONNECTED STANDBY

Connected Standby is configured by the user and allows the operating system to initiate and respond to network access requests. This allows prescribed functions and applications to reach out to servers and update content (for example, Outlook, OneDrive data synch, and so on) or respond to incoming requests (for example, voice over IP phone calls, Instant Messaging, and so on).

When enabled, Connected Standby will consume higher power as it will allow for more applications to periodically wake the system up and connect to servers for data.

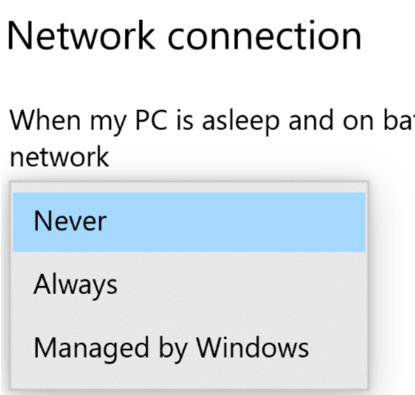
DISCONNECTED STANDBY

Disconnected Standby is configured by the user and disables the operating system's capability to initiate and receive network traffic during sleep state operations. This configuration will improve the system's total power configuration but may introduce missed network operations and functions due to the inability to receive calls/IMs, and so on.

CONFIGURING CONNECTED VERSUS DISCONNECTED STANDBY

The user can configure Connected or Disconnected Standby through the Settings option in the Power and Sleep section for Network Connection.

Figure 1. Modern Standby Configuration



- Setting this configuration to **Never** sets the system to Connected Standby when on battery.
- Setting this configuration to **Always**, the system will configure the system to Disconnected Standby.
- Setting this configuration to **Managed by Windows**, the operating system determines based on current battery availability and software installation to enable Connected Standby

For advanced users and IT administrators, the following registry key can be utilized to disable Connected Standby and force Disconnected Standby.

```
[HKEY_LOCAL_MACHINE\SYSTEM\ControlSet001\Control\Power]

"EnforceDisconnectedStandby"=dword:00000001

 POWERCFG /SETACVALUEINDEX 381b4222-f694-41f0-9685-ff5bb260df2e
SUB_NONE CONNECTIVITYINSTANDBY 0

POWERCFG /SETDCVALUEINDEX 381b4222-f694-41f0-9685-ff5bb260df2e
SUB_NONE CONNECTIVITYINSTANDBY 0
```

Phases of Modern Standby

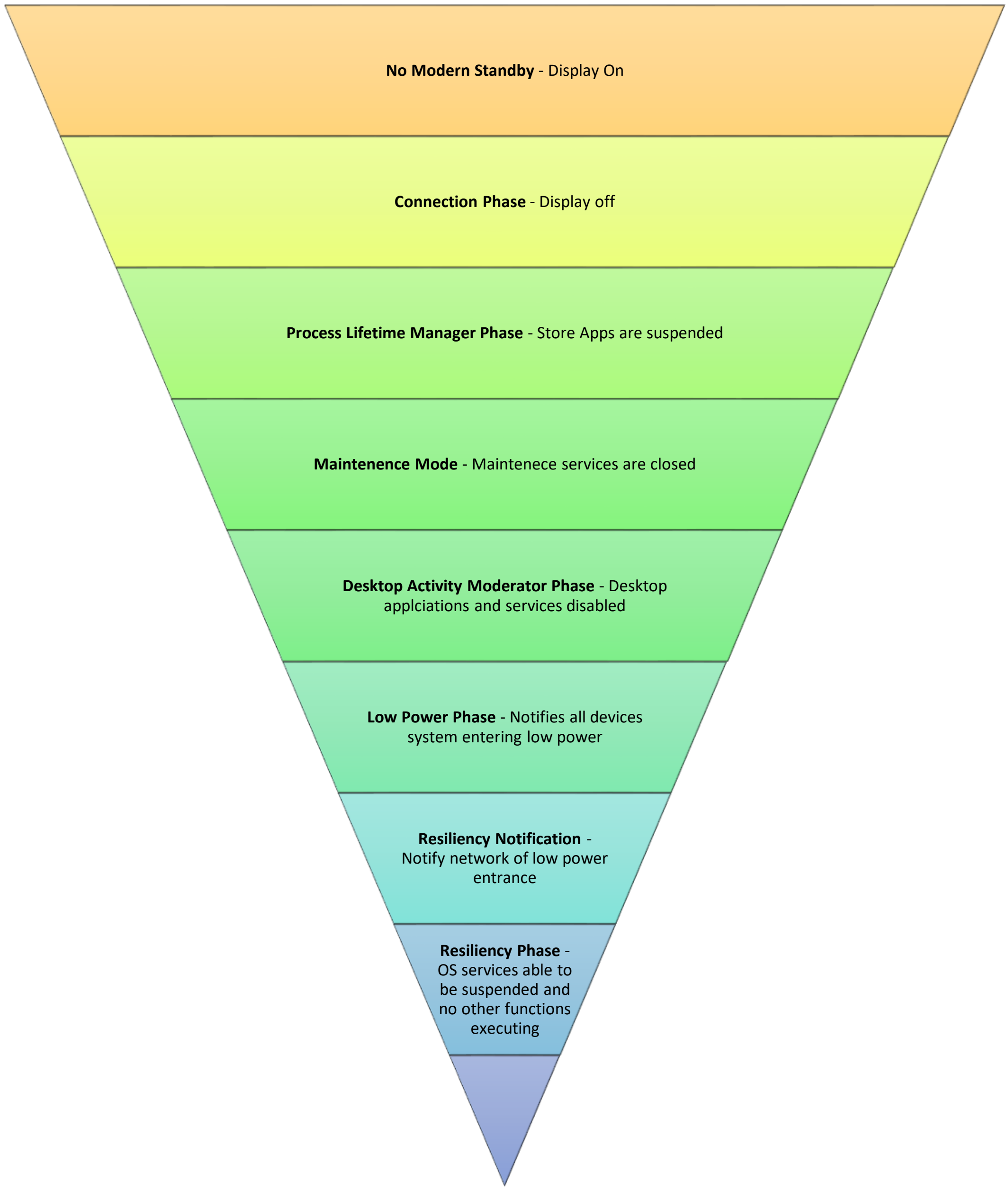
Windows implements Modern Standby in a multitude of manners. The concept of Modern Standby is to allow dynamic and aggressive low-power entrance and exits upon usage demands. Due to this nature, Microsoft has implemented a tiered approach to Modern Standby. The table below from Microsoft highlights this information: (https://docs.microsoft.com/en-us/windows-hardware/design/device-experiences/prepare-software-for-modern-standby)

Table 1. Modern Standby Software Phases

Phase	Description	Tasks Performed	Exited when…	Typical Duration
No-CS phase **Note This is also the phase where the device waits for the sleep timeout to elapse.**	The system is powered on and the screen is turned on. The system is not in standby.	No standby preparation tasks are being performed.	The screen is powered down.	N/A
Connection phase	The system is checking for remote desktop connections.	Determine if remote desktop session(s) exist. Begin tracking outstanding power requests.	There are no remote desktop sessions connected.	Zero seconds if no remote desktop sessions are connected. Phase will last until all remote desktop sessions are disconnected or have timed out.
Presence phase	This phase is currently not used by Windows 8 or Windows 8.1.			

Process Lifetime Manager (PLM) phase	The system suspends Microsoft Store apps that are in the foreground.	Suspend all foreground Microsoft Store apps. Check for ongoing non-offloaded audio playback or communications app activity.	All foreground Microsoft Store apps have been suspended and no non-offloaded audio playback is occurring.	Typically, less than five seconds. If non-offloaded audio playback is ongoing, this phase will block until audio playback stops. Audio playback may be part of a music or communications app.
Maintenance phase	The system executes maintenance tasks.	Wait for maintenance tasks to complete if running (most common on AC power).	No system maintenance tasks are running.	Typically, less than one second. The system is most likely to block on maintenance phase on AC power.
Desktop Activity Moderator (DAM) phase	The system pauses desktop applications to reduce their power consumption during standby.	Check for outstanding power requests (PowerRequestExecutionRequired). Wait for outstanding power requests to be dropped by the application or enforce a maximum time-out on battery power (five minutes).	All outstanding power requests have been cleared by applications or the maximum time-out has been reached.	Typically, zero seconds. If the system is on battery power, outstanding power requests will cause this phase to block for a maximum of five minutes. The applications with power requests can be inspected by running Powercfg.exe with the /requests option. If the system is on AC power, outstanding power requests will cause this phase to block indefinitely or until the power request is cleared by the application.
Low-power phase	The system notifies registered subscribers that the power manager is entering a low-power, long-resume-latency phase. This is used by some devices as a hint to power down.	Notify registered subscribers.	All registered subscribers have been notified.	Typically, five seconds.
Resiliency notification phase	The network subsystem is notified to enter a low-power mode.	Notify the network subsystem. Network adapters that do not support modern connected standby are turned off (D3).	The network subsystem has been notified.	Typically, less than one second.
Resiliency phase	The system is ready for the SoC to enter the lowest power mode and remain idle.	PDC resiliency clients are notified that the system is in resiliency phase. Session-0 services are throttled by the DAM to no more than one second of activity every 30 seconds. The power manager waits for activators to turn on their reference and cause the system to remain active.	The system exits standby due to user input or a power button press. The system transitions to maintenance phase to run system maintenance.	The majority of time the system is in standby.

Figure 2. Modern Standby Software Phases



As the operating system disables applications and services from running by putting them to sleep, the system will utilize less power. When operating system services demanding hardware access are put to sleep, the hardware devices will propagate into idle power states, thereby reducing overall power consumption. For each phase, the operating system will allow fewer operating functions to execute.

Resiliency Mode is the final mode of which all Modern Standby systems are to achieve. In Resiliency Mode, all software services and associated hardware devices are put to sleep to eliminate excessive power consumption.

System Requirements

This section provides detailed information on the requirements to support Modern Standby. In general, most behavior is focused on the configuration of the system and ensuring that all applications, drivers, firmware, and hardware properly enter into their independent lowest idle states. This will allow for the overall system to enter the lowest possible power state.

As the operating system moves from one phase of Modern Standby to another, all devices associated with the software services will be evaluated to ensure that they can enter into their associated low power states if no additional accesses are requried.

BIOS REQUIREMENTS

Dell configures all supported systems to be fully compliant with Modern Standby and tests our systems and firmware to Microsoft specifications.

Dell does not allow for users to modify any Modern Standby configurations within the BIOS setup. This includes disabling Modern Standby to utilize legacy S3 operations.

In general, the BIOS is not directly involved with Modern Standby execution. The role of BIOS is to configure the devices connected and ensure that capabilities are surfaced to the operating system through ACPI methods. Additionally, the BIOS will act as a proxy for ACPI communications to the devices when operations are directed of them.

BIOS shall enumerate support for Modern Standby by enumerating the ACPI_S0_LOW_POWER_IDLE FADT flag within the ACPI system configuration table.

Of note, Linux supports a similar power management scheme to Modern Standby called Suspend to Idle on releases above Ubuntu 18.04.x and RHEL 8.x

> Linux details are posted at Suspend to Idle (Linux Modern Standby)

BIOS CONFIGURATION OF SYSTEM

Intel provides significant reference code for which Dell heavily leverages and configures to expose and enumerate Modern Standby. The BIOS is also responsible for modifying device capabilities via ACPI enumeration modifications. Examples include wake support, and so on.

HARDWARE COMPONENT AND DRIVER REQUIREMENTS

https://docs.microsoft.com/en-us/windows-hardware/design/device-experiences/prepare-hardware-for-modern-standby

As the operating system places applications and services into sleep states, the devices associated with these states will become idle and are expected to enter their lowest idle power state. This state is often referred to as Deepest Runtime Idle Power State (DRIPS). DRIPS is identified by each individual device.

Dell validates all hardware devices in shipping configurations to ensure that they can properly enter DRIPS to support Modern Standby behaviors. Any additional devices added to the system must be carefully tested to ensure compliance and alignment to system performance.

For a system to provide optimal performance while in the low power state, all hardware components and associated drivers must support entrance into the device's lowest power state possible without impacting the system.

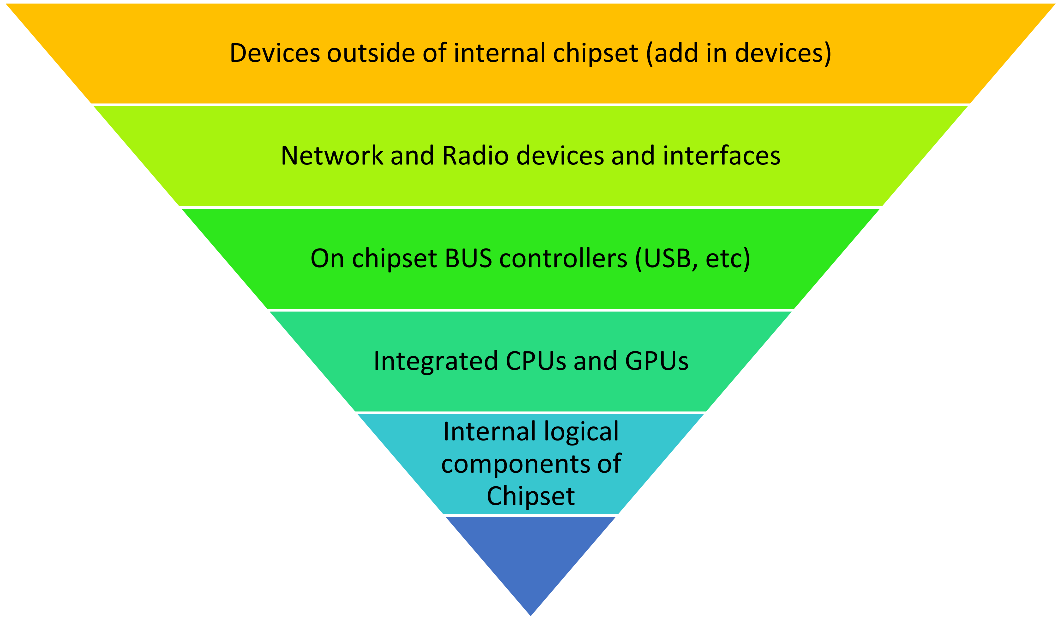
DRIPS: Deepest Run-time Idle Platform State

The DRIPS state always has the following characteristics:

- DRIPS is the lowest power consumption state for the platform in which memory is preserved in a self-refresh mode.
- DRIPS allow the platform to wake on events from networking, radio, and input devices.
- No CPU code can run during the DRIPS state.
- In the DRIPS state, the platform will consume the least amount of power possible by design
-

For the total system to enter the lowest power state possible, all devices must enter their associated individual lowest power states.

Figure 3. Hardware Power Topology



For each phase of the hardware system, all devices above it must enter their DRIPS. For example, the integrated CPU cannot enter DRIPS if the chipset BUS controller is not able to enter DRIPS.

NOTE: It is important to understand that externally connected devices may block the system from entering the lowest power state possible.

Microsoft has created additional driver frameworks to increased support for devices to enter DRIPS in a dynamic and intelligent manner. This is performed through the introduction of Directed Power Management (https://docs.microsoft.com/en-us/windows-hardware/design/device-experiences/directed-power-management).

Microsoft mandates that all certified devices and device drivers must support the Windows Power Management Framework (PoFx) for Component Level Power Management. Support and registration of input into this includes:

- D-state support
- Transition Latency
- Residency requirements for transitions
- Nominal power assumed to be consumed

POFX driver samples are available at https://github.com/Microsoft/Windows-driver-samples/tree/master/pofx

All devices must support appropriate device-specific power functions to react based on Windows commands. Windows details this as the Runtime Power Management framework which mandates the power state that the device shall enter.

Windows is targeting to create and mandate a Directed power framework (DFx) for devices which do not adequately power down the driver and device in a specified time-frame (Microsoft is currently targeting this to be set to two minutes). Exact functionality of this behavior is not yet provided.

All devices must support entrance into D3 Hot mode. Upon entrance into D3 hot, the device must transition to the D3 cold state, to allow the bus controller to enter low power state. If the device maintains entrance into the D3 hot state, the host controller, as well as subsequent higher-level components and SOC will not be able to enter lower a power state.

D3 Hot

The D3 Hot state is the device state for which the device is in near full power off mode but can still communicate to the bus controller for status and context. Devices in D3 Hot can re-enumerate through the software operations and not require hardware interactions. The D3 Hot state indicates that the device requires power to maintain system state configuration data in a refresh manner (memory, CPU cycles, and so on.).

D3 Cold

The D3 Cold state is the device state for which all power has been removed from the device. The device may be able to draw limited power from non-standard channels.

- Devices in the D3 Cold state require hardware methods to reset the device and provide enumeration. The D3 Cold state indicates that the device does not require external power and will self-gate power and the context will be saved in a non-volatile manner.

For more information, see: https://docs.microsoft.com/en-us/windows-hardware/drivers/kernel/device-sleeping-states#d3cold

Identification

Each device must enumerate, through ACPI or driver methods, a full list of capabilities and requirements as described by Microsoft. This includes the ability to support the D3 Hot or D3 Cold device state.

https://docs.microsoft.com/en-us/windows-hardware/drivers/ddi/content/wdm/ns-wdm-_device_capabilities

SOFTWARE REQUIREMENTS

Finally, all software applications and services installed onto a system must be aware of Modern Standby functionality and concepts as well. Software applications must be able to be put into a sleep state and relinquish all handles and connections to hardware and drivers to allow the system to enter the lowest possible sleep state.

Installing an application which is not Modern Standby aware or capable may restrict the PC from entering Modern Standby and achieving optimal battery life capabilities.

Microsoft includes power state awareness into all Windows Store applications and frameworks for Store application creations. These are enabled during build time and must be adhered to by the application.

This support is not present for legacy Windows 32 desktop applications. During the Desktop Activity Moderator Phase of Modern Standby, the operating system will request all desktop applications to enter a sleep state. Applications not aware of Modern Standby may ignore these commands and could cause the system to not enter the optimal power configuration.

Troubleshooting and Advanced Functionality

If you are experiencing unexpected power behavior when in Modern Standby, Microsoft provides several powerful utilities to debug and provide capabilities for Modern Standby identification and optimization build into the Windows 10 operating system.

Microsoft also has several other utilities (Windows Performance Analyzer and Connected Standby Assessment and Stress tests) that are included in development and debug kits which are outside the scope of most users are not included in this reference. For more information, please see Microsoft's information at: https://docs.microsoft.com/en-us/windows-hardware/design/device-experiences/tools-available

POWERCFG UTILITY

Powercfg is a command line utility that Microsoft provides with Windows 10 operating systems. Powercfg provides powerful power mode identification and debugging capabilities.

For more information, see: https://docs.microsoft.com/en-us/windows-hardware/design/device-experiences/powercfg-command-line-options

The link above provides exhaustive information on how to utilize powercfg, but the key usages should start at:

Powercfg /a – this function allows the user to verify the system's support capability for low power. If this command identifies "Standby (S0 Low Power Idle) as a supported power configuration, your system supports Modern Standby.

```
C:\WINDOWS\system32>powercfg /a
The following sleep states are available on this system:
    Standby (S0 Low Power Idle) Network Connected
```

Powercfg /sleepstudy – this function provides the user with a detailed power consumption report during sleep of all applications, drivers, and devices. This report provides the user with indications of potentially impacting components which are blocking the system from entering Resiliency Mode.

CONNECTED VS. DISCONNECTED STANDBY CONFIGURATION

As stated above, a common system modification to improve power consumption during Modern Standby is to disable Connected Standby. Due to the increased network requirements, Connected Standby will consume more power and is an initial default method for debug and modification to allow for improvements.

UPDATE DRIVERS, APPLICATIONS, AND FIRMWARE

As detailed above, the ability for all drivers, applications, and firmware to be Modern Standby aware is critical to the overall power optimization of a system. As such, ensure your system has the latest verified configuration of drivers, applications and firmware for your system. Updated drivers for your system can be found at https://dell.com/support.

Summary

Modern Standby is the next evolution of the operating systems sleep state and is meant to bridge the user experience from legacy PC devices and current mobile devices. Modern PCs and future PCs should all exhibit similar behaviors when pushing the power button or going idle due to inactivity.

Modern Standby will help to reduce fragmentation in the personal electronic ecosystem, by providing the best in class battery life, responsiveness, and capabilities while in a low-power, non-idle state.

Reference Links

https://docs.microsoft.com/en-us/windows-hardware/design/device-experiences/modern-standby

Learn more

Visit Dell.com/Windows 10 for more information on Dell's Operating System support.

About the authors

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