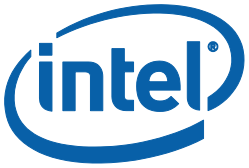


Intel® Smart Connect Technology 3.0

Platform Design Specification

August 2012

Revision 1.0

Intel Confidential

Document Number: 503673

Contents

1 Introduction 8
- 1.1 Purpose of this Document 8
- 1.2 Intel® Smart Connect Technology Life Cycle 9
- 1.3 Potential Platform Thermal Concerns 10
- 1.4 Reference Documents 10
- 1.5 Terminology 11

2 Platform Requirements 12
- 2.1 Component List 12
- 2.2 Checklist 13
- 2.3 Deep Sx Coexistence Considerations 14
- 2.4 Intel® Rapid Start Technology Coexistence Considerations 14
- 2.5 Intel® Smart Response Technology Coexistence 16

3 Hardware 17
- 3.1 Antennae Design 17
- 3.2 Platform Mini-Card Sx Requirements 17

4 BIOS/EC 19
- 4.1 BIOS Requirements 19
  - 4.1.1 Programming the Periodic Wake Timer 21
  - 4.1.2 BIOS ACPI Requirements 23
- 4.2 Embedded Controller (EC) 39
  - 4.2.1 Timer Wake Method and Display Handling 39
  - 4.2.2 Thermal 39
  - 4.2.3 System Fans 39
  - 4.2.4 Power Savings 40
  - 4.2.5 Power Button Override 40
  - 4.2.6 Audio Muting 40
  - 4.2.7 Intel® Smart Connect Technology Mode Indicator LED 41
- 4.3 S3 State Considerations 41
  - 4.3.1 Power Button in S3 State 41
  - 4.3.2 Intel® Smart Connect Technology Wake Timer Cycle Overview 41
  - 4.3.3 Platform Firmware Considerations for SAOS and SASD 41
  - 4.3.4 Incomplete S3 Transitions 42
- 4.4 S0 State Considerations 42
  - 4.4.1 Power Button in S0-ISCT State 43
  - 4.4.2 How to Determine When the System is in SO-ISCT Versus S0-Normal Mode 43
  - 4.4.3 S0-ISCT System State Design Considerations 44
  - 4.4.4 S0 Normal System State 44
  - 4.4.5 S0-ISCT State Thermal Considerations 45

5 NetDetect 46
- 5.1 Overview 46
- 5.2 Architecture 46
  - 5.2.1 NetDetect Flow 47

5.2.2 NetDetect Behavior on Power Loss 48
5.2.3 NetDetect Configuration 48
5.2.4 Radio On/Off Switch Effect on NetDetect 48

6 Intel® Smart Connect Technology SW 50
6.1 Overview 50
6.2 Intel® Smart Connect Technology Agent 51
6.2.1 S0-ISCT Duration 52
6.2.2 Network Connectivity Check 52
6.2.3 Duty Cycle 53
6.2.4 Battery Level Consideration 53
6.2.5 Thermal and Battery Monitoring during S0-ISCT 56
6.2.6 Intel® Smart Connect Technology Agent Configuration 57
6.2.7 Application White List 60
6.2.8 Intel® Smart Connect Technology Applet Dll Interface Prototypes 61
6.2.9 Intel® Smart Connect Technology Applet Dll Interface Example 70

7 Thermal Considerations 75
7.1 Overview 75
7.2 Temperature Sensing and Thermal Control 77
7.2.1 Skin Temperature Sensor 77
7.2.2 Thermal Control during Intel® Smart Connect Technology Agent 77
7.2.3 Initial Thermal Related Delay for Intel® Smart Connect Technology Agent 78
7.2.4 Summary of Intel® Smart Connect Technology Thermal Control 79

8 Chief River CRB Intel® Smart Connect Technology Support 81

9 Intel® ME Co-existence with Intel® Smart Connect Technology 82
9.1 WLAN Power Control 82
9.2 Intel® ME WLAN Provisioning 82

Figures

Figure 1-1. Typical Intel® Smart Connect Technology Activity 9
Figure 2-1. Intel® Rapid Start Technology Interaction 15
Figure 3-1. Example PCIe* Mini-card Power with Optional S3 Power Control 18
Figure 4-1. Intel® Smart Connect Technology Agent and BIOS interaction 20
Figure 4-2. System S0 State Transition Triggers 43
Figure 5-1. NetDetect Flow 47
Figure 6-1. Intel® Smart Connect Technology SW Stack 50
Figure 6-2. Intel® Smart Connect Technology Agent Operation Flow 51
Figure 6-3. Configuration Applet 57
Figure 7-1. Platform Power & CPU / Skin Temperature Trace Example for 'In-bag' Intel® Smart Connect Technology Usage 75
Figure 7-2. Wake Timer Exponential Back-off Example for Thermal Control 78
Figure 7-3. Example of Intel® Smart Connect Technology Operation over Extended Period 80
Figure 8-1. Chief River CRB Jumper Settings 81

Tables

Table 2-1. Required Components 12
Table 2-2. Optional Components 12
Table 4-1. IAOE Intel® Smart Connect Technology Control Methods 24
Table 4-2. IAOE Control Method GABS 24
Table 4-3. IAOE Control Method GAOS 25
Table 4-4. SAOS Bit 1 Value 26
Table 4-5. IAOE Control Method SAOS 27
Table 4-6. IAOE Control Method GANS 27
Table 4-7. IAOE Control Method SANS 28
Table 4-8. IAOE Control Method GWLS 28
Table 4-9. IAOE Control Method SWLS 28
Table 4-10. IAOE Control Method GWWS 29
Table 4-11. IAOE Control Method SWWS 29
Table 4-12. IAOE Control Method GPWR 30
Table 4-13. IAOE Control Method SASD 31
Table 4-14. IAOE Control Method GPCS 32
Table 4-15. IAOE Control Method Values Summary 33
Table 4-16. SAOS Values 44
Table 6-1. Sleep Duration Extension on Battery Power 53
Table 6-2. Sleep Duration Extension While Charging 55
Table 6-3. Intel® Smart Connect Technology Agent Configuration Settings 59
Table 9-1. Intel® ME Co-existence with Intel® Smart Connect Technology 82

Revision History

Document Number	Revision Number	Description	Revision Date
503673	0.7	• Updates for 3.0 • New document number for 3.0 version • Added new ACPI message GPCS (Section 4.1.2.3.12) • Added new bits to ACPI message GAOS / SAOS (Section 4.1.2.3.2) • Updated ASL Sample Code for new ACPI message changes (4.1.2.5) • Updated 2013 WLAN cards supported (Section 2.1) • Added description of Extended wake duration (Section 1.1 and Section 6.2.1.1) • Added additional BIOS flows (Section 4.1) • Removed bit 0 from GWLS / SWLS – ISCT Agent now determines Radio On/Off State (Sections 4.1.2.3.6 and 4.1.2.3.8) • Added section on thermal / battery life monitoring duration S0-ISCT session (Section 6.2.5) • Updated power button handling during S0-ISCT for non-EC based platforms (Section 4.4.1) • Added section on Intel® Smart Response Technology Coexistence (Section 2.5) • Updated Applet Dll interfaces section to include missing API's (Section 6.2.8) • Added section on how to create GUI application using Applet Dll interfaces (Section 6.2.9)	June 2012
	0.8	• Clarified .NET requirements. Windows* 7 SP1 includes .NET 3.51. iSCT on Windows* 8 has no .NET issues (Section 2.1)	July 2012
	0.9	• Clarified that Physical/Soft Radio On/Off Switch is optional (Section 2.1)	July 2012
	1.0	• Added registry settings for NetDetect and NetDetect/Rapid Start Coexistence and removed previous setting (Section 5.2.3 and Section 6.2.6) • Updated Fan recommendation in S0-ISCT (Section 4.2.3) • Updated Antennae Recommendation to no RF attenuation when lid is closed (Section 3.1) • Updated SAOS/GAOS/GPCS ACPI Control Method implementation requirements to match 3.0 HF1 changes to Extended Wake Duration of removing Lid Open requirements for mobile platforms (Section 4.1) • Updated IP Address timeout to 15 seconds (Section 6.2.2)	August 2012

§

1 Introduction

1.1 Purpose of this Document

This platform design specification provides instructions and recommendations for integrating the Intel® Smart Connect Technology (ISCT) into a platform. The intent of this document is to describe the hardware, BIOS, and EC changes required for a platform. In addition to the platform requirements, the required software components and their configuration are included along with system testing to verify Intel® Smart Connect Technology is working correctly.

Intel® Smart Connect Technology is a feature of the platform in which the software on the platform and combination of NIC (LAN/WLAN/WWAN) features provides content updates during periods of PC in-activity. These can be categorized as:

- Always On/Always Updated:
  - Intel® Smart Connect Technology Agent schedules platform to wake up from S3 periodically to allow network applications to obtain new data (email updates, social media applications …) and then transitions back to S3.
  - Power friendly wake durations:
    - Standard Wake Duration if the platform is connected to battery. Wake duration is limited to maximum of 165 seconds to conserve battery power.
    - Extended Wake Duration if the platform is connected to AC. Extended wake duration allows for larger content download. Once network activity falls below 100KB for 10 seconds, the platform is transitioned back to S3.
  - During wakeup, Intel® Smart Connect Technology OS Service (Agent) places platform into a lower power S0 state (e.g., panel turned off, CPU in lowest P-state). This state can be referred to as S0-ISCT.
  - Factors of battery life remaining, thermal considerations and amount of data to update factor into "Always Updated" period of activity.
- Intel Energy Efficient Always On Connectivity (EE-AOC) – mobile only:
  - WLAN running in S3 (AC/Battery) with NetDetect FW allows NIC to scan for WiFi networks that match a configured profile list and if a match is found, the platform wakes to S0-ISCT to get connected and update content.
  - WWAN running in S3 (AC/Battery with Layer 2/3 connectivity that maintains connectivity to service provider (no data transfer)

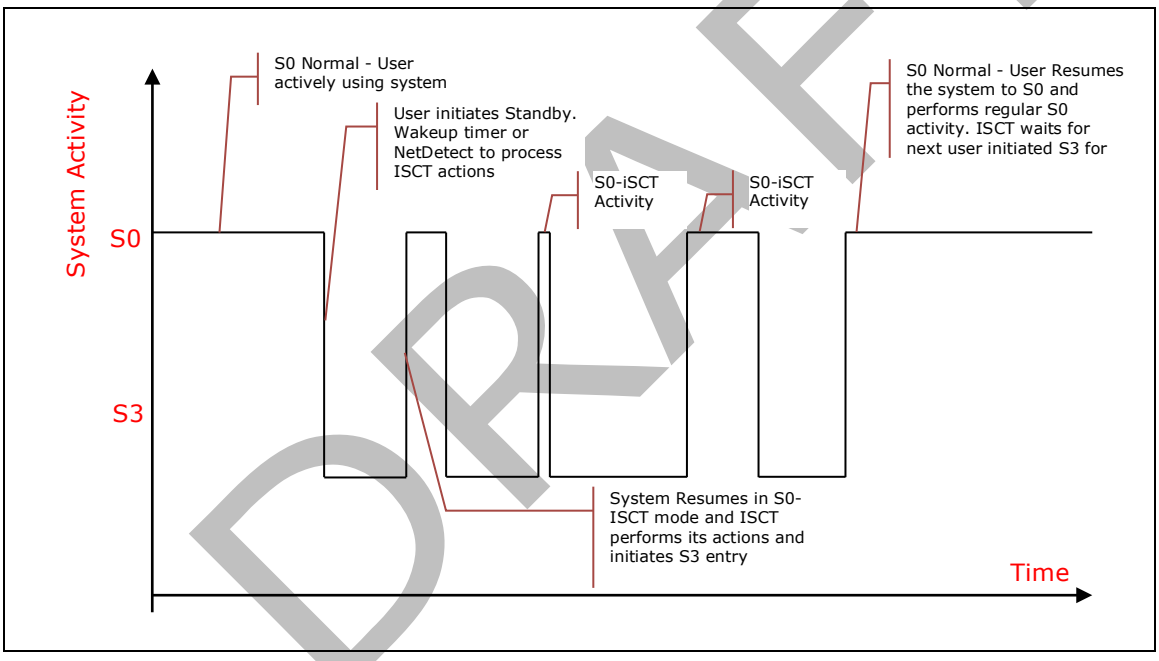
For mobile platforms, special attention to thermal monitoring and control is defined to ensure safety and reliability for systems confined to areas where thermals may rise unexpectedly due to insulating qualities of the environment (e.g. operation in a book bag or briefcase).

1.2 Intel® Smart Connect Technology Life Cycle

The Intel® Smart Connect Technology Agent, once installed and configured to be active, periodically wakes up the system from S3 and performs user state gathering and initiates re-entry to S3 to wake up after a set time interval or based on network presence. For RTC wake events enabled by the user or other software residing on the platform, those wake events will not be run in the S0-ISCT mode if the BIOS sets the wake reason to indicate an no S0-ISCT mode RTC wake.

An example time sequence diagram shown in and the subsequent sections outline a typical SCT cycle and highlight key areas of concerns. Recommendations for handling these concerning areas are highlighted as well. Figure 1-1 illustrates SCT behavior and the subsequent sections outline a typical SCT cycle and highlight key areas of concerns. Recommendations for handling these concerning areas are highlighted as well.

Figure 1-1. Typical Intel® Smart Connect Technology Activity



1.3 Potential Platform Thermal Concerns

During anytime the system is in S0, the system is actively consuming power and dissipating heat with fans on in a user present. However, the system environment during the automatic S0-ISCT mode is unknown. The system might be inside a bag inside a car or might be at the user's desk in idle mode with the lid open. The thermal constraints (maximum allowed temperature for various components and the chassis; fan usage constraints etc.) for the different environments varies drastically, making it necessary to take unattended (automatic) S0-ISCT wake into system design Consideration. Refer to Chapter 7 for more information on thermal considerations.

1.4 Reference Documents

Document	Document Number
ACPI / Power Management	http://www.acpi.info/
ACPI / Power Management in Microsoft Operating Systems	http://www.microsoft.com/whdc/system/pnppwr/powermgmt/default.mspx
Chief River Platform Design Guide	471984
Chief River Platform Power Delivery Design Guide	458544
RS – Panther Point Platform Controller Hub (PCH) External Design Specification (EDS) – Volumes 1-2	V1-29562 V2-29563
PCI Express Base Specification Rev. 2.0*	www.pcisig.com
RS – Intel® Rapid Start Technology BIOS Specification 0.6.1	30258
Intel® Smart Connect Technology 2.0 Platform Validation Test Plan	485844
Intel® Smart Connect Technology 2.0 Platform Installation and Troubleshooting Guide	487752
SMBIOS Specification	http://dmtf.org

1.5 Terminology

Term	Description
Agent	Intel® Smart Connect Technology OS Service
CRB	Customer Reference Board
CRV	Chief River
EC	Embedded Controller/Keyboard Controller
EE-AOC	Intel Energy Efficient Always On Connectivity
Intel® ME	Intel® Management Engine
RTC	Real Time Clock
RW	Remote Wake
SCT, ISCT	Intel® Smart Connect Technology
S0-ISCT	Reduced S0 power model that the Intel® Smart Connect Technology Agent runs to update content
Wireless Local Area Network (WLAN)	A local area communications network based on wireless technology
Wireless Wide Area Network (WWAN)	A wide area communications network based on cellular technology

2 Platform Requirements

2.1 Component List

The following components are required to support Intel® Smart Connect Technology on a platform:

Table 2-1. Required Components

Item	Supplier
CPU/PCH: Intel® CPU (All Ultra-low voltage, Standard Voltage Intel® Core™ processor Only) and any PCH SKU	OEM
Windows* 7 SP1 / Windows* 8 Platform	OEM
Intel NetDetect Compatible WLAN Card • 6300 (Puma Peak) • 6250 (Kilmer Peak) • 6235 (Jackson Peak 2) • 6205 (Taylor Peak) • 2230 (Jackson Peak 1) • 2200 (Marble Peak) • 3160 (Wilkins Peak 1) • 7260 (Wilkins Peak 2)	OEM
Intel® Smart Connect Technology Agent	Intel
UI for Intel® Smart Connect Technology Agent configuration	Intel or OEM
Intel® Smart Connect Technology Agent Configuration Applet Dll	Intel
HW/BIOS/EC Changes (see notes in respective sections)	OEM
Intel® Smart Connect Technology Agent Configuration	OEM
Radio On/Off Switch (optional)	OEM
Remote Wake enabled applications (optional)	OEM

The following components are optional to support Intel® Smart Connect Technology on a platform:

Table 2-2. Optional Components

Item	Supplier
WWAN (3G) NIC with L2/L3 Connectivity in S3 if WWAN supported (optional)	Ericsson* F3607 and F5521

2.2 Checklist

The following checklist provides a list of required tasks to assist the integration and ensure all required Intel® Smart Connect Technology integration steps are completed. Additional tasks of validation and manufacturing preparation are not included.

Item	√
Windows* 7 SP1 / Windows* 8 Platform	
S3 (Rapid Start S4) power to mini-cards used for Always Connected (PCIe* and WWAN USB) in AC/Battery	
Platform control of S3 (Rapid Start S4) power to mini-card (optional)	
BIOS ACPI IAOE control method	
For systems with EC Timer capability (required for Mobile): • EC Timer implemented • EC control of backlight (if EC wakeup method via power button) • EC Timer only programmed in S3 and not OS Hibernate S4	
For systems with RTC Timer only capability (Systems with no EC): • RTC Timer implemented • RTC Timer only programmed in S3 and not OS Hibernate S4	
PCI Express* Wake Disable (PCIEXP_WAKE_DIS) bit 14 in PM1_EN PCH register disabled (0b)	
All LED indicators maintain S3 state when platform is in S0-ISCT	
Usage of LED to provide notification of Intel® Smart Connect Technology enablement (optional)	
Thermal runaway protection in event of skin temperature exceeded for notebook in bag (optional)	
NetDetect capable Intel® WLAN Driver	
Intel® Smart Connect Technology SW installed	
Antennae design allows closed lid RF reception	
Windows* 7 Hybrid Sleep Disabled	

2.3 Deep Sx Coexistence Considerations

For platforms implementing Deep Sx and Intel® Smart Connect Technology together, the platform must use an EC timer for the Periodic Wake setting and attach the PME WAKE# to the EC and have the EC wake the platform for EC timer expiration and NetDetect generated wakes.

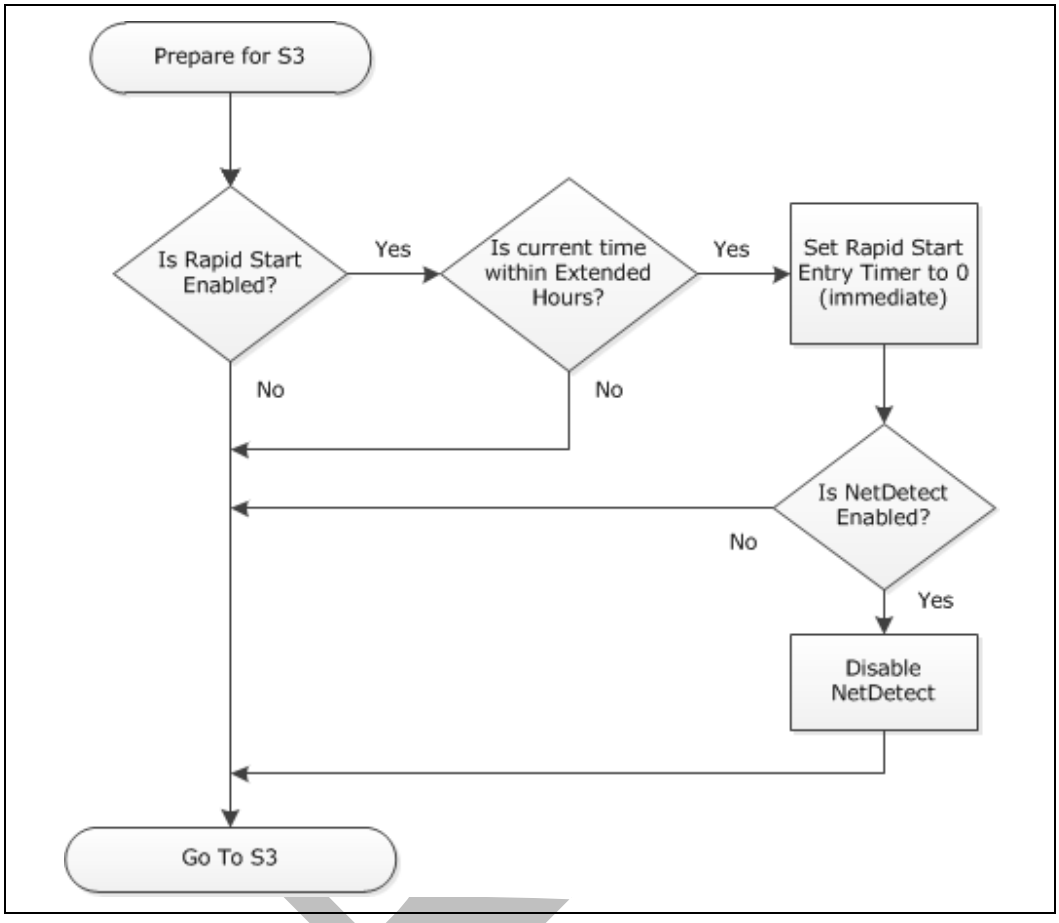
2.4 Intel® Rapid Start Technology Coexistence Considerations

Intel® Rapid Start Technology is a technology that addresses the desire for greater system responsiveness and lower power consumption during sleep states. Intel Rapid Start Technology snapshots system memory state on S3 (standby), transfers to SSD and transitions platform to S4 providing a zero power standby state. Upon power-on, restores non-zero system memory from SSD and resumes OS from S3 state.

Currently on platforms where Intel® Smart Connect Technology and Intel® Rapid Start Technology coexist, the Intel® Smart Connect Technology Agent in off hours (Extended Power Saving) checks if Intel® Rapid Start Technology is enabled on the platform (active), and if it is, programs The Rapid Start Entry timer with a value of 0 min (so that the platform will go to Rapid Start mode immediately upon transition to S3). If Intel® Rapid Start Technology is not enabled (active), no changes are made to the Intel® Rapid Start Technology settings. During non-Extended Power Savings hours, no change is made to the Intel Rapid Start Technology settings. For the case where Intel® Smart Connect Technology is disabled by end user or via the BIOS, The Intel® Smart Connect Technology Agent will not enable Intel Rapid Start Technology. The Intel® Smart Connect Technology communicates settings thru the Rapid Start Technology Driver.

The following figure illustrates the interaction with Intel® Rapid Start Technology as the Intel® Smart Connect Technology prepares to enter S3.

Figure 2-1. Intel® Rapid Start Technology Interaction



If Intel® Rapid Start Technology is enabled on the target Intel® Smart Connect Technology platform, the following is a list of design requirements:

- S4 AC/Battery power to the WLAN/WWAN mini-cards (PCIe* and WWAN USB) (mobile only)
- PCIE* wake event support for NetDetect in S4 for both AC and Battery modes (mobile only)
- BIOS follow the requirements of handling an existing RTC clock setting. Consult the Intel® Rapid Start Technology BIOS Specification for more information

Note: Refer to Section 4.1 for BIOS requirements to address any contention amongst various timers.

Throughout this document Intel® Rapid Start Technology integration points are indicated, to assist in Intel® Smart Connect Technology integration on a platform that is Intel® Rapid Start Technology enabled.

2.5 Intel® Smart Response Technology Coexistence

Intel® Smart Connect Technology uses a feature of Intel® Smart Response Technology to reduce chances of HDD shock in a non-SSD platform. If the HDD in the platform support PUIS (Power-Up In Standby), the drive will only spin-up when the spin-up ATA command is sent to the drive.

Upon resume from S3, if the platform enters S0-ISCT, the Intel® Smart Connect Technology Agent will instruct the Intel® Smart Response Technology driver to not spin-up the drive for the time of the S0-ISCT session unless there is a cache miss and the Intel® Smart Response Technology driver is required to spin-up the drive. If the platform does not enter S0-ISCT or a user event exits the platform from S0-ISCT, then the HDD is spun up.

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3 Hardware

This section covers HW related design requirements that affect mobile platforms only.

3.1 Antennae Design

One usage model of Intel® Smart Connect Technology is ability to receive content updates when the lid of a notebook is closed and not connected to a LAN connection. To support this usage model, RF attenuation of the WLAN antennae needs to be minimized to allow periodic wake content updates with WLAN with the lid closed. The amount of acceptable RF attenuation is a platform designer choice – our recommendation for platforms is no attenuation with the lid closed to provide the optimal user experience.

3.2 Platform Mini-Card Sx Requirements

For each Intel® Smart Connect Technology mini-card supported (WLAN, WWAN (both PCIe* and USB), the following hardware support is **required**:

- Powered in S3 (optionally S4 if Intel® Rapid Start Technology is supported) by OEM determined +3.3V power rail that is powered in AC and Battery modes.
  - Voltage must be stable when transitioning to S3 (S4 optionally)
  - BIOS/EC controlled regardless of Intel® ME configuration
- Connection of PCIe WAKE# pin to PCH or EC for NetDetect platform wakeup when recognized Access Point is detected in S3.

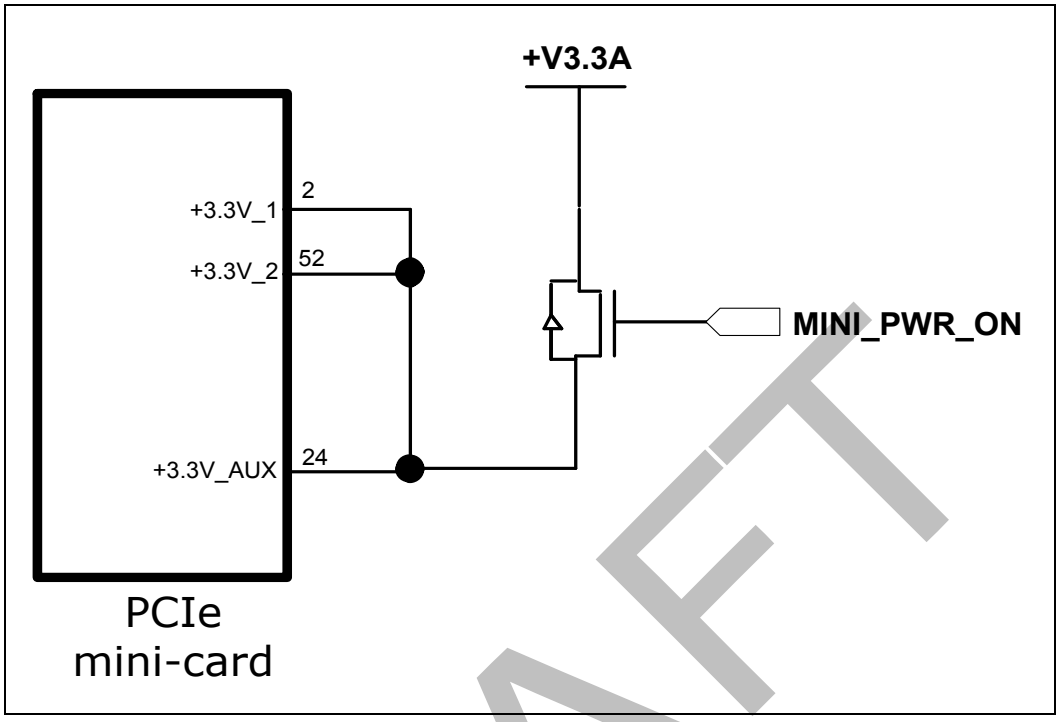
For each Intel® Smart Connect Technology mini-card supported (WLAN, WWAN (both PCIe* and USB), the following hardware support is **optional**:

- Radio On/Off switch or equivalent hot key to disable the RF transmission on the platform. If prior to entering S3 and the radio is turned off, The Intel® Smart Connect Technology Agent software will not schedule a timer based wake up or enabled NetDetect.

Note: Since the PCH requires the Suspend Well powered in the Sx state for handle PCIe* wake events, an alternative is to use the EC to monitor PCIe wake events and avoid powering the Suspend Well in S3 (or S4).

The following figure shows an example implementation of Intel® Smart Connect Technology with optional FET to control power to mini-card during S3.

Figure 3-1. Example PCIe* Mini-card Power with Optional S3 Power Control



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4 BIOS/EC

The Intel® Smart Connect Technology provides interfaces for the BIOS and Embedded Controller (EC) modify some of the runtime behavior of Intel® Smart Connect Technology. The BIOS is required to implement Intel® Smart Connect Technology ACPI methods that provide platform configuration information and runtime control required by the Intel® Smart Connection technology. The following sections provide details on those interfaces.

4.1 BIOS Requirements

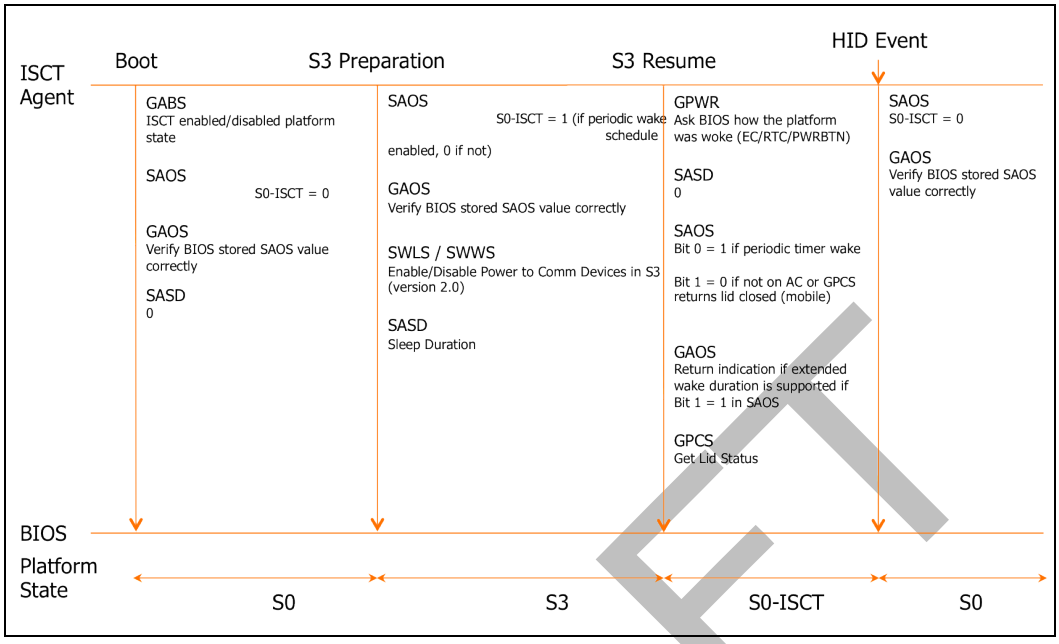
- Creation and support of the Intel® Smart Connect Technology ACPI pseudo device object with the ability to query/control via ACPI for the following Intel® Smart Connect Technology features:
  - Enable/Disable Intel® Smart Connect Technology mode
  - Enable/Disable Intel® Smart Connect Technology Notification (LED alerts, …)
  - Indication of Intel® Smart Connect Technology is performing periodic wakes
  - Enable/Disable WLAN Module Powered in S3 (Rapid Start S4)
  - Enable/Disable WWAN Module Powered in S3 (Rapid Start S4)
  - Platform Wake Reason (EC, Power Button, HID Event, or RTC)
- Ensure the PCI Express* Wake Disable (PCIEXP_WAKE_DIS) bit 14 in PM1_EN PCH register is set to 0b to allow wakes by the Intel WLAN card.

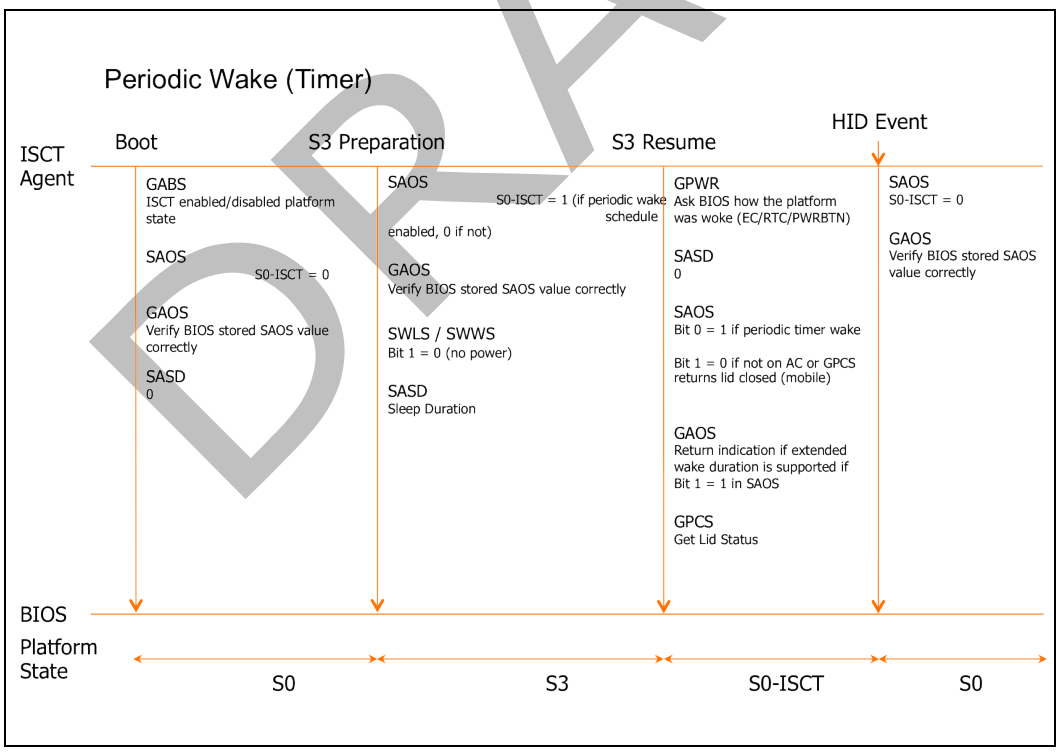
Note: This is the default setting of the register. This is not a requirement for desktop platforms.

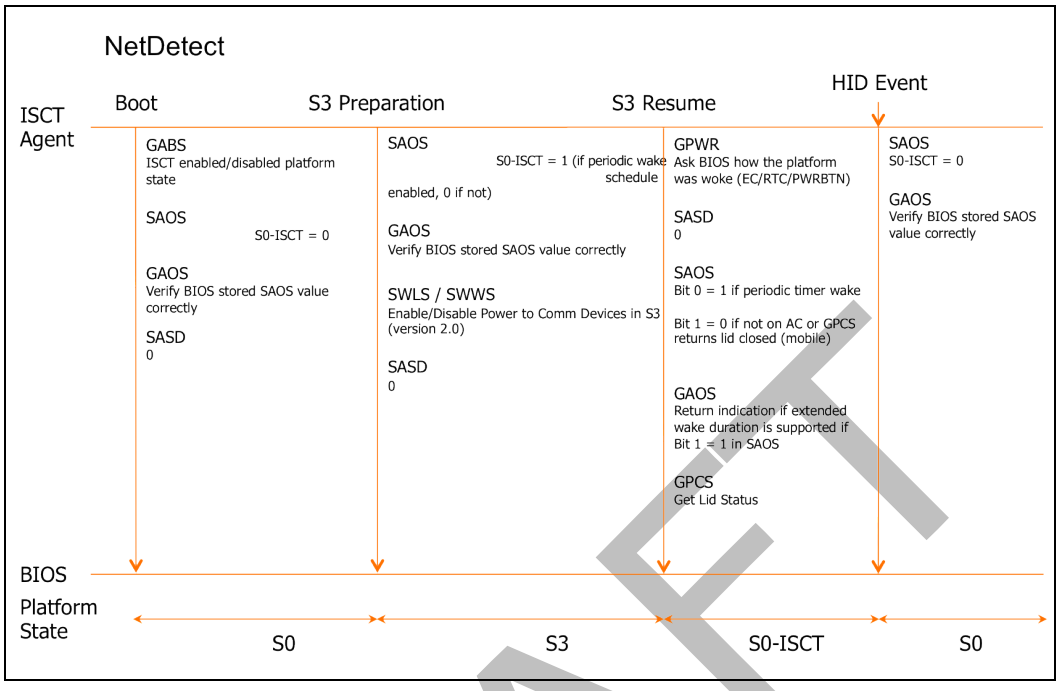
- If a USB device is used to generate PME wake event, ensure the PME_EN bit 11 in the General Purpose Event 0 Enables Register (GPE0_EN) PCH register is set to 1b to allow USB device wakes.

The following figures illustrate the interaction between the Intel® Smart Connect Technology Agent and the BIOS.

Figure 4-1. Intel® Smart Connect Technology Agent and BIOS interaction







4.1.1 Programming the Periodic Wake Timer

The periodic wake timer can be either the RTC wake timer (for systems without EC) or EC timer (required for mobile platforms). Intel® Smart Connect Technology Agent will call the SASD ACPI control method with the timer value to program the timer to. For both mobile and desktop platforms BIOS has to program either the EC or RTC timer as described in the following sections. The periodic wake timer is only programmed in S3 and not S4 by the BIOS or EC.

EC Timer is the preferred method of periodic timer capability because:

- No contentions with OS Programmed RTC timer events
- EC Timer allows PCH to be powered off in S3
- EC upon timer expiration can check platform sensor state (e.g. thermal, accelerometer, …) and prevent or delay wake if conditions not good

4.1.1.1 RTC Timer (Desktops without EC Timer Capability)

Because the RTC timer is a shared resource on the platform, prior to programming the RTC timer with the periodic wake value, the BIOS needs to check if an existing RTC wake setting is earlier than the requested periodic wake time. If the value is earlier, then the BIOS will not override the setting with the SASD value.

For RTC timer usage, it will be necessary to specify in the GABS ACPI control method that the SASD timer value is absolute (actual) format since the current RTC timer value will be in an absolute format (yymmddhhmmss).

Ensure that the timer values stored in NVS are valid and properly initialized on boot (either the default Intel® Rapid Start Technology entry timer value or all 1's if only Smart Connect Technology). A wake timer value of zero implies immediate wake for the given timer; therefore, don't zero initialize a timer.

Upon receiving the SASD ACPI control method:

- Save the SASD timer value in ACPI NVS

Upon entry to S3:

- If Intel® Rapid Start Technology is enabled, then the following checks are performed between the saved SASD (iSCTTimer), current RTC timer (RTCValue) and Rapid Start timer (RapidStartTimer). With the appropriate timer value programmed in the RTC:

    a. If (RTCValue <= iSCTTimer) AND (RTCValue <= RapidStartTimer) THEN No RTC overwrite required (do not program the RTC timer)

    b. Else If (iSCTTimer <= RapidStartTimer) THEN Program RTC = iSCTTimer

    c. Else Program RTC = RapidStartTimer while preserving the difference (new timer value) between the existing FFStimer value and iSCTTimer. This preserved new timer value will be programmed during S3 →RapidStart(S4) entry

- If Intel® Rapid Start Technology is *not* enabled or used, then the following checks are performed between the SASD (iSCTTimer) and current RTC timer (RTCValue). With the appropriate timer value programmed in the RTC:

    a. If (RTCValue <= iSCTTimer) THEN No RTC overwrite required (do not program the RTC timer)

    b. Else Program RTC = iSCTTimer

Upon RTC wake from S3:

1. BIOS checks the RTC timer value against the known iSCTTimer and RapidStartTimer values (previously preserved) to identify whether the wake is Smart Connect Technology or Rapid Start Technology related or something else (OS programmed wake event)
2. In the case of Smart Connect Technology, report in GPWR ACPI control method return value that the wake was for S0-ISCT. If BIOS determines at time of S0-ISCT RTC Wake that platform conditions are not appropriate for S0-ISCT mode, it can delay the OS resume and return back to S3
3. In the case if wake is Rapid Start Technology related wake event, BIOS will take the Rapid Start Technology entry flow
4. If the RTC timer value is neither Smart Connect Technology or Rapid Start technology timer value than BIOS will take the normal S3 resume path and report in GPWR ACPI control method return value that the wake was for non-periodic RTC wake.

4.1.1.2 EC Timer

Specify in the GABS ACPI control method that the SASD timer value is "duration" format

Upon receiving the SASD ACPI control method:

- Save the SASD timer value in ACPI NVS

Upon entry to S3:

- Program the EC wake timer using the value saved for the SASD value

Upon wake from S3:

- Report in GPWR ACPI control method return value that the wake was for S0-ISCT.
- Turn off the backlight so that the OS does not turn on the display. OS treats EC wake as user event and turns on the display.

4.1.2 BIOS ACPI Requirements

4.1.2.1 IAOE _HID Object

The BIOS is required to create an ACPI pseudo device object with a _HID value of EISAID ("INT33A0") under ACPI device tree "_SB.IAOE". This identifies the ACPI object as an Intel® Smart Connect Technology ACPI pseudo device. The Intel® Smart Connect Technology SW requires this device to be present during installation of the SW.

4.1.2.2 IAOE ACPI GNVS Variables

The BIOS will need to allocate a small set of ACPI GNVS variables that will reflect the run time IAOE configuration settings (i.e., IAOE WLAN Setting, IAOE EC Timer setting value). A set of ACPI control methods (defined later in this section) will provide the capability to these variables at runtime through Intel® Smart Connect Technology OS driver.

4.1.2.3 IAOE ACPI ASL Control Methods

The BIOS must provide the following control methods to support Intel® Smart Connect Technology on the platform. These control methods are architectural and must be implemented in the BIOS ASL code under the IAOE ACPI Device Object (PnP ID INT33A0).

Table 4-1. IAOE Intel® Smart Connect Technology Control Methods

Control Method	Description
GABS	Get Intel® Smart Connect Technology BIOS Enabled Setting
GAOS	Get Intel® Smart Connect Technology Function Status
SAOS	Set Intel® Smart Connect Technology Function Status
GANS	Get Intel® Smart Connect Technology Notification Status
SANS	Set Intel® Smart Connect Technology Notification Status
GWLS	Get WLAN Module Status
SWLS	Set WLAN Module Status
GWWS	Get WWAN Module Status
SWWS	Set WWAN Module Status
GPWR	Get Platform Wake Reason
SASD	Set Intel® Smart Connect Sleep Duration
GPCS	Get Platform Component State

4.1.2.3.1 IAOE ACPI Control Method GABS

This control method returns the enabled/disabled status of Intel® Smart Connect Technology configured in the BIOS. The Intel® Smart Connect Technology Agent reads these values at OS boot time when the Agent begins execution. The values are set by the BIOS at boot time and not changed during S0. This allows the BIOS/EC to specify what Intel® Smart Connect Technology functions the Intel® Smart Connect Technology SW is allowed.

Arguments:

None – Control method takes no input arguments.

Table 4-2. IAOE Control Method GABS

Return Value (Bits)	Description
0	Intel® Smart Connect Technology Configured: 0 = Disabled, 1 = Enabled
1	Intel® Smart Connect Technology Notification Control: 0 = Unsupported, 1 = Supported
2	Intel® Smart Connect Technology WLAN Power Control:0 = Unsupported, 1 = Supported
3	Intel® Smart Connect Technology WWAN Power Control: 0 = Unsupported, 1 = Supported
4	Must be set to 1
5	Sleep duration value format: 0 = Actual time, 1 = duration in seconds (see SASD for actual format)
6	RF Kill Support (Radio On/Off): 0 = Soft Switch, 1 = Physical Switch

Return Value (Bits)	Description
7	Reserved (must set to 0)

4.1.2.3.2 IAOE ACPI Control Method GAOS

The Get Intel® Smart Connect Technology Function Status control method returns the current status of Intel® Smart Connect Technology S0-ISCT state in the BIOS as set by the SAOS method. Refer to the section on SAOS for the return value handling of Bit 1.

Arguments:

None – Control method takes no input arguments.

Table 4-3. IAOE Control Method GAOS

Return Value (Bits)	Description
0	Intel® Smart Connect Technology Mode: 0 = Disabled, 1 = Enabled
1	Wake Mode Select: 0 = ISCT Wake Mode, 1 = Extended ISCT Wake Mode
2-7	Reserved (set to 0)

4.1.2.3.3 IAOE ACPI Control Method SAOS

The Intel® Smart Connect Technology Agent calls the SAOS function and sets Intel® Smart Connect Technology Mode (bit 0) to 1 (S0-ISCT state) prior to suspending the platform when Periodic Wake is enabled by the Intel® Smart Connect Technology Configuration Utility (GUI). The value will remain 1 until a user event (power button, keyboard/mouse, lid switch) returns the OS to the non S0-ISCT state. This allows the BIOS/EC to know when SCT is performing idle time data updates and turn off unneeded LEDs, fans and other power savings features. Upon calling of the SAOS function by the Intel® Smart Connect Technology Agent, BIOS will store the value and return it via the GAOS function. The S0AS method is also called at boot time by the Agent to notify the BIOS of the current setting of the S0-ISCT state (the value will be 0 at boot time).

Bit 1 is set when Bit 0 (ISCT Mode) is set to 1 (enabled). Bit 1 indicates to the BIOS whether the wake duration will be extended (until network activity subsides) or normal (based on email traffic). If the BIOS can support extended wake duration, then BIOS will return a 1 for bit 1 in the GAOS ACPI control method. If it cannot, then BIOS will return a 0 for bit 1 in the GAOS ACPI control method. Bit 1 is set to 0 if the platform is not on AC (detected by Agent).

Table 4-4. SAOS Bit 1 Value

Bit 1 Value	AC Status
0	On Battery
1	On AC

Note: The SAOS method is only called if the BIOS have set Bit 0 of the GABS method to 1b.

The Agent calls the SAOS ACPI control method before the OS sends PBT_APMSUSPEND when the system is in S0-ISCT. The Agent calls SAOS after PBT_APMSUSPEND if the platform was in normal S0 and the platform transitions to S3 by user or unattended timer expiration.

Arguments:

Arg1: **Intel® Smart Connect Technology Function Index** (Integer), where each bit in the Intel® Smart Connect Technology Function Index corresponds to the enable/disable status of an Intel® Smart Connect Technology function or a sub-function.

Table 4-5. IAOE Control Method SAOS

Intel® Smart Connect Technology Function Index (Bits)	Description
0	Intel® Smart Connect Technology Mode: 0 = Disabled, 1 = Enabled
1	Wake Mode Select: 0 = ISCT Wake Mode, 1 = Extended ISCT Wake Mode • ISCT Wake Mode: Wake Mode: BIOS or EC should not turn on the fan initially, leave the display backlight off and keep all system LEDs in the S3 state. BIOS or EC should also enable the platform watchdog timer if it is used. • Extended ISCT Wake Mode: BIOS or EC should not turn on the fan initially, leave the display backlight off and keep all system LEDs in the S3 state. BIOS should also disable any wake duration watchdog timer if used.
2-7	Reserved

4.1.2.3.4 IAOE ACPI Control Method GANS

The Get Intel® Smart Connect Technology Notification Status control method returns the current enabled/disabled status of Intel® Smart Connect Technology notification in the BIOS as set by the SANS method.

Arguments:

None – Control method takes no input arguments.

Table 4-6. IAOE Control Method GANS

Return Value (Bits)	Description
0	Intel® Smart Connect Technology Notification: 0 = Disabled, 1 = Enabled
1-7	Reserved

4.1.2.3.5 IAOE ACPI Control Method SANS

The Intel® Smart Connect Technology Agent will call the SANS method and set the bit to '1' when an application indicates that new data is available for the user. Upon the user returning the platform to normal S0 mode, the Intel® Smart Connect Technology Agent will set this bit to 0. Upon calling of the SANS function by the Intel® Smart Connect Technology Agent, BIOS stores the value and returns it via the GANS function.

Arguments:

Arg1: **Intel® Smart Connect Technology Notification Index** (Integer), where each bit in the Intel® Smart Connect Technology Notification Index corresponds to the enable/disable status of an Intel® Smart Connect Technology notification.

Table 4-7. IAOE Control Method SANS

Intel® Smart Connect Technology Notification Index (Bits)	Description
0	Intel® Smart Connect Technology Notification: 0 = Disabled, 1 = Enabled
1-7	Reserved

4.1.2.3.6 IAOE ACPI Control Method GWLS

The Get WLAN Module Status control method returns the current WLAN module HW state of enabled/disabled in the BIOS.

Arguments:

None – Control method takes no input arguments.

Table 4-8. IAOE Control Method GWLS

Return Value (Bits)	Description
0	Reserved (set to 0)
1	WLAN Module Powered in S3:0 = Disabled, 1 = Enabled
2	WLAN Module Powered in S4 (Rapid Start):0 = Disabled, 1 = Enabled
3	WLAN Module Powered in S5:0 = Disabled, 1 = Enabled
4-7	Reserved (set to 0)

4.1.2.3.7 IAOE ACPI Control Method SWLS

The Set WLAN Module Status control method is called by the Intel® Smart Connect Technology Agent to instruct the BIOS/EC of when to enable/disable power to the WLAN.

Arguments:

Arg1: **WLAN Powered Index** (Integer), where each bit in the Intel® Smart Connect Technology WLAN Powered Index corresponds to the enable/disable state.

Table 4-9. IAOE Control Method SWLS

WLAN Powered Index (Bits)	Description
0	N/A (WLAN Wireless Disable is Read only) – Always set to 0
1	WLAN Module Powered in S3:0 = Disabled, 1 = Enabled
2	WLAN Module Powered in S4 (Rapid Start):0 = Disabled, 1 = Enabled
3	WLAN Module Powered in S5:0 = Disabled, 1 = Enabled

WLAN Powered Index (Bits)	Description
4-7	Reserved

4.1.2.3.8 IAOE ACPI Control Method GWWS

The Get WWAN Module Status control method returns the current WWAN module HW state of enabled/disabled in the BIOS and whether the WWAN module is to support L2 connectivity.

Arguments:

None – Control method takes no input arguments.

Table 4-10. IAOE Control Method GWWS

Return Value (Bits)	Description
0	Reserved (set to 0)
1	WWAN Module Powered in S3:0 = Disabled, 1 = Enabled
2	WWAN Module Powered in S4 (Rapid Start):0 = Disabled, 1 = Enabled
3	WWAN Module Powered in S5:0 = Disabled, 1 = Enabled
4-7	Reserved (set to 0)

4.1.2.3.9 IAOE ACPI Control Method SWWS

This Set WWAN Module Status control method is called by the Intel® Smart Connect Technology Agent to instruct the BIOS/EC of when to enable/disable power to the WWAN. BIOS upon per executing the request will update the GWWS return values.

Arguments:

Arg1: **WWAN Powered Index** (Integer), where each bit in the Intel® Smart Connect Technology WWAN Powered Index corresponds to the enable/disable state.

Table 4-11. IAOE Control Method SWWS

WWAN Powered Index (Bits)	Description
0	N/A (WWAN Wireless Disable is Read only) – Always set to 0
1	WWAN Module Powered in S3:0 = Disabled, 1 = Enabled
2	WWAN Module Powered in S4 (Rapid Start):0 = Disabled, 1 = Enabled
3	WWAN Module Powered in S5:0 = Disabled, 1 = Enabled
4-7	Reserved

4.1.2.3.10 IAOE ACPI Control Method GPWR

The Intel® Smart Connect Technology Agent calls the GPWR method to get the wake reason from the BIOS after resume from S3 or S4. The Agent determines whether to remain in the S0-ISCT mode using the return values from the BIOS. For example, if Bit 0 is set to '1' and the rest of the bits set to '0', this indicates to the Agent that the S3 or S4 Sleep state was interrupted by the user and that the Agent should not perform periodic update and exit to the S0 state and will call SAOS ACPI method with a value of '0' to indicate to the BIOS/EC that periodic wake/sleep mode has been halted.

If the wake was for Periodic wake by EC Timer or RTC Timer, then Bit 0 is set to '0' and set Bit 1 to '1'. If the EC or RTC Wake timer was not for the S0-ISCT mode (for example user set RTC timer), then set Bit 0 to '0', Bit 1 to '0' and set Bit 2 to '1'.

If the for PME Wake (this can be from any PCI-Ex based device including Intel WLAN NetDetect or from USB xHCI controllers caused by USB device wake-up events) set Bit 3 to "1' and the other bits 0 to '0'.

Arguments:

None – Control method takes no input arguments.

Table 4-12. IAOE Control Method GPWR

Intel® Smart Connect Technology Function Index (Bits)	Description
0	User pressed power button or HID event
1	Periodic Wake BIOS timer caused wake (EC or RTC)
2	Non-Periodic Wake RTC timer caused wake
3	Wake due to PME (This can be from any PCI-Ex based device including USB xHCI controllers caused by USB device wake-up events).
4-7	Reserved (set to 0)

4.1.2.3.11 IAOE ACPI Control Method SASD

The Intel® Smart Connect Technology Agent calls the SASD method with the number of seconds to program the platform timer (EC or RTC) to for the next periodic wake. Upon resume from S3 or initial boot of platform, the Agent will call the SASD method with a value of 0 to indicate there is no wake scheduled until called prior to S3 entry. Because the Agent cannot discern between S3 and OS Hibernate S4, the SASD method will be called in both sleep states. It is the BIOS responsibility to detect which sleep state the platform is transitioning to and only program the timer upon S3 transition.

If a RTC timer is used, the Intel® Smart Connect Technology Agent always treats RTC wake as an Intel® Smart Connect Technology wake even if the RTC wake was scheduled by another application because the RTC wake cannot be associated with who scheduled it. To prevent the Agent from handling all RTC wake events, the BIOS can compare the time passed by SASD and RTC value after resume from S3 or S4. If

the two values match, the BIOS informs the Agent by returning Bit 2 = '1' (RTC timer) when the GPWR ACPI control method is called by the Agent upon resume. Otherwise if the two values do not match, BIOS returns Bit 0 = '1' and the rest of the bits as zero of the GWPR ACPI control method. This informs the Agent to not enter the S0-ISCT mode and keep the system in S0 mode so that the non-ISCT RTC wake will be handled by the application that scheduled it.

If the ACPI Control Method GABS indicates an actual time is to be used, the following encoding is used:

Bit 31: 0 = Sleep Duration in seconds for Bits 0 thru 30

Bit 31: 1 = Actual time with Bits 0 thru defined as:

Bits 26-30: Year offset from 2000 (e.g.11 denotes 2011)

Bits 22-25: Month

Bits 17-21: Day

Bits 12-16: Hour (24 hour format)

Bits 6-11: Minutes

Bits 0-5: Seconds

If NetDetect is enabled, the SASD value for all bits will be 0 indicating no periodic wake is required and the BIOS is not required to set a timer wake value.

Arguments:

Arg1: **Intel® Smart Connect Technology Sleep Duration** where the value is the Intel® Smart Connect Technology Agent Sleep Duration in seconds.

Table 4-13. IAOE Control Method SASD

Intel® Smart Connect Technology Function Index (Bits)	Description
0-31	Sleep Duration value in seconds (e.g. 900)

4.1.2.3.12 IAOE ACPI Control Method GPCS

The Intel® Smart Connect Technology Agent calls the GPCS method to get the current state of platform components.

Arguments:

None – Control method takes no input arguments.

Table 4-14. IAOE Control Method GPCS

Intel® Smart Connect Technology Function Index (Bits)	Description
0	Lid state: 0 – Closed, 1 – Open (refer _LID in section 9.4 of the ACPI 5.0 specification). Note: if the platform does not have a lid (e.g. desktop or tablet, then return '1' to indicate open
1-7	Reserved (set to 0)

4.1.2.4 IAOE Control Method Values Summary

The following table summarizes the values passed from the Intel® Smart Connect Technology Agent to the BIOS during the transition to S3.

Table 4-15. IAOE Control Method Values Summary

Events	SAOS	SASD	SWLS	NetDetect	Notes
User disable ISCT via GUI	0	N/A	N/A	Disabled	
User Enable ISCT via GUI, **Radio On**	1	If network connectivity, non-zero timer value	If no network connectivity in S0 (LAN/WLAN/WWAN), SWLS=2, else 0	Enabled if no network connectivity, disabled if network connectivity	
User Enable ISCT via GUI, **Radio Off**	1	0	See below as it depends on type of Radio On/Off switch	Enabled if no network connectivity, disabled if network connectivity	Timer is disabled if Radio is off. Required for FAA compliance. Once user exits aircraft, radio can be turned back on to allow NetDetect wake

If the platform has a physical Radio On/Off switch (GABS Bit 6 set to '1') and there is no other network connect (LAN) the following will be observed in the ACPI control method values:

- Radio if OFF before going to suspend:
  - SAOS = 1, SASD = 0 and SWLS = 2 (will cause WLAN NIC to be still powered on)
  - NetDetect will be enabled as WLAN NIC has power prior to entering S3
  - If the user turns the radio ON in S3, NetDetect will wake the platform when AP found and because SAOS = 1, platform will enter S0-ISCT to update content
- Radio is ON in S0 and turned OFF in S3:
  - SAOS = 1, SASD = non-zero and SWLS = 2 (No power to the WLAN NIC)
  - In this case, when in S3, and the radio is turned OFF, EC should stop the timer. Since there is no power to WLAN NIC, NetDetect will not wake the platform).
  - If the user turns the radio ON again in S3, EC should wake the platform after a default time (5 minutes for example).

If the platform does not have a physical Radio On/Off switch (GABS Bit 6 = '0') but instead has a "soft-switch" and there is no other network connection (LAN), the following with be observed in the ACPI control method values:

- Radio if OFF before going to suspend:
  - SAOS = 1, SASD = 0 and SWLS = 0
  - NetDetect will not be enabled as there is no way to turn on the radio in S3 without returning to S0.
  - Platform will not wake by periodic timer
- Radio is ON in S0:
  - OS = 1, SASD = 0 and SWLS = 2 (will cause WLAN NIC to be still powered on)

Regardless of the type of Radio On/Off control, if there is a network connection via the LAN prior to entering S3, NetDetect will not be enabled.

4.1.2.5 Example ASL Code

The following ASL code is provided as an example for the BIOS implementer to construct their IAOE ACPI Methods. Details of EC are not provided as those are platform specific.

```
{
  Scope (\_SB)
  {
    Device (IAOE)
    {
        Name (_HID, "INT33A0")
        Name (_UID, 0x00)
        Name (ASCT, 0x1F)
        Name (AOS1, 0)
        Name (ANS1, 0)
        Name (AWS1, 0)

        //
        // GABS - Get Intel® Smart Connect Technology BIOS Enabled Setting
        // Input:   None
        // Return:
        // Bits   Description
        // 0      Configured: 0 = Disabled, 1 = Enabled
        // 1      Notification Control: 0 = Unsupported, 1 = Supported
        // 2      WLAN Power Control : 0 = Unsupported, 1 = Supported
        // 3      WWAN Power Control : 0 = Unsupported, 1 = Supported
        // 4      Reserved (must set to 1)
        // 5      Sleep duration value format: 0 = Actual time, 1 =
duration in seconds
        // 6      RF Kill Support (Radio On/Off): 0 = Soft Switch, 1 =
Physical Switch
        // 7      Reserved (must set to 0)
        //
        Method (GABS, 0, NotSerialized)
        {
          // Change code according to platform settings
          Return (ASCT)
        }

        //
        // GAOS - Get Intel® Smart Connect Technology Function Status
        // Input:   None
        // Return:
        // Bits   Description
        // 0      Mode: 0 = Disabled, 1 = Enabled
        // 1      Wake Mode Select: 0 = Normal, 1 = Extended
        // 2 - 7  Reserved
        //
        Method (GAOS, 0, NotSerialized)
        {
```

```
            // Change code according to platform settings and support for
Extended wake duration
            Return (AOS1)
          }

          //
          // SAOS - Set Intel® Smart Connect Technology Function Status
          // Input:
          // Bits   Description
          // 0      Mode: 0 = Disabled, 1 = Enabled
          // 1      Wake Mode Select: 0 = Normal, 1 = Extended
          // 2 - 7  Reserved
          //
          Method (SAOS, 1, NotSerialized)
          {
             If (LEqual (And(Arg0, 0x01), 0x01))
             {
               Store(1, AOS1)
             }
             Else
             {
               Store(0, AOS1)
             }
          }

          //
          // GANS - Get Intel® Smart Connect Technology Notification Status
          // Input:   None
          // Return:
          // Bits   Description
          // 0      Notification: 0 = Disabled, 1 = Enabled
          // 1 - 7  Reserved
          //
          Method (GANS, 0, NotSerialized)
          {
            Return (ANS1)
          }

          //
          // SANS - Set Intel® Smart Connect Technology Notification Status
          // Input:
          // Bits   Description
          // 0      Notification: 0 = Disabled, 1 = Enabled
          // 1 - 7  Reserved
          //
          Method (SANS, 1, NotSerialized)
          {
             If (LEqual (And(Arg0, 0x01), 0x01))
             {
               Store(1, ANS1)
             }
             Else
             {
               Store(0, ANS1)
```

```
    }
}

//
// GWLS - Get WLAN Module Status
// Input:   None
// Return:
// Bits   Description
// 0      Reserved (set to 0)
// 1      WLAN Module Powered in S3: 0 = Disabled, 1 = Enabled
// 2      WLAN Module Powered in S4: 0 = Disabled, 1 = Enabled
// 3      WLAN Module Powered in S5: 0 = Disabled, 1 = Enabled
// 4 - 7  Reserved (set to 0)
//
Method (GWLS, 0, NotSerialized)
{
  // Change code according to HW definition
  Return (0x0)
}

//
// SWLS - Set WLAN Module Status
// Input:
// Bits   Description
// 0      N/A (WLAN Wireless Disable is Read only) Always set to 0
// 1      WLAN Module Powered in S3: 0 = Disabled, 1 = Enabled
// 2      WLAN Module Powered in S4: 0 = Disabled, 1 = Enabled
// 3      WLAN Module Powered in S5: 0 = Disabled, 1 = Enabled
// 4 - 7  Reserved
//
Method (SWLS, 1, NotSerialized)
{
   //
  // Change code according to direct EC to power
   // WLAN card appropriately.
   //
}

//
// GWWS - Get WWAN Module Status
// Input:   None
// Return:
// Bits   Description
// 0      Reserved (set to 0)
// 1      WWAN Module Powered in S3: 0 = Disabled, 1 = Enabled
// 2      WWAN Module Powered in S4: 0 = Disabled, 1 = Enabled
// 3      WWAN Module Powered in S5: 0 = Disabled, 1 = Enabled
// 4 - 7  Reserved (set to 0)
//
Method (GWWS, 0, NotSerialized)
{
  // Change code according to HW definition
  Return (0x0)
}
```

```
//
// SWWS - Set WWAN Module Status
// Input:
// Bits   Description
// 0      N/A (WWAN Wireless Disable is Read only) Always set to 0
// 1      WWAN Module Powered in S3: 0 = Disabled, 1 = Enabled
// 2      WWAN Module Powered in S4: 0 = Disabled, 1 = Enabled
// 3      WWAN Module Powered in S5: 0 = Disabled, 1 = Enabled
// 4 - 7  Reserved
//
Method (SWWS, 1, NotSerialized)
{
  //
  // Change code accordingly to direct EC to power
   // WLAN card appropriately.
   //
}

//
// SASD - Set Intel® Smart Connect Technology Sleep Duration
// Input:
// Bits   Description
// 0 - 31 Sleep Duration
//
Method (SASD, 1, NotSerialized)
{
  // Change code if EC utilizes this value
}

//
// GPWR - Get Wake Reason
// Input:   None
// Return:
// Bits   Description
// 0      User Pressed Power Button, HID event or RTC wake:
//        0 = False, 1 = True
// 1      Wake due to Periodic Wake EC or RTC: 0 – False, 1 = True
// 2      Wake due to non-Periodic RTC Wake: 0 = False, 1 = True
// 3      Wake due to PME: 0 = False, 1 = True
// 4      Set to 0
// 5 - 7  Reserved (set to 0)
//
Method (GPWR, 0, NotSerialized)
{
  // Change code accordingly to wake activity reported to Agent
  Return (0x0)
}

//
// GPCS - Get Platform Component Status
// Input:   None
// Return:
// Bits   Description
```

```
            // 0      Lid State: 0 – Closed, 1 - Open
            // 1 - 7  Reserved (set to 0)
            //
            Method (GPCS, 0, NotSerialized)
            {
              // Change code according to lid status
              Return (0x1)
            }

        } // Device (IAOE)
      } // Scope (\_SB)
    } // End SSDT
```

4.2 Embedded Controller (EC)

4.2.1 Timer Wake Method and Display Handling

If the method of wake (e.g., power button) is handled by the Operating System as a user event, the display will be turned on upon the transition from S3 to S0-ISCT by the Operating System. RTC wake, PME wake and SCI_EN wake events are treated by the Operating system as an unattended wake and the Operating System does not turn on the display. Additionally (although rare), an application running during the S0-ISCT state may turn the display on.

To prevent the display from turning on, the EC can turn off the backlight when the ACPI method SAOS is called with a '1' (GAOS returns 1) and remain turned off until SAOS is called with a value of 0 (GAOS returns 0).

4.2.2 Thermal

The EC should provide platform support for efficient and safe Intel® Smart Connect Technology operation. The EC requirements can be found in the next sections.

Intel® Smart Connect Technology usages, introduces new mobile system cooling challenges. Under normal Intel® Smart Connect Technology operation, systems are expected to update while they are unattended in environments or conditions that are not thermally desired, including in a bag, in trunk, etc. Layers of thermal protection must be in place to protect against all scenarios including case when OS lost control of execution. For example, the EC can check the thermal sensors and determine that the platform is in an environment that is too hot and subsequently direct the system to not wake up to S0, but instead reprogram the wake EC timer for a later time and remain in S3. This also can be done for checking the battery levels to force remaining in S3. The EC must also support the ability to turn off the platform if the platform exceeds the OEM defined thermal levels in which any of the platform components can be damaged.

4.2.3 System Fans

Upon resume from S3 for the Intel® Smart Connect Technology S0-ISCT session, our requirement is that the systems fans remain turned off initially so that the platform appears as it was in S3. The Intel Smart Connect Technology Agent monitors the CPU

temperature once every second during S0-ISCT session; upon reaching the thermal threshold (DeltaTjMax registry setting) the Intel Smart Connect Technology Agent requests the OS to transition back to S3.

When "Extended Wake Duration" is enabled by the BIOS via the GAOS ACPI Control Method (platform is on AC), the CPU temperature may start to rise steadily during the extended wake period. To prolong the S0-iSCT session when CPU temperature begins rising, the EC may spin the processor fan at a low RPM so that there is no acoustics event noticeable by the user. Running the fan will provide additional processor and system cooling to deliver desirable longer extended wake periods for certain applications such as large media downloads.

For Normal Wake Duration, the amount of time spent in S0-ISCT (maximum of 165 seconds) has been shown to not require the system fans to be turned on.

Fans should only be turned on if the following conditions are met:

1. System is running on AC mode
2. Lid is open for mobile systems.
3. System is docked (lid state open or closed)

Note: We do not recommend running the fans when the system is running on battery with lid closed (not docked) or system in a bag type scenario.

4.2.4 Power Savings

For power savings it is recommended, since the BIOS understands when Intel® Smart Connect Technology mode is enabled, that the EC changes its normal resume behavior and not turn on the LEDs (except Intel® Smart Connect Technology indicator LED), Fans, and backlight, etc.

4.2.5 Power Button Override

Intel® Smart Connect Technology does not require any special processing for power button overrides. The EC should perform the normal operation of shutting down the platform.

4.2.6 Audio Muting

The Intel® Smart Connect Technology Agent will mute the audio (if not muted already) upon entering the S0-ISCT state and restore the audio mute setting upon exit to normal S0. To accomplish this and prevent race conditions, the Agent monitors when the Operating System or drivers set the mute setting and then mutes the audio afterwards. If a additional delay period needs to be set, add a DWORD registry entry "AudioDelayMilliSeconds" and set the requested value in milliseconds (e.g. 3000) appropriately for the audio devices. See the Registry Settings section for more information on modifying registry values.

If the BIOS performs any audio notification upon transition from S3 to S0-ISCT, it is requested the BIOS does not do this to prevent the user from thinking the platform

has been woken up. Upon resume from S3, the BIOS can check the state of GAOS to determine if the resume is to normal S0 or S0-ISCT.

4.2.7 Intel® Smart Connect Technology Mode Indicator LED

The platform can use the existing system status LED in two alternate modes when the user on the platform enables Intel® Smart Connect Technology:

1. Keep the system status LED indicating S3 state during S0-ISCT state (ACPI method SAOS is called with a value of 1 - GAOS returns 1) and return to normal S0 state indication when SAOS is called with a value of 0 (GAOS returns 0).
2. Provide notification to the user Intel® Smart Connect Technology is enabled in S3 (ACPI method SAOS is called with a value of 1), the system status LED shall turn on for 2 seconds every 20 seconds or indicate S0-ISCT mode for the brief period when S0-ISCT state is active (turn on 2 seconds every 20 seconds).

4.3 S3 State Considerations

Overview: When Intel® Smart Connect Technology is active and enabled on a system, and the user initiates an S3 transition, Intel® Smart Connect Technology Agent prepares the system for automatic wakeup after specific time duration to perform actions based on the current system conditions and configuration.

4.3.1 Power Button in S3 State

When the platform is in the S3 state and the power button is pressed, the behavior is to resume to the S0 state instead of the S0-ISCT state. By the user pressing the power button, they are indicating that they wish to have control of the platform. The Intel® Smart Connect Technology Agent needs notification from the EC that the power button was pressed to not enter the S0-ISCT state upon resume from S3. The BIOS must set bit 0 of the ACPI control method GPWR that the power button was pressed to inform the SW Service to not enter the S0-ISCT state.

4.3.2 Intel® Smart Connect Technology Wake Timer Cycle Overview

Prior to suspending the platform, the Intel® Smart Connect Technology Agent will call the ACPI Control Method SASD with the value of the periodic wake. If this value is non-zero, the BIOS will instruct the EC to set a timer to wake the platform after a sleep of the specified seconds in the SASD value. When the timer expires the EC will wake the platform from S3 and instruct the BIOS to return a value of 1 in Bit 1 of the GPWR ACPI Control Method.

4.3.3 Platform Firmware Considerations for SAOS and SASD

When Intel® Smart Connect Technology is active and enabled, upon the user initiated S3 entry,

- Intel® Smart Connect Technology Agent evaluates the SAOS ACPI object with a parameter value of '1' to indicate the subsequent S0 could be an S0-ISCT mode.

- After programming the next wake timer (RTC or EC), the Agent evaluates the SASD ACPI object with a parameter value of "equal to the next wake timer" to be used by EC/BIOS for pre-SCT wake system check.

In response to SAOS object evaluation, the platform could prepare for next S0-ISCT mode. This includes the following:

- Set a flag within the firmware (BIOS and EC) to indicate while resuming that the system might be entering S0-ISCT mode.
- EC may use the next wake timer info to prepare from the upcoming wake.

4.3.4 Incomplete S3 Transitions

With Intel® Smart Connect Technology initiating more frequent S3 transitions than a typical system, there may be an increased vulnerability for an incomplete S3 transition and OS hanging in the middle. This could cause the system to remain active, causing battery drain and causing the system thermal issues.

It is recommended that the platform take additional precautions and monitor for such incomplete S3 transitions.

One possible solution to prevent such incomplete transitions is for EC to monitor System S3 transition completion (assertion of SLP_S3# pin from PCH) from the time SAOS ACPI object is evaluated. If after a predetermined period of time after SAOS ACPI object is evaluated or from any S3 entry request to OS, the EC fails to see SLP_S3# pin asserted, EC may cause a critical system shutdown to prevent system thermal violations.

The pseudo code illustrated in Example 1 below explains the algorithm that could be used in system EC.

Example 1. OS Hang During S3 Entry Handler Pseudo Code

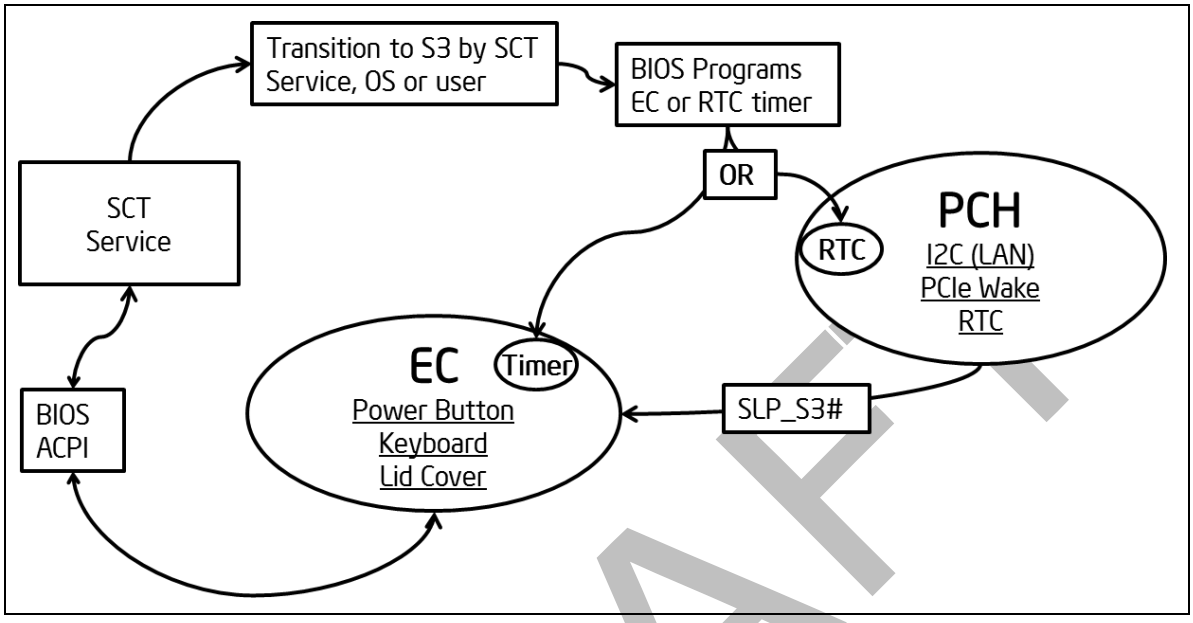
```
STEP 1: EC: Record time when SAOS or SASD Object is evaluated by the SCT
SW
STEP 2: EC: Wait Pre-determined time period (e.g. 30 to 60 seconds)
STEP 3: EC: Check if SLP_S3# is asserted to indicate system has entered
S3 state.
STEP 4a: If SLP_S3# is asserted, do nothing and exit
STEP 4b: If SLP_S3#
   • Is not asserted, cause a hardware critical thermal shutdown of the
     platform. Data loss my happen.
   • Program a wake in EC to check again
```

4.4 S0 State Considerations

Platform wake trigger can be initiated by many sources. The figure below conceptually illustrates the various platform triggers that could cause an S0 transition from S3. As seen from the illustration, there are certain events that the EC will be able to identify as a user event, while there are other events that the BIOS can read from PCH resisters. The BIOS can determine the wake cause when it is handling the event from the PCH and or EC and identify if the event is user triggered or not. All other triggers could be caused automatically without a user trigger. If Intel® Smart Connect Technology Agent is enabled it performs a quick check to determine if the wake event

was an automatic wake or caused by a user activity. Any automatic wake is considered an SCT wake, SCT will take over and do the automatic updates and put the system back to Sx state per configuration.

Figure 4-2. System S0 State Transition Triggers



4.4.1 Power Button in S0-ISCT State

When the platform is in the S0-ISCT state and the user presses the power button, the Intel® Smart Connect Technology Agent will exit the S0-ISCT state and return the OS to the default behavior of *the OS policy that is set to for the power button*. This could be suspend, shutdown, hibernate or no-action (return to normal S0 state).

There is a corner case that in the first second or two after the S3 resume, the Agent will not be able to trap the power button as the OS has not resumed execution of all services and applications. The change to encounter this issue is very limited due to the short time duration.

4.4.2 How to Determine When the System is in SO-ISCT Versus S0-Normal Mode

The GAOS ACPI control method returns the current status of the Intel® Smart Connect Technology Agent in the BIOS. Table below shows the bit value of GAOS during various system states.

EC and BIOS can use the information from SLP_S3# and GAOS to determine if the system is in S0-ISCT versus S0-Normal mode and can set the platform appropriately for automatic non-use operation.

SAOS values in various modes:

Table 4-16. SAOS Values

	S3	S0-ISCT	S0-Normal
SAOS	1	1	0
SLP_S3#	Asserted	De-asserted	De-asserted

4.4.3 S0-ISCT System State Design Considerations

The S0 system state triggered by Intel® Smart Connect Technology has some special considerations. Since the ISCT Agent performs its periodic tasks at times when the user may not be present in front of the system, the following special considerations may be applied when the system resumes in the S0-ISCT mode.

- **System Audio:** The platform may keep the system Audio turned off during S0-ISCT session. SCT Agent requests the OS to mute audio.
- **System Display and Backlight:** Until the platform knows for sure the current S0 entry is a user-triggered state, the platform may keep the system display and backlight turned off. SCT Agent requests the OS to keep the display off.
- **LED Indicators:** The platform may also keep the system status LEDs to indicate S3 status or indicate S0-ISCT mode indicator for the brief period when S0-ISCT state is active.
- **Thermal Trip Points (Mobile):** Under normal usage of S3 -> to S0-ISCT systems thermal are expected to be within acceptable range. SCT Agent checks for CPU temperature. A "backoff" mechanism is implemented in SCT Agent to start scheduling doubling the sleep duration time for system to cool sufficiently till next wake. Please refer to section Chapter 7 for more details. Platform may use aggressive thermal trip points and manage the platform to those trip points during SO-ISCT session. This may include the platform notifying the Operating System Thermal Management Subsystem with new _PSV, _HOT, _CRT trip points. If EC is managing the system thermals, it is recommended that the EC use aggressive platform thermal limits.
- **System Fan(s):** Since the system operating environment is to be considered unknown when in S0-ISCT mode, the system fans are recommended to be turned off when in S0-ISCT mode. If desired, the fans may be turned on later in the S0-ISCT session if the thermals begin to rise and the system lid is open for mobile (to prevent operating environment where the notebook is in a bag). If the system is docked and lid is closed, it is acceptable to spin fans. This will allow longer Extended Wake Duration sessions where the system fans are turned off. For Normal Wake Duration there should be no need to turn on the system fans. If the fans are turned on, care should be taken to reduce the acoustics impact at the initial spin up so that fans spin up properly but not be ramped to full speed. Platform fan control is responsible for monitoring the system temperatures and fan speed management.

4.4.4 S0 Normal System State

This S0 system state indicates that the user has triggered a transition to S0 and hence the platform can safely assume normal usage modes and hence can apply normal thermal and platform settings.

- **System Audio:** System audio assuming user presence.

- **System Display and Backlight:** Display and backlight on assuming user presence.
- **LED Indicators:** Normal states as when the user is present. Additionally any specific SCT LEDs may be turned off by SCT service once SCT service determines the system is in S0 normal state.
- **Thermal Trip Points:** Trip points as applicable when a user is actively using the system may be applied.
- **System Fan(s):** System fans may be operated normally based on system thermal conditions.

4.4.5 S0-ISCT State Thermal Considerations

Similar to the concern described in section 4.3.4, any OS hangs that happen when in S0-ISCT mode with no user intervention could lead to system thermal violations. To prevent this from happening, it is recommended that the platform implement activity monitoring functionality to ensure the system is active and not hung.

The platform may implement a watchdog timer mechanism to notify the EC of system activity when in S0-ISCT mode. If the EC sees that the watchdog register/value does not get updated for several seconds, it can then trigger a forced shutdown assuming OS hang situations.

For detailed discussion on platform thermal considerations refer to Chapter 7.

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5 NetDetect

5.1 Overview

NetDetect is a feature of select Intel® WLAN Drivers. NetDetect improves the power consumption of Intel® Smart Connect Technology by replacing periodic wakes with network detection wakes. NetDetect enables the WLAN device to scan for Access Points (APs) while the system is in the S3 state. NetDetect is implemented in the microcode of the Intel WLAN NIC.

5.2 Architecture

Prior to entering S3 and Intel® Smart Connect Technology is enabled for periodic wakes, the Intel® Smart Connect Technology Agent will determine network connectivity by querying the Microsoft* Windows Connection Manager*. If the request to enter S3 is during the S0-ISCT mode and no network connection is available, the SCT Agent will query the Intel® WLAN Driver to determine if the WLAN device supports NetDetect. If NetDetect is available, the SCT Agent will ask the WLAN driver to enable NetDetect. The SCT Agent will also call the BIOS's ACPI SWLS ACPI control method and ask the BIOS to enable power to the WLAN device during S3. If the request to enter S3 is from the user or result of unattended usage, NetDetect is not configured by the SCT Agent due to the short period of time (typically 2 seconds) that the SCT Agent has to transition to S3.

Once the platform is in S3, and an initial hold-off time equal to the current periodic wake sleep period occurs (30 minutes in extended hours), the microcode of the WLAN device will periodically (about every two minutes) turn on the receiver of the WLAN NIC to scan for APs. If an AP is found, the microcode will compare the SSID to any APs that were previously configured by the user as "***Connect automatically***".

If the SSID matches, the microcode will wake the platform by asserting the PME WAKE# line. Once the platform wakes to S0, the Intel WLAN Driver will disable NetDetect until enabled again by the SCT Agent.

5.2.1 NetDetect Flow

NetDetect Enabled:

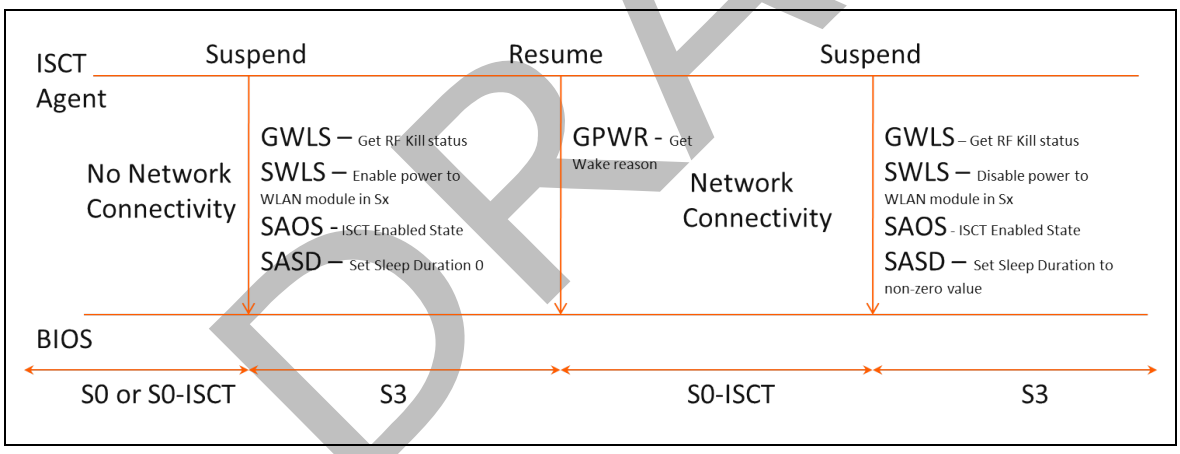
- When in S0 or S0-ISCT, there is no network connectivity, at suspend time, Intel® Smart Connect Technology Agent will disable the timer by setting sleep duration to 0 (if not physical Radio On/Off switch, see section below for more details)
- The Agent will request BIOS/EC enable power to WLAN NIC in Sx state using SWLS ACPI control method
- The Agent will enable NetDetect in WLAN driver

NetDetect Disabled:

- When in S0 or S0-ISCT, if there is network connectivity at suspend time, Agent will enable the timer by setting sleep duration to non-zero value and not enable NetDetect
- The Agent will disable power to WLAN NIC in Sx state using SWLS ACPI control method
- The ISCT Agent will disable NetDetect in WLAN driver

Note: *Intel® Smart Connect Technology function status is always enabled (SAOS = 1)*

Figure 5-1. NetDetect Flow



5.2.2 NetDetect Behavior on Power Loss

If during the Sx state, power is removed from the Intel WLAN and later restored while the platform is in S3, a boot of the OS is required to re-load the NetDetect microcode for the WLAN device.

5.2.3 NetDetect Configuration

There are several OEM registry settings that effect NetDetect operation on the platform. They are:

- **NetDetectPref**: Set to 0 to disable NetDetect on a platform that does not have a WLAN card supporting NetDetect (for example Desktop system). Default value is 1 to enable NetDetect on platforms.
- **NDFFSCoExist**: Set to 1 to enable the co-existence of NetDetect and Intel® Rapid Start Technology on the platform. Default value is 0 to disable the enabling of NetDetect in extended hours when the ISCT Agent enabled Rapid Start Technology.

See the Setup & Configuration Guide for more information on creating OEM default registry values.

5.2.4 Radio On/Off Switch Effect on NetDetect

Prior to entering S3, the Intel® Smart Connect Technology Agent calls the OS to obtain the status of the WLAN Radio on/off state. The Agent will look at the value of the GABS ACPI control method bit 6 to determine if the platform has a physical Radio On/Off switch or soft switch.

If the platform has a physical Radio On/Off switch (GABS Bit 6 set to '1') and there is no other network connect (LAN) the following will be observed:

- Radio if OFF before going to suspend:
  - NetDetect will be enabled as WLAN NIC has power prior to entering S3
  - If the user turns the radio ON in S3, NetDetect will wake the platform when AP found and platform will enter S0-ISCT to update content
- Radio is ON in S0 and turned OFF in S3:
  - In this case, when in S3, and the radio is turned OFF, EC should stop the timer. Since there is no power to WLAN NIC, NetDetect will not wake the platform).
  - If the user turns the radio ON again in S3, EC should wake the platform after a default time (5 minutes for example)

If the platform does not have a physical Radio On/Off switch (GABS Bit 6 = '0') but instead has a "soft-switch" and there is no other network connection (LAN), the following with be observed in the ACPI control method values:

- Radio if OFF before going to suspend:

  - NetDetect will not be enabled as there is no way to turn on the radio in S3 without returning to S0
  - Platform will not wake by periodic timer
- Radio is ON in S0:
  - NetDetect enabled

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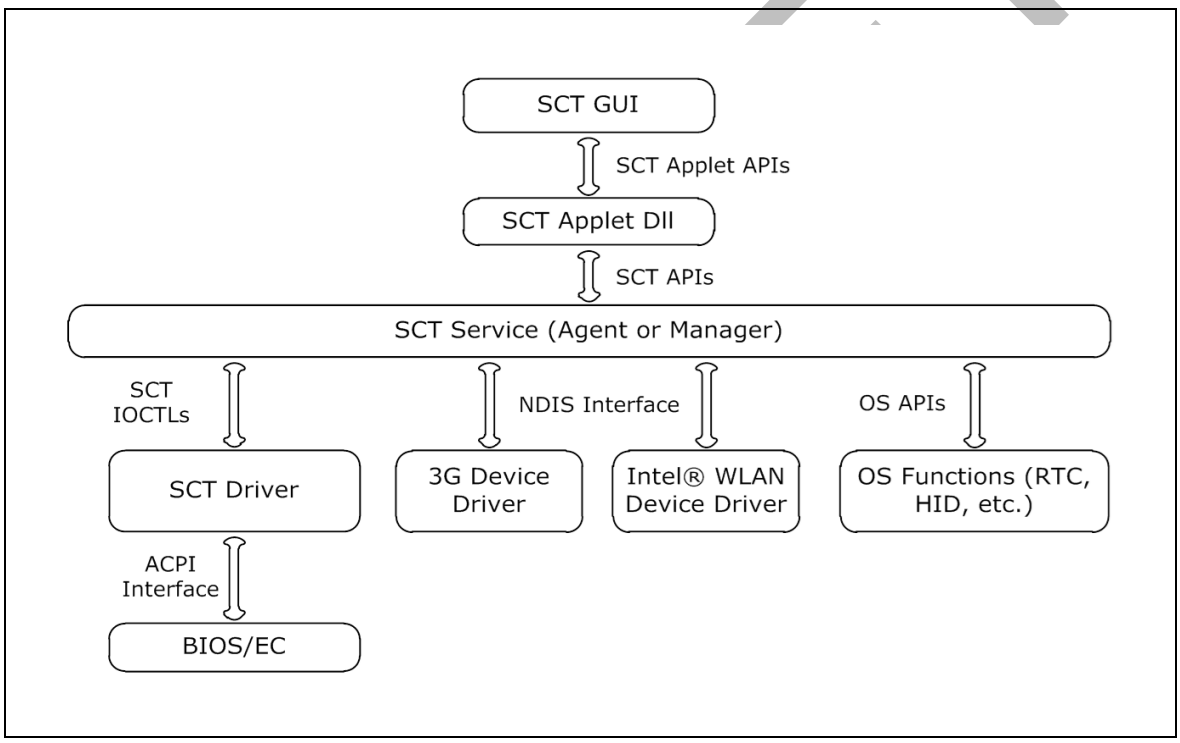
6 Intel® Smart Connect Technology SW

6.1 Overview

Intel® Smart Connect Technology uses OS resident components to manage Intel® Smart Connect Technology operations on the platform.

Figure 6-1 illustrates these components.

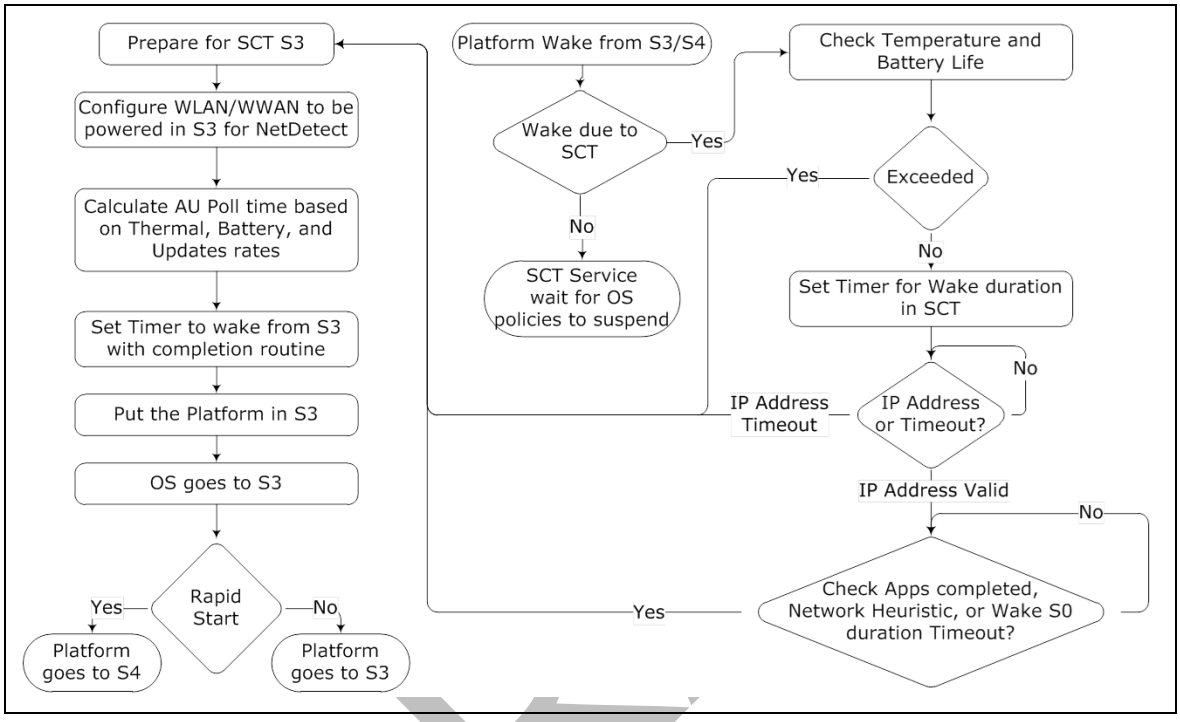
Figure 6-1. Intel® Smart Connect Technology SW Stack



6.2 Intel® Smart Connect Technology Agent

The Intel® Smart Connect Technology Agent controls the Intel® Smart Connect Technology operation on the platform. Figure 6-2 illustrates the operation of the Intel® Smart Connect Technology Agent.

Figure 6-2. Intel® Smart Connect Technology Agent Operation Flow



6.2.1 S0-ISCT Duration

To maintain platform thermals and reduce battery drain, the Intel® Smart Connect Technology Agent limits the amount of time spent in S0-ISCT. The S0-ISCT time duration depends upon the following:

- Network Heuristics determine the amount of time spent in S0-ISCT. Currently the Agent monitor Exchange, IMAP, and POP3 protocols for activity. After detecting inactivity on these protocols, the Agent puts the system back to S3.
  - For IMAP and POP3 protocols, the inactivity period is 10 seconds
  - For Exchange protocols, the inactivity period is 5 seconds
- Time constraints derived from previous S0-ISCT sessions:

  The maximum S0-ISCT allowable wake time is controlled by a registry value of S0WakeDurationLimitSeconds. This registry value has a default and maximum value. The Agent keeps a history of the last two S0-ISCT sessions.
  - If two consecutive S0-ISCT sessions complete in less than the default value of S0WakeDurationLimitSeconds, this session maximum time is set to S0WakeDurationLimitSeconds maximum setting (more time)
  - If two consecutive S0-ISCT sessions required went to the maximum allowable S0WakeDurationLimtSeconds, this session is restricted to a default S0WakeDurationLimitSeconds (less time)
  - If there is no history (new installation), then the S0-ISCT session is limited to S0WakeDurationLimitSeconds default value for two consecutive sessions

6.2.1.1 Extended Media Download S0-ISCT Duration

The S0-ISCT wake duration can be extended by the platform by responding to the GAOS ACPI control method with Bit 1 set to '1'. The Agent will indicate Extended Media S0-ISCT duration is supported by setting Bit 1 of the SAOS ACPI control method to '1'. Extended wake duration allows for larger content download. Once network activity falls below 100KB for 10 seconds, the platform is transitioned back to S3.

For mobile platforms, this is only supported if the platform is on AC.

During the Extended Media download S0-ISCT session, the BIOS/EC may turn on the fans to allow longer sessions. Depending on the thermal capabilities of the platform, the recommendation is to use the low speed setting of the fans.

6.2.2 Network Connectivity Check

Upon entering the S0-ISCT mode, the Intel® Smart Connect Technology Agent performs the following network connectivity checks:

- Check for network connection on available network devices (LAN/WLAN/WWAN).
- If no network connection, then transition platform back to S3 (enable NetDetect if possible)
- If network connection(s) exists:

  - Set 15 second IP Address Start wait timer to allow sufficient time for network cards to obtain IP address and VPN reconnection
  - Listen for IP Address change notification
- If no IP address is available after 15 seconds (IP Address timer expires), transition platform back to S3 (enable NetDetect if possible)

Note: If multiple network connects exist, the OS will determine which one to use (typically based on connection speed).

6.2.3 Duty Cycle

When the Intel® Smart Connect Technology calculates the next sleep duration it takes into consideration battery life, current S0-ISCT session duration, thermal conditions and duty cycle for the actual sleep time used. Duty cycle is a rule that the Agent uses to preserve battery life and prevent thermal issues during S0-ISCT mode if the battery (> 90%) and thermals are normal. The duty cycle is calculated as: S0-ISCT session duration/(S0-ISCT session duration + S3 sleep duration) <= 10%.

For example using default wake duration of 65 seconds and sleep duration of 5 minutes (300 seconds), the duty cycle calculation is: 65/(65 + 300) = 15%. This value exceeds the 10% duty cycle rule. Thus the Agent adjusts the sleep duration to 585 (about 10 minutes) to meet the 10% rules. If the application running upon resume to the S0-ISCT mode quickly updates data and the network heuristics show that network activity has reduced after 10 seconds for example, then the next wake duration may be 5 minutes since the duty cycle is smaller.

6.2.4 Battery Level Consideration

The Intel® Smart Connect Technology Agent uses the current aggregated battery level (summation of all batteries in the system) when calculating the sleep duration. For the case of battery is being charged, an adjustment is made due to heat generation of the charging action by the batteries and can affect the thermal of the platform. Note that the Agent does not schedule periodic wake or NetDetect enabling when the battery level is below the default registry setting of 15%.

The Agent increases the sleep duration as follows:

Table 6-1. Sleep Duration Extension on Battery Power

Battery Level	Sleep Duration Extension
< 90 %	2 minutes
< 80 %	4 minutes
< 70 %	5 minutes
< 60 %	10 minutes
< 50 %	15 minutes
< 40 %	20 minutes
< 30 %	30 minutes

Battery Level	Sleep Duration Extension
< 20 %	60 minutes
< 10 %	90 minutes

Table 6-2. Sleep Duration Extension While Charging

Battery Level	Sleep Duration Extension
< 90 %	1 minutes
< 80 %	2 minutes
< 70 %	3 minutes
< 60 %	4 minutes
< 50 %	5 minutes
< 40 %	10 minutes
< 30 %	15 minutes
< 20 %	30 minutes

6.2.5 Thermal and Battery Monitoring during S0-ISCT

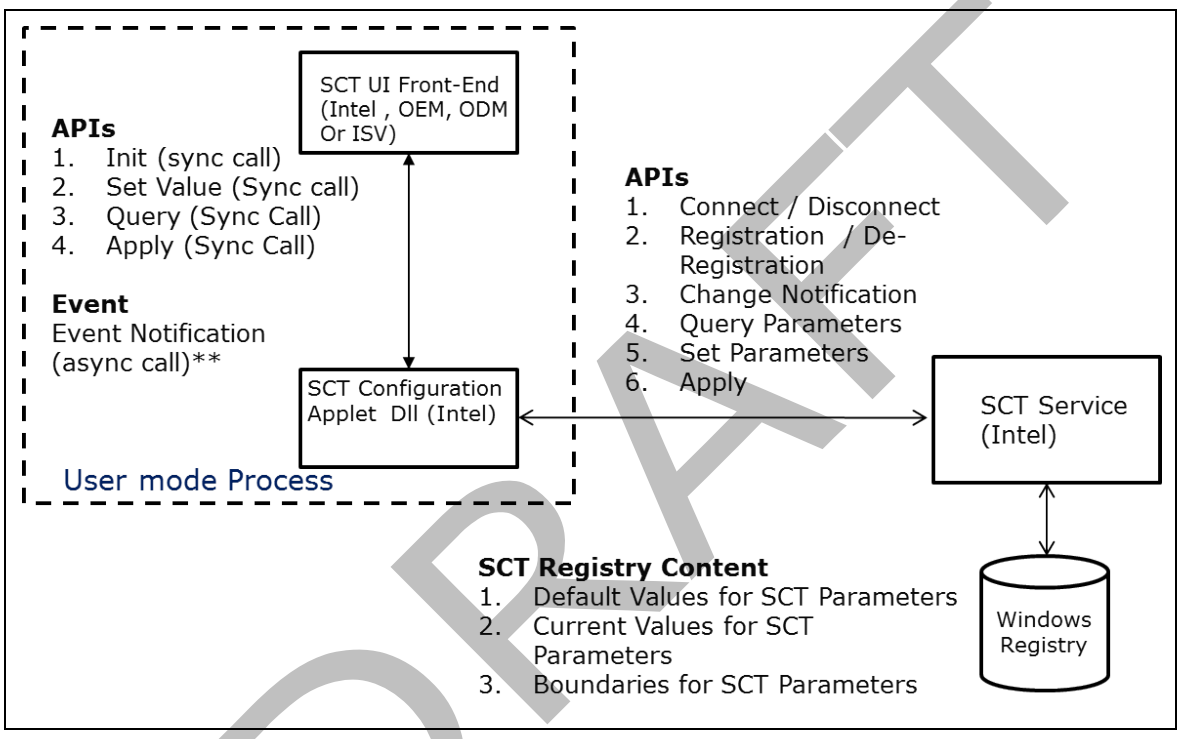
The Intel® Smart Connect Technology Agent monitors the thermal and battery life (if on battery) during the S0-ISCT session every 1 second. If the Agent detects the CPU temperature has exceeded CPU Tj delta of 50°C (default registry setting for **ThermalThresholdCentigrade**), the platform transitions to S3. If the Agent detects the battery threshold while on battery (no AC present) falls below 15% (default registry setting for **DCBatteryThresholdHalt**), the platform transitions to S3.

Prior to transitioning to S3 for either of these cases, the Agent will evaluate the thermal and battery state to determine the sleep duration.

6.2.6 Intel® Smart Connect Technology Agent Configuration

An OEM can configure the Intel® Smart Connect Technology Agent by using the Intel® Smart Connect Technology Configuration Applet Dll. The Dll provides an interface that allows the UI to configure settings for the Intel® Smart Connect Technology Agent. The following figure shows the interaction of the UI with the Intel® Smart Connect Technology Configuration Applet Dll and the Intel® Smart Connect Technology Agent.

Figure 6-3. Configuration Applet



The Intel® Smart Connect Technology Configuration Table lists all of the various parameters configurable for the Intel® Smart Connect Technology Agent through the Intel® Smart Connect Technology Configuration Applet Dll.

The Intel® Smart Connect Technology Agent uses the OS registry to store the configuration values. To allow OEMs flexibility in their usage of the Intel® Smart Connect Technology, they may wish to provide their own values. See the Setup & Configuration Guide for more information on creating OEM default registry values.

[HKEY_LOCAL_MACHINE\SOFTWARE\Intel\Intel® Smart Connect Technology\Always Updated]

Note: When a registry value is updated, the Intel® Smart Connect Technology Agent must either be restarted or the system rebooted for the values to take effect.

Some of the parameters are exposed to the UI and others are OEM configured based on the specific platform support Intel® Smart Connect Technology. The default setting will be set to values in the Intel® Smart Connect Technology Configuration Table below. Intel® Smart Connect Technology configuration table value specifies the Min and Max range and is programmed as part of installation. The Intel® Smart Connect Technology configuration table is expected to be stored in non-volatile secure storage.

Table 6-3. Intel® Smart Connect Technology Agent Configuration Settings

Name	Registry Key	Min	Max	Default	Registry Setting	UI	BIOS/ EC
Intel® Smart Connect Technology Global Enable/Disable	PeriodicWakeEnabled	Disabled	Enabled	Disabled	√	√	√
Daytime Intel® Smart Connect Technology Update Frequency	S3SleepDurationSeconds	5 mins	60 mins	15 min	√	√	
Night time Start Range h:mins	NightTimeDuskMinutes	0h 00min	24h 00mins	19h 00mins	√	√	
Night time Stop Range h:mins	NightTimeDawnMinutes	0h 00min	24h 00mins	7h 00mins	√	√	
Night time Intel® Smart Connect Technology Update Frequency	S3SleepDurationNightSeconds	10 mins	1380 mins (23 hours)	120 mins (2 hours)	√		
Battery Life % before disabling Intel® Smart Connect Technology	DCBatteryThresholdHalt	Current OS Suspend setting	95%	15%	√		
S0-Maxiumum-time-wake-duration	S0WakeDurationLimitSeconds	10 sec	165 sec	45 sec	√		
CPU Thermal Threshhold of when ISCT increases sleep duration	ThermalThresholdCentigrade	60°C below TJ-	40°C below TJ-MAX	50°C below TJ-MAX	√		
WhiteList			10 entries		√		
Audio Settings Delay when entering S0-ISCT mode	AudioDelayMilliSeconds	0		2000 (2 seconds)	√		

Wake Duration *is the amount of time the system spends in the ISCT-S0 state under normal conditions (no thermal issues).*

The values S0-Maxiumum-time-wake-duration *is used to specify the amount of time allowed for a platform to stay in ISCT-S0 due to thermal limitations to ensure skin temps do not exceed Intel thermal guideline.*

Expose in UI are the possible values that can be configured in the OEM version of the Intel® Smart Connect Technology UI. The OEM can choose to display a subset of these values to have a simple UI to expose minimal configuration to the user.

6.2.6.1 Registry Settings

6.2.6.1.1 Event Logging

The Intel® Smart Connect Technology uses the OS Event Log to store log information in the "Applications" Log. The "Source" field is "ISCT".

6.2.7 Application White List

The Intel® Smart Connect Technology provides the ability to control the periodic wake of the platform by checking prior to entering S3 if an application is running from a defined list of applications ("White List"). The Intel® Smart Connect Technology Agent will suspend the S0-ISCT/S3 cycle if none of the applications defined in the white list are running prior going into S3 mode. A non-existent or empty list will indicate that the Intel® Smart Connect Technology Agent will always do the S3/S0-ISCT cycle irrespective of running applications.

The White List is stored in the OS Registry under the key of:

[HKEY_LOCAL_MACHINE\SOFTWARE\Intel\Intel® Smart Connect Technology\Always Updated]

in the "WhiteList" string. The list supports a maximum of 10 applications. The ";" separated entries are the application executable name. The list is read at the start of the Intel® Smart Connect Technology Agent.

Note: The WhiteList registry value must also be created in the OEM section. Please see the Setup & Configuration Guide for information on how to add an OEM setting.

6.2.8 Intel® Smart Connect Technology Applet Dll Interface Prototypes

The software interface to the Intel® Smart Connect Technology Applet Dll is provided as a 32 bit Microsoft .NET* compatible DLL (iSCTConnect.dll). Microsoft .NET obtains the API method information via introspection of the iSCTConnect.dll upon inclusion into a project using the DLL.

General Data Structures

```
namespace ISCT
{

  public ref class AgentConnect
  {
    public:
      static uint isctConnect();
      static uint isctDisconnect();
      static uint isctRestoreDefaults();
      static uint isctEnable();
      static uint isctDisable();
      static uint isctGetEnableState();
      static uint isctSetDaytimeSleepDuration(uint
nSleepDurationSeconds);
      static uint isctGetDaytimeSleepDuration();
      static uint isctSetNighttimeSleepDuration(uint
nSleepDurationSeconds);
      static uint isctGetNighttimeSleepDuration();
      static uint isctSetDuskMinutes(uint nDuskMinutes);
      static uint isctGetDuskMinutes();
      static uint isctSetDawnMinutes(uint dwDawnMinutes);
      static uint isctSetDawnMinutes();
      static ulong isctGetLastWakeTime();
      static ulong isctGetLastSleepDuration();
      static uint isctGetNumberOfCycles();
      static sbyte* isctGetVersion();
};
}
```

AgentConnect::isctConnect

Syntax

uint AgentConnect::isctConnect();

Parameters

None

Description of Function

The first function called before calling other AgentConnect APIs. This function establishes connection to the Intel® Smart Connect Technology Agent.

Return Codes

0: Operation completed successfully

Parameters

AgentConnect::isctDisconnect

Syntax

uint AgentConnect::isctDisconnect();

Parameters

None

Description of Function

Function disconnects the GUI from the Intel® Smart Connect Technology Agent. All updated Intel® Smart Connect Technology Configuration Values must be updated prior to calling this function. Additionally this function must be called prior to exiting of the GUI application to prevent resource leaks.

Return Codes

0: Operation completed successfully

AgentConnect:isctRestoreDefaults

Syntax

uint AgentConnect::isctRestoreDefaults();

Parameters

None

Description of Function

Function restores the default OEM values (if they exist) for all Intel® Smart Connect Technology registry values. If a value does not exist in the OEM section or a value exceeds the minimum or maximum allowed values, the Intel® Smart Connect Technology default value will be used.

Return Codes

0: Operation completed successfully

AgentConnect::isctEnable

Syntax

uint AgentConnect::isctEnable();

Parameters

None

Description of Function

Function enables Intel® Smart Connect Technology content updates.

Return Codes

0: Operation completed successfully

AgentConnect::isctDisable

Syntax

uint AgentConnect::isctDisable();

Parameters

None

Description of Function

Function disables Intel® Smart Connect Technology content updates.

Return Codes

0: Operation completed successfully

AgentConnect:isctGetEnableState

Syntax

uint AgentConnect::isctGetEnableState();

Parameters

None

Description of Function

Function returns the current state of the ISCT content updates.

Return Codes

0: Content updating is enabled

1: Content updating is disabled

AgentConnect:isctSetDaytimeSleepDuration

Syntax

uint AgentConnect::isctSetDaytimeSleepDuration(UINT nSleepDurationSeconds);

Parameters

uint – number of seconds to sleep

Description of Function

Function sets the number of seconds to sleep in the daytime (non-extended hours).

Return Codes

0: Operation completed successfully

AgentConnect:isctGetDaytimeSleepDuration

Syntax

uint AgentConnect::isctGetDaytimeSleepDuration();

Parameters

None

Description of Function

Function gets the number of seconds to sleep in the daytime (non-extended hours).

Return Codes

>0: The current sleep duration in seconds

-1: Operation failed

AgentConnect:isctSetNighttimeSleepDuration

Syntax

uint AgentConnect::isctSetNighttimeSleepDuration(uint nSleepDurationSeconds);

Parameters

uint – number of seconds to sleep

Description of Function

Function sets the number of seconds to sleep in the nighttime (extended hours).

Return Codes

0: Operation completed successfully

AgentConnect:isctGetNighttimeSleepDuration

Syntax

uint AgentConnect::isctGetNighttimeSleepDuration();

Parameters

None

Description of Function

Function gets the number of seconds to sleep in the nighttime (extended hours).

Return Codes

>0: The current sleep duration in seconds

-1: Operation failed

AgentConnect:isctSetDuskMinutes

Syntax

uint AgentConnect::isctSetDuskMinutes(uint nDuskMinutes);

Parameters

uint – number of minutes since midnight (00:00) that extended hours start

Description of Function

Function sets the starting time from midnight that extended hours start.

Return Codes

0: Operation completed successfully

AgentConnect:isctGetDuskMinutes

Syntax

uint AgentConnect::isctGetDuskMinutes();

Parameters

None

Description of Function

Function gets the number of starting time of extended hour time in minutes from midnight.

Return Codes

>0: The current start of extended hour time in minutes

-1: Operation failed

AgentConnect:isctSetDawnMinutes

Syntax

uint AgentConnect::isctSetDawnMinutes(uint nDawnMinutes);

Parameters

uint – number of minutes since midnight (00:00) that extended hours end

Description of Function

Function sets the starting time from midnight that extended hours end.

Return Codes

0: Operation completed successfully

AgentConnect:isctGetDawnMinutes

Syntax

uint AgentConnect::isctGetDawnMinutes();

Parameters

None

Description of Function

Function gets the number of ending time of extended hour time in minutes from midnight.

Return Codes

>0: The current end of extended hour time in minutes

-1: Operation failed

AgentConnect:isctGetLastWakeTime

Syntax

ulong AgentConnect::isctGetLastWakeTime();

Parameters

None

Description of Function

Function returns the last wakeup time in ulong (64 bit) format that contains the FILETIME information. The caller must convert this to FILETIME and use the FileTimeToSystemTime() Windows API to convert the value to a SYSTEMTIME value.

For example:

FILETIME LastWakeFileTime;

ulong ullLastWakeTime = AgentConnect.isctGetLastWakeTime();

LastWakeFileTime.dwLowDateTime = (uint)ullLastWakeTime;

LastWakeFileTime.dwHighDateTIme = (uint)(ullLastWakeTIme >> 32);

SYSTEMTIME LastWakeSystemTime;

FileTimeToSystemTime (LastWakeFileTime, LastWakeSystemTime);

Return Codes

>0: The last wakeup time in in 64 bit format

-1: Operation failed

AgentConnect:isctGetLastSleepTime

Syntax

ulong AgentConnect::isctGetLastSleepTime();

Parameters

None

Description of Function

Function returns the last time the system went to S3 with Intel® Smart Connect Technology enabled. The value is in ulong (64 bit) format that contains the FILETIME information. The caller must convert this to FILETIME and use the FileTimeToSystemTime() Windows API to convert the value to a SYSTEMTIME value.

For example:

FILETIME LastSleepFileTime;

ulong ullLastSleepTime = AgentConnect.isctGetLastSleepTime();

LastSleepFileTime.dwLowDateTime = (uint) ullLastSleepTime;

LastSleepFileTime.dwHighDateTIme = (uint)(ullLastSleepTime >> 32);

SYSTEMTIME LastWakeSystemTime;

FileTimeToSystemTime (LastSleepFileTime, LastSleepSystemTime);

Return Codes

>0: The last sleep time in in 64bit format

-1: Operation failed

AgentConnect:isctGetNumberOfCycles

Syntax

uint AgentConnect::isctGetNumberOfCycles();

Parameters

None

Description of Function

Function returns the number of sleep/wake cycles since the last time the platform was in S0.

Return Codes

>0: The number of sleep/wake cycles since last S0

-1: Operation failed

AgentConnect:isctGetVersion

Syntax

sbyte* AgentConnect::isctGetVersion();

Parameters

None

Description of Function

Function returns a string containing the current Intel® Smart Connect Technology version number (for example: 2.0.0.0)

Return Codes

NULL: Operation failed

6.2.9 Intel® Smart Connect Technology Applet Dll Interface Example

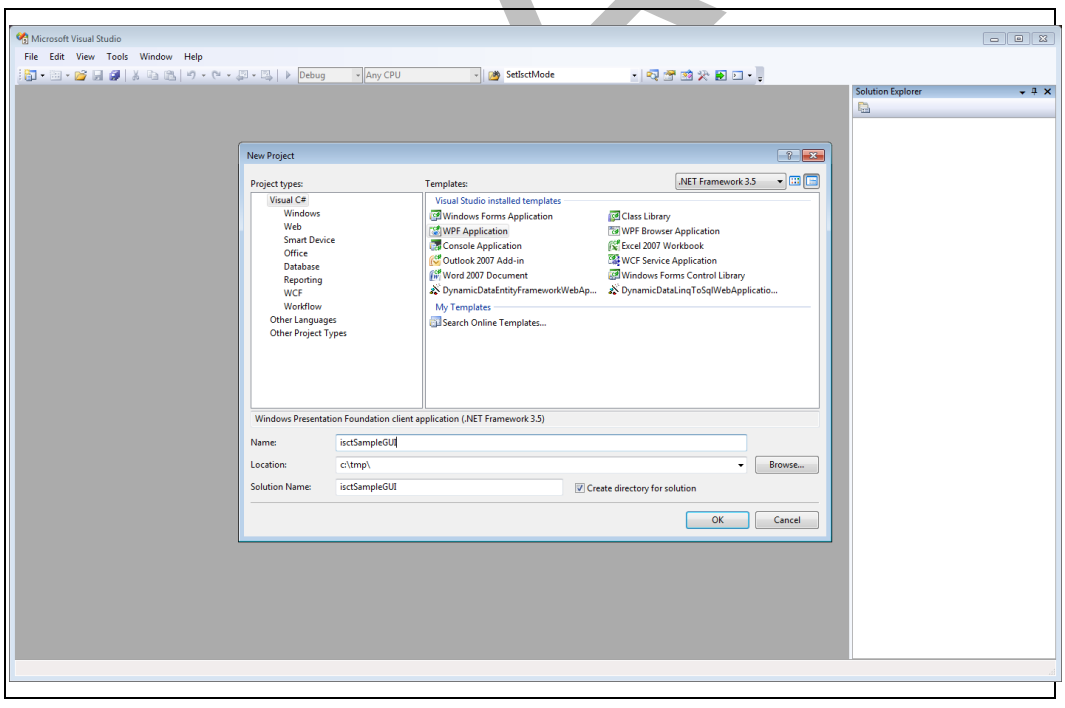
This section shows how to create a sample application that interfaces to the Applet Dll interface described in the previous section.

OEM must provide attribution of the Intel® Smart Connect Technology as follows:

- Use the following wording: "powered by Intel® Smart Connect Technology" on the main window
- Location: This can vary based on GUI design. A recommendation is to place it below the main title or branding of the GUI.
- Font Size: Variable. It is expected that the font will be one size smaller than the main title of the GUI. (e.g., 8pt Font for the main title and 7pt font for "powered by Intel® Smart Connect Technology")

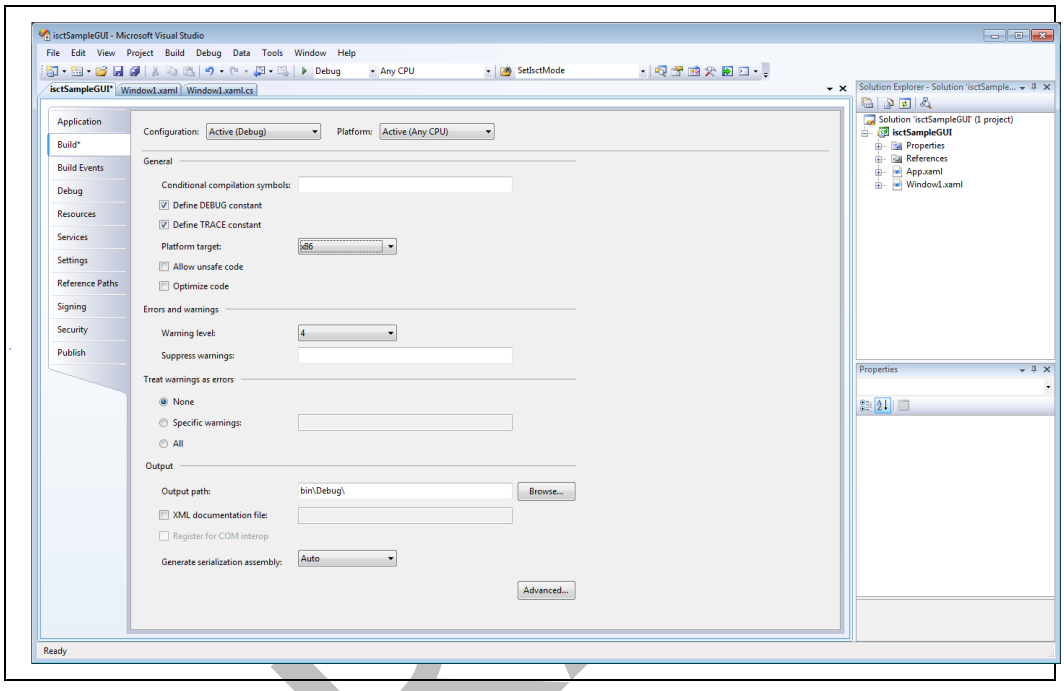
In addition to the attribution, OEM must provide a screen shot or mock up to Intel for approval.

Create a Microsoft Visual Studio* 2008 SP1 Visual C# .NET Framework 3.5 WPF Application using the New Project Wizard



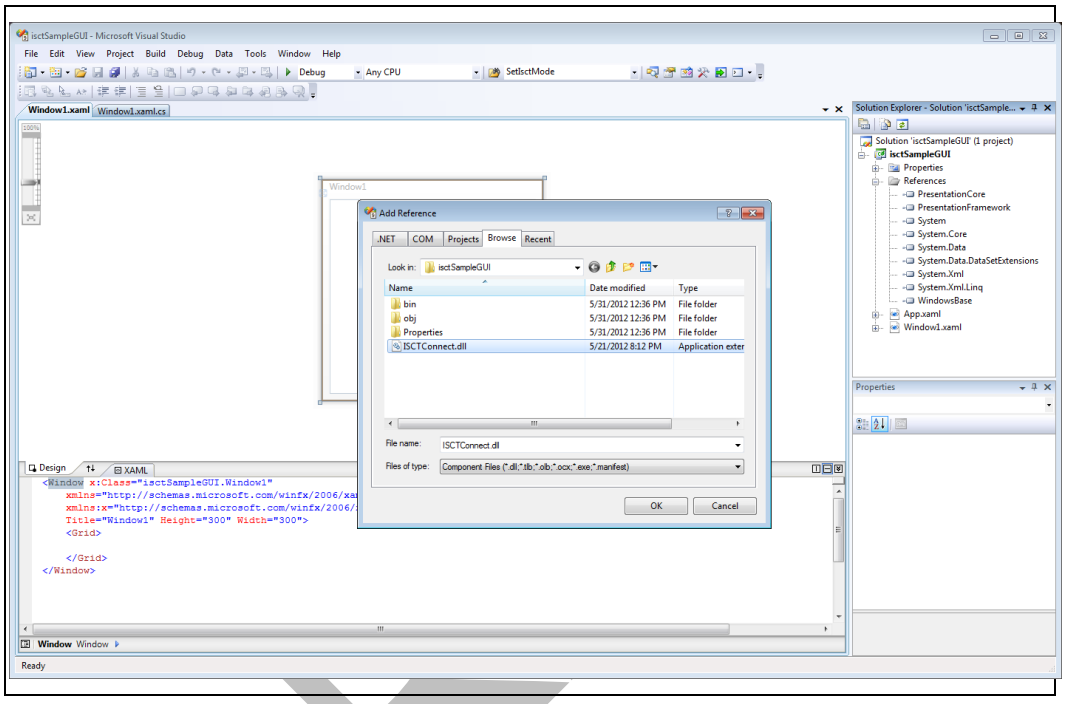
Note: Microsoft Visual Studio* 2010 can be used, however since .NET Framework 3.5 SP1 is required to use the Applet Dll, Visual Studio 2010 does not directly support .NET Framework 3.5 SP1. If Microsoft Visual Studio 2008* SP1 is installed on the development platform prior to installation of Microsoft* Visual Studio 2010, then Microsoft* Visual Studio 2010 can be used.

Open the Properties of the solution and verify that the "Platform Target" in the "Build" tab is set to "x86".

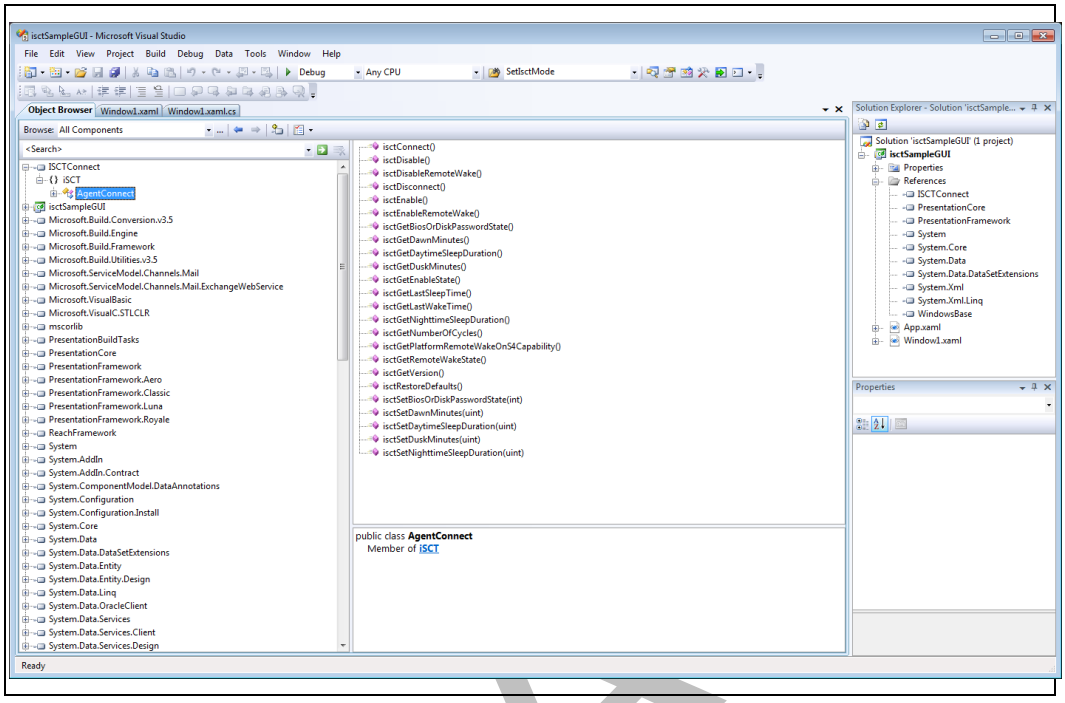


Add iSCTConnect.dll as a Reference Object:

1. Copy "iSCTConnect.dll" from the installation directory of Intel® Smart Connect Technology to the projects directory (in this example C:\tmp\isctSampleGui\iSCTSampleGui)
2. Right click on "References" in the Solution Explorer and select "Add Reference…"
3. On the "Browse" tab select "iSCTConnect.dll" as the reference to add to the solution

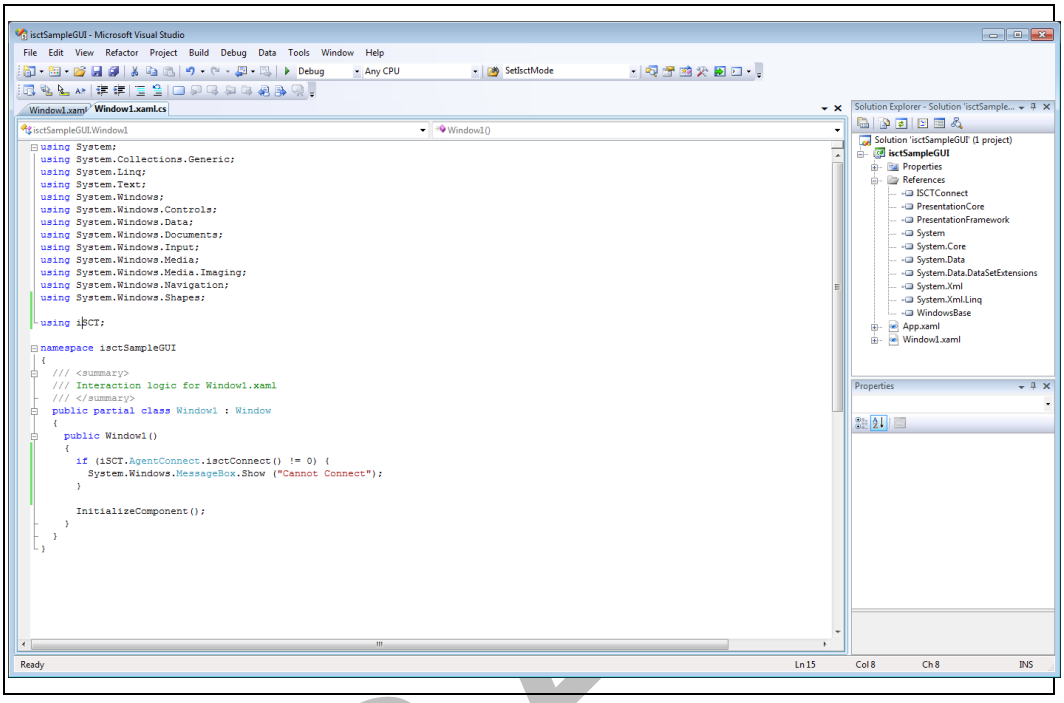


Once added the object "iSCTConnect" will now appear in the list of References and when opened in the Object Browser the methods will be shown



Add "using iSCT;" as an object reference in the file "MainWindow.xaml.cs" file.

As a test of using the iSCT.AgentConnect object, add code to call the "isctConnect()" API.



Now build the sample application and when it is executed, a new window titled "MainWindow" will appear on the desktop. This indicates that the connection to the Agent was successful.

Additional APIs of the iSCT.AgentConnect object can be used to create a GUI application.

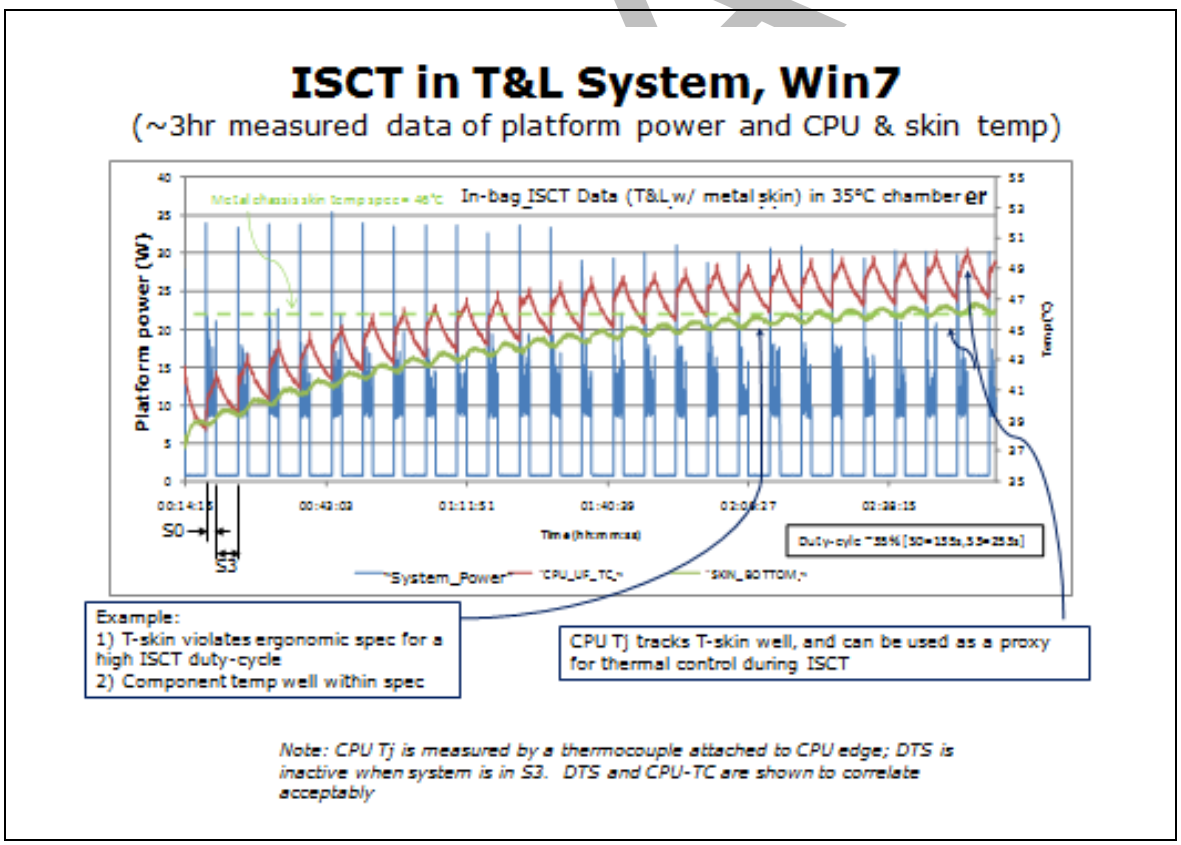
7 Thermal Considerations

7.1 Overview

Illustrative thermal behavior of a notebook platform running Intel® Smart Connect Technology is shown in this section. The examples included here from typical thin-and-light notebook systems are to be used only as illustrations and do not include the entire envelope of system/component/workload variations in the industry.

In Intel® Smart Connect Technology the platform cycles through repeated s-state transitions between sleep and wake, and correspondingly cycles through durations of very low sleep power and relatively higher wake power. Depending upon the duty-cycle of Intel® Smart Connect Technology operation (i.e., a metric to define the duration of wake time compared to sleep time duration in Intel® Smart Connect Technology) the platform can slowly warm up. This warming-up is exacerbated if the system is in thermally challenging environment, like inside a bag, shows an example of such an event.

Figure 7-1. Platform Power & CPU / Skin Temperature Trace Example for 'In-bag' Intel® Smart Connect Technology Usage



Shown in are the measured time traces of platform power (left axis), and CPU and bottom skin hotspot temperatures (right axis) of a typical thin-and-light notebook system that is kept inside a bag inside a thermally controlled 35°C chamber. The total system power was measured after the AC adapter power source. The temperature was read by thermocouples attached to the key components (CPU, Comms, Mem, chipset, etc.) and skin hot spots at top and bottom. Although it is to be expected that the actual junction temperature of components could be couple of degrees higher than the temperatures recorded by attached thermocouples, the overall trends are to be similar and representative. The thermocouple approach used here allowed constant temperature monitoring across platform power states (S0, S3, S4, mechanical off).

In the illustration of S0 duration started with a sharp power spike (~30W in this example), and then maintained a lower active power state (at around ~10-15W) for the remainder of the S0 duration. During S3 the system consumed a much lower sleep power (~0.5W). These S0 and S3 power characteristics are dependent upon various factors, such as, processor p-state, number of active cores, processor architecture type (core or atom platform), the generation of the product, etc.

The notebook system, being thermally constrained inside a bag, fails to dissipate the heat to environment and slowly warms up. The overall warming upward trend can be observed in the figure and depends upon average platform power during Intel® Smart Connect Technology (approximately 4.5W in the current example for a very high duty cycle).

In addition to overall warming trend, in a finer scale, CPU also goes through miniature thermal excursions during every Intel® Smart Connect Technology cycle. This can be seen by localized temperature peaks and valleys, as seen by saw-tooth pattern of CPU TC plot during higher power wake and lower power sleep states. The localized peak values depend upon the p-state limit and wake duration during Intel® Smart Connect Technology, but, exits far away (by few ten's of degrees) from the Tj,max specification limit of the product (105°C in this example).

Note that, similar to CPU temperature, other key components (PCH, COMMs, Mem) also experience similar thermal excursions. Even though component temperature specifications are not threatened due to nominal Intel® Smart Connect Technology operation, the skin temperature can easily exceed ergonomic specification. For the current example (a very aggressive duty-cycle of ~35%) the specification violation happens within 3 hours of Intel® Smart Connect Technology onset, and the system temperature keeps on climbing.

Therefore, the thermal considerations for Intel® Smart Connect Technology are control of skin temperature within ergonomic limit (examples: ~46°C for metal skin, ~58°C for plastic skin, ~40°C for a touchscreen display), and control of temperature excursion driven component and platform reliability impact.

7.2 Temperature Sensing and Thermal Control

As can be seen, the thermal risk of skin spec violation is very real during Intel® Smart Connect Technology, and thus should be monitored and controlled in a 'closed-loop'. To monitor we need a skin temperature sensor, and to control we need a mechanism and logic.

7.2.1 Skin Temperature Sensor

For Intel® Smart Connect Technology one can use any existing skin sensor or any other sensor that correlates well to the skin temperature for closed-loop thermal control. From a handful of experimental data (on typical thin-and-light systems) the CPU Tj was found to correlate reasonably well with the skin temperature, and therefore used here as a proxy for skin temperature. It is to be recommended that OEMs verify this correlation for a specific system design beforehand, if the system does not have any dedicated skin temperature sensor.

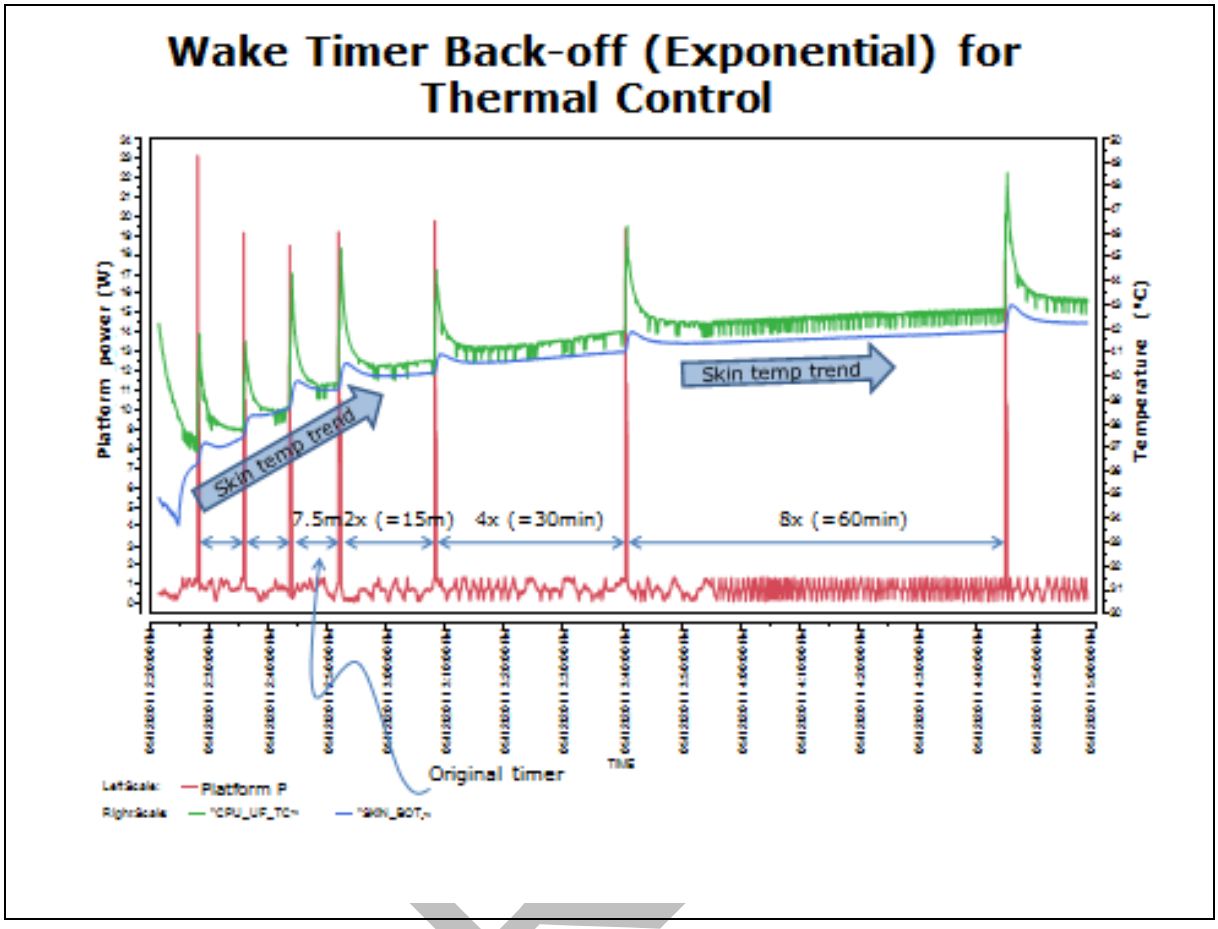
7.2.2 Thermal Control during Intel® Smart Connect Technology Agent

Intel® Smart Connect Technology operates in 'pull-mode' based on a periodic wake timer. By delaying the wake timer while CPU Tj is higher than allowable Intel® Smart Connect Technology threshold a 'closed-loop' thermal control can be achieved by monitoring CPU Tj (as reported by DTS). This allowable Intel® Smart Connect Technology threshold CPU Tj was selected in current example as 50°C to ensure a safe skin temp (ergonomic spec is 46°C for a metal skin).

Note: The allowable Intel® Smart Connect Technology threshold CPU Tj is expected to be considerably lower than CPU Tj,max spec (generally near 100°C).

In this illustration, an ergonomically safe skin temperature was maintained in a closed loop knob by exponentially backing-off the wake-up timer when thermal control was needed. That is, CPU Tj was read near the end of S0-ISCT state, and, if registered higher than the threshold 50°C temperature, the wake timer was to be backed-off to twice the original wake timer. This allowed the platform to cool down with twice the extended s3 period. At the next wake, if CPU Tj still registered higher than the threshold, timer was further backed backed-off yet another 2-fold. When CPU Tj conformed to threshold limit the original timer was re-instated. Figure 7-2 shows an example of such an thermal control event and skin temperature response.

Figure 7-2. Wake Timer Exponential Back-off Example for Thermal Control



Shown in Figure 7-2 above are the measured time traces of platform power (left axis), and CPU and bottom skin hotspot temperatures (right axis) of a typical thin-and-light notebook system in a bag inside a temperature controlled chamber. The experimental parameters were selected to create a repeat exponential back-off situation and demonstrate that it can effectively help in thermal control. In this example, back-off mechanism kept on triggering, and continually delayed the original wake timer of 4mins to 8mins, 16mins, 32mins and was able to cease the increase of system's skin temperature.

7.2.3 Initial Thermal Related Delay for Intel® Smart Connect Technology Agent

It was also observed that when a hot system, after a prolonged intense operation under an aggressive workload, is inserted immediately into a bag, the skin actually warms up for several minutes (found to be up to 5 minutes for this example of thermally aggressive environment), before starting to cool, and coming back to ergonomically safe limit. This is because of heat redistribution from hotter inner components to relatively cooler skin. Therefore it is recommended that OEMs imply an algorithm to delay entrance to Intel® Smart Connect Technology mode to let platform cool for at least 5 minutes.

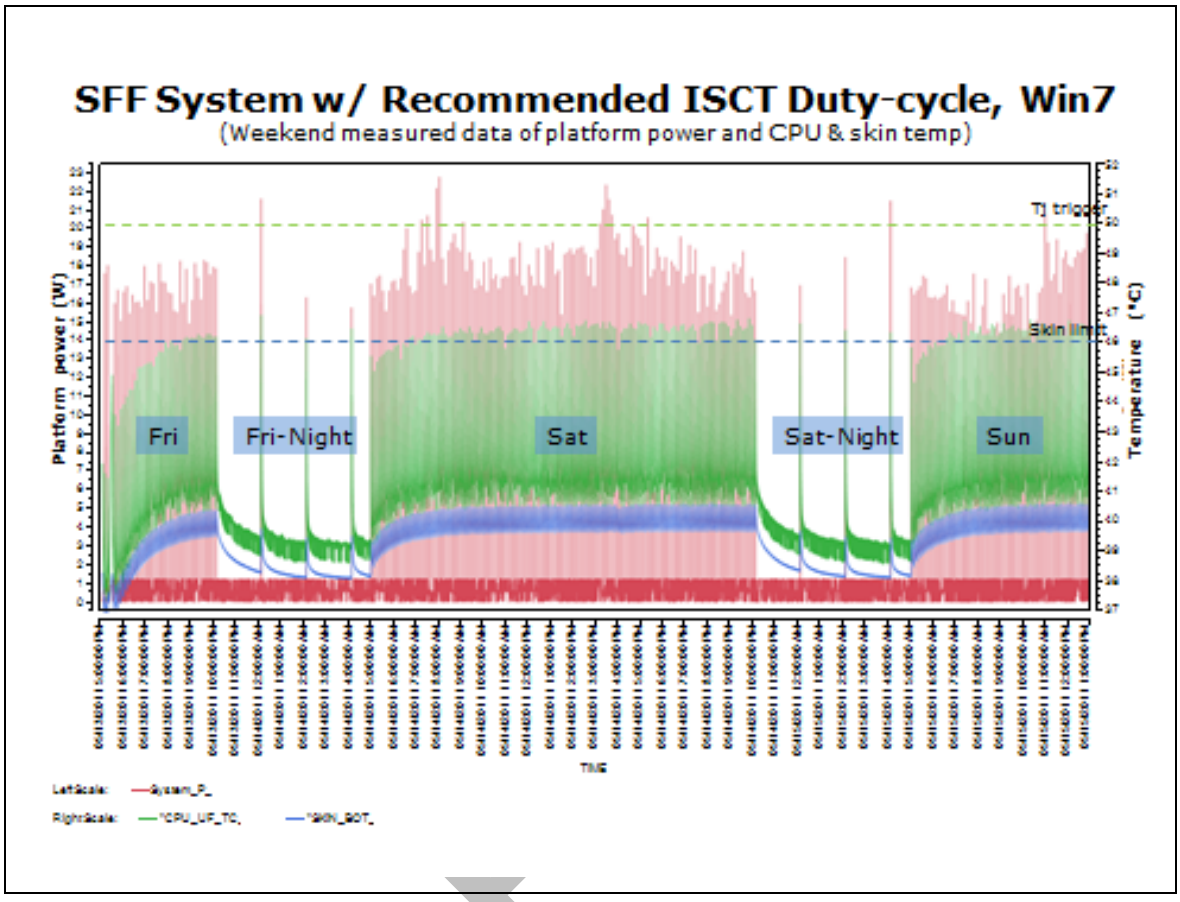
7.2.4 Summary of Intel® Smart Connect Technology Thermal Control

For the runs shown, the following conditions help maintain thermal control of the system while running the Intel® Smart Connect Technology Agent.

- Average (S3 and S0 average) Intel® Smart Connect Technology power limit of 2W for thin-and-light notebooks (can be scaled down by 15% for an ultrathin SFF system).
- CPU p-state limited to lowest state (Pn) during Intel® Smart Connect Technology operation.
- Intel® Smart Connect Technology software limits duty-cycle within 10% for T&L systems.
- Exponential back-off algorithm based on CPU Tj threshold of 50°C.
- S0-ISCT max duration limit, 1 time max = 165s, consecutive max = 45s.
- Initial delay of 5 minutes for Intel® Smart Connect Technology start to aid platform cooling.

When the Intel® Smart Connect Technology runs with the above constraints, an intended and uninterrupted operation was observed for an extended period.
An illustration of this is shown in Figure 7-3.

Figure 7-3. Example of Intel® Smart Connect Technology Operation over Extended Period



Additionally, OEMs should consider the following recommendations:

- Turn fan off during in-bag Intel® Smart Connect Technology operation. Fan does not help in-bag cooling, but can cause harm by plugging platform vents with lint.
- If in-bag battery charging is detected, slow down Intel® Smart Connect Technology events to prevent platform heating.

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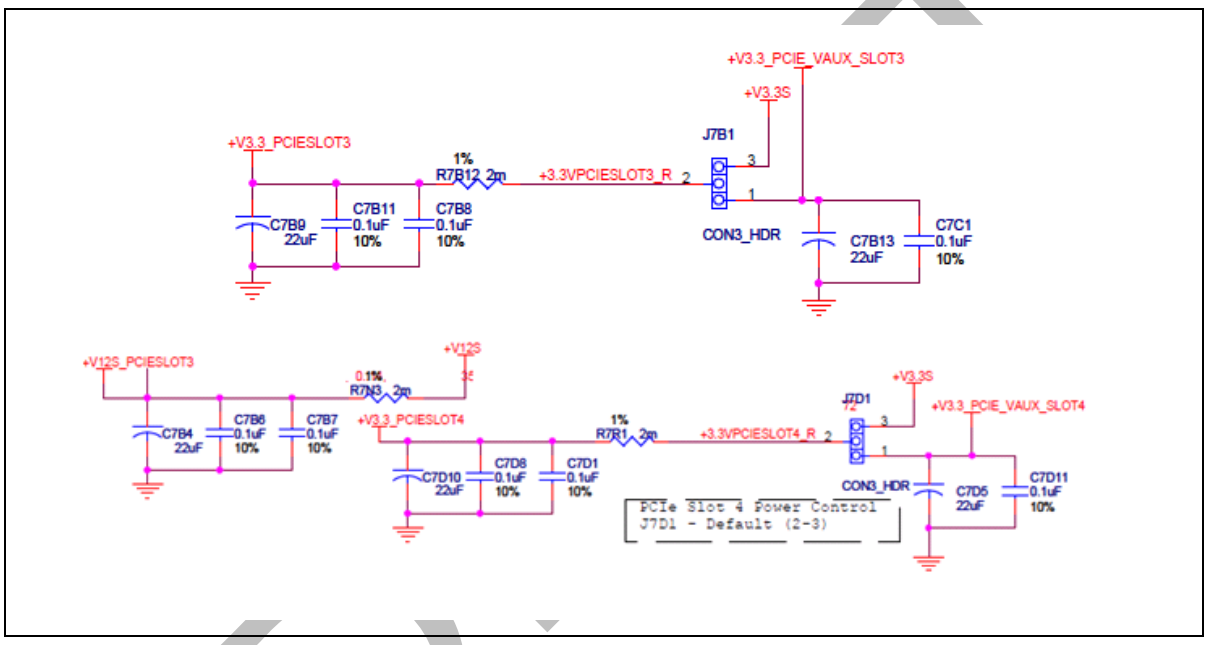
8 Chief River CRB Intel® Smart Connect Technology Support

To support Intel® Smart Connect Technology connectivity during S3 on the Chief River CRB, +V3.3 rail of platform need to be connected to +V3.3_VAUX rail. This can be done by changing the jumper setting of J7B1 from default of 2-3 to 1-2 and jumper J7D1 from default of 2-3 to 1-2.

Figure 8-1. Chief River CRB Jumper Settings



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9 Intel® ME Co-existence with Intel® Smart Connect Technology

Intel® Smart Connect Technology does not have any dependency on Intel® MEI driver or Intel ME FW. Additionally Intel® Smart Connect Technology does not consume SPI flash space. The Intel® Centrino® Wireless NetDetect feature is resident in the FW of the WLAN NIC.

9.1 WLAN Power Control

Because Intel® Smart Connect Technology requires power to the WLAN card in Sx, the EC of the platform should ignore Intel ME requests to turn off the power to the WLAN card and respond appropriately to the IAOE ACPI method SWLS when it is called by the Intel® Smart Connect Technology Agent to turn on/off power to the WLAN in Sx.

9.2 Intel® ME WLAN Provisioning

When the Intel® ME is provisioned for WLAN support during its M3 state and the platform is on AC, NetDetect will not be functional as the Intel® ME will take ownership of the WLAN card. The following table illustrates the Intel® ME states and provisioning modes that effect Intel® Smart Connect Technology and NetDetect operations.

Table 9-1. Intel® ME Co-existence with Intel® Smart Connect Technology

System State	Intel® ME State	Intel WLAN Ownership	Provisioned	Power State	Intel® Smart Connect Technology	NetDetect Available
S0	M0	Host	Yes	AC	Yes	Yes
S3	M3	ME	Yes	AC	Yes	No
S4	M3	ME	Yes	AC	Yes	No
S3	Moff	Host	Yes	AC	Yes	Yes
S4	Moff	Host	Yes	AC	Yes	Yes
S3	Moff	Host	Yes	DC	Yes	Yes
S4	Moff	Host	Yes	DC	Yes	Yes
S3	M3	Host	No	AC	Yes	Yes
S4	M3	Host	No	AC	Yes	Yes
S3	Moff	Host	No	DC	Yes	Yes
S4	Moff	Host	No	DC	Yes	Yes

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