UEFI Boot Time Optimization Under Microsoft* Windows 7*

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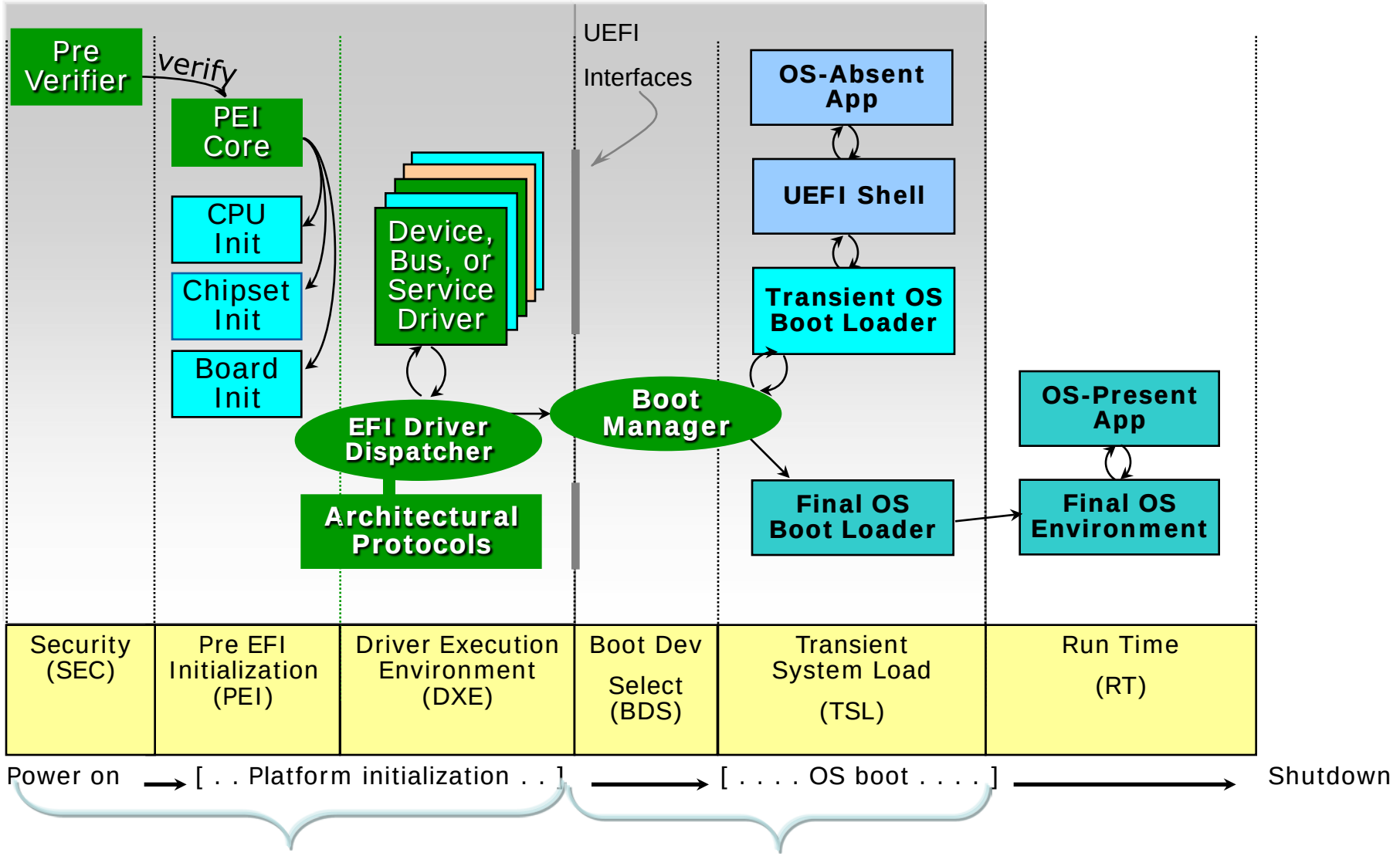
EFIS004

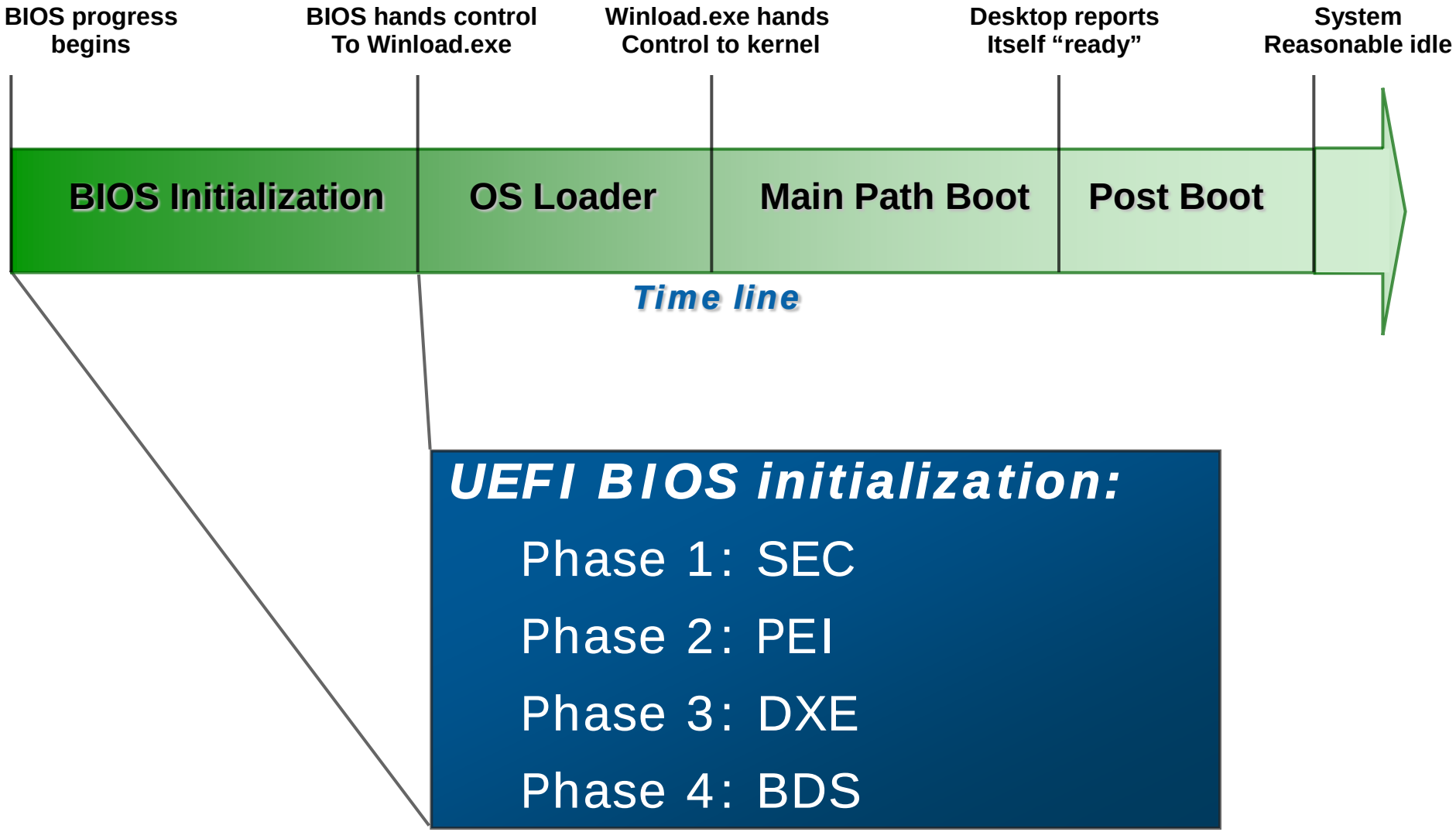
Agenda

- Overview of boot time
- Performance improvements
- Sample results
- Demo
- Why fast POST for Windows* 7
- Other considerations for Windows 7

Overall View of Boot Time Line



Overview of Boot Time



Overview of Boot Time

- 4 UEFI BIOS Initialization phases:
  - **SEC** (Security) phase: Pre-RAM code handles CPU initialization to create temporary stack in CPU cache.
  - **PEI** (Pre-EFI initialization) phase: finishes CPU initialization, discovers the DRAM, and determines boot mode (cold boot, S3, S4)
  - **DXE** (Driver Execution Environment) phase. Loads drivers that initialize the rest of system hardware.
  - **BDS** (Boot Device Selection) phase. Finds boot devices, loads the OS, and passes control over to the OS.

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Typical UEFI BIOS Initialization Time

Intel® Mobile Platform with Intel® Core™ i7-920XM Processor Extreme Edition[1]	
SEC phase	1.638 s
PEI	2.647 s
DXE	1.296 s
BDS	3.139 s
Total Duration: 8.720 s[2]	

[1] Reference platform

[2] Using InsydeH2O BIOS*; Source - Insyde Software Corp

Performance Improvements

SEC phase:

- Aggregate all SEC and PEI drivers to 1 64Kb block of flash
  - All code must be in the processor's cache before enabling Non-Eviction Mode
- If code is outside NEM area, it is running extremely slow
- Set CPU throttling to min (max power)
- CPU microcode loading
  - Only 1 in system; no searching

Performance Improvements

PEI:

- Memory Init:
  - Don't clear memory to zero with code
  - Use hardware if available in memory controller
  - Or don't clear it at all, if no ECC req'd
- Skip Memory detection:
  - No SMBus SPD reads
  - Good for closed systems

Performance Improvements

DXE:

- DXE dispatcher tries to load and run DXE drivers in a round robin loop
  - Reduce dependencies to a minimum
  - Try to have drivers loaded in efficient order
  - a-priori
  - Don't hard-code drivers in a-priori file, unless absolutely necessary -- can only get it wrong

Performance Improvements

Other DXE improvements:

- Multi-threading:
  - UEFI drivers are re-entrant although not yet MP safe
  - Carefully assign discrete tasks to the APs during DXE
- Remove PS/2 devices:
  - Legacy devices are slow to respond
  - Use high-speed USB devices

Performance Improvements

Other DXE improvements:

- Legacy Option ROMs:
  - Originally designed to extend functionality of PC-AT systems with device-specific code
    - PXE UNDI, video, storage devices
  - Replaced by UEFI device drivers, and UEFI compliant Option ROMs
  - Don't initialize Legacy Option ROMs if you don't need the device

Use UEFI drivers instead

Performance Improvements

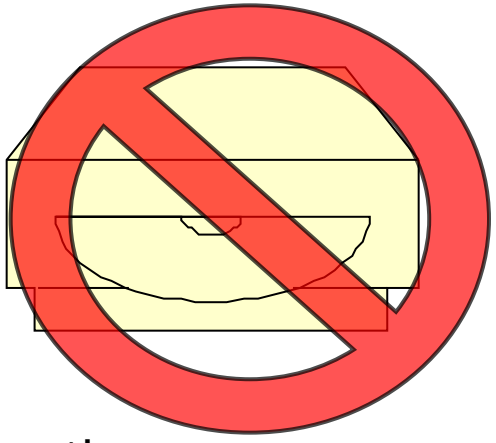
Other DXE improvements:

- Video:
  - Legacy video is extremely slow and time consuming to boot
  - Insist on Native UEFI video drivers
  - Use console redirection to avoid initializing video
- SATA channels:
  - Don’t initialize extra SATA channels
  - Let Windows* 7 do it

Performance Improvements

BDS phase:

- Use SSD instead of rotating media:
  - Rotating media is comparatively slow



- Pre-select the boot device:
  - No searching for devices -- It's too slow
    - Systems boot from same device 99%+ of the time
  - Cut this phase to almost nothing by booting from a single pre-determined device

Performance Improvements

Other overall improvements:

- Compiler optimizations:
  - UEFI code is written in C
  - Make sure max speed is enabled

- Embedded Controller (EC)
  - Slow device -- Minimize usage
  - SPI flash with UEFI BIOS behind EC – very slow
  - Direct SPI Flash off SouthBridge

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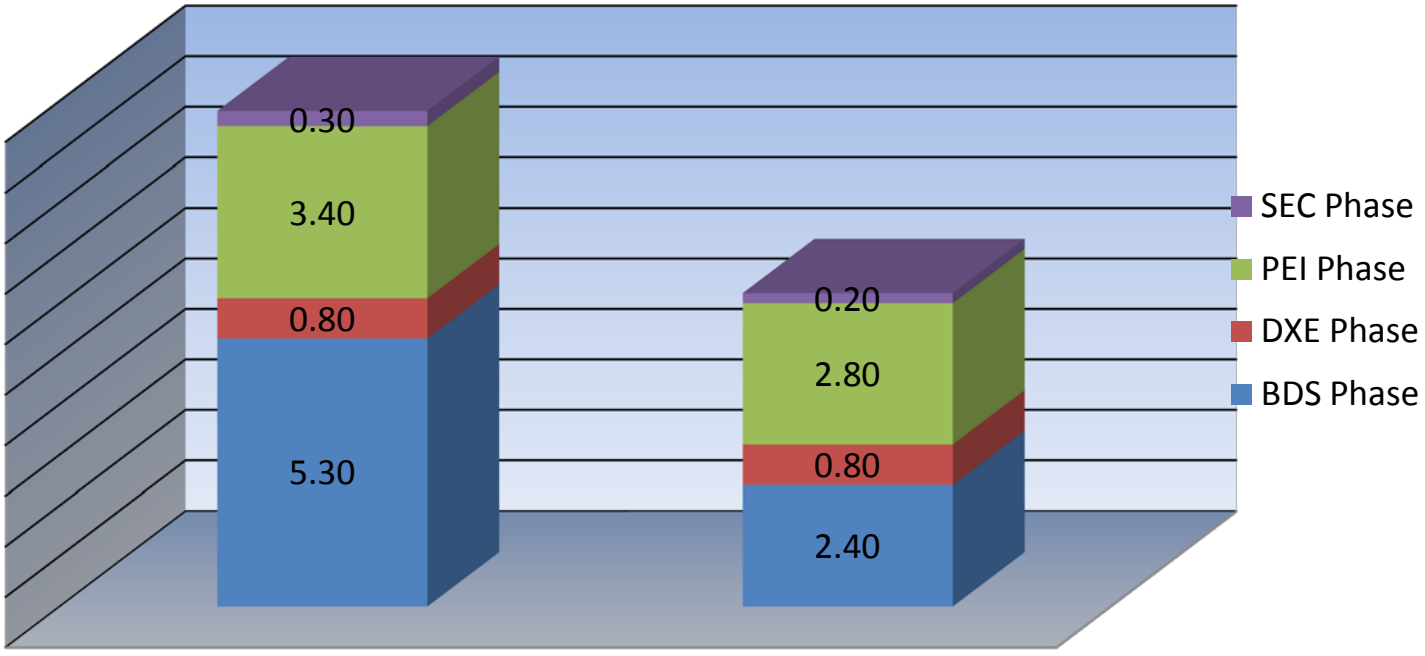
Customer Platform Improvements

UEFI BIOS optimization - InsydeH2O customer BIOS

Task	Before (sec)	After (sec)
SEC Phase	0.30	0.20
PEI Phase	3.40	2.80
DXE Phase	0.80	0.80
BDS Phase	5.30	2.40
Total	**9.80**	**6.20**

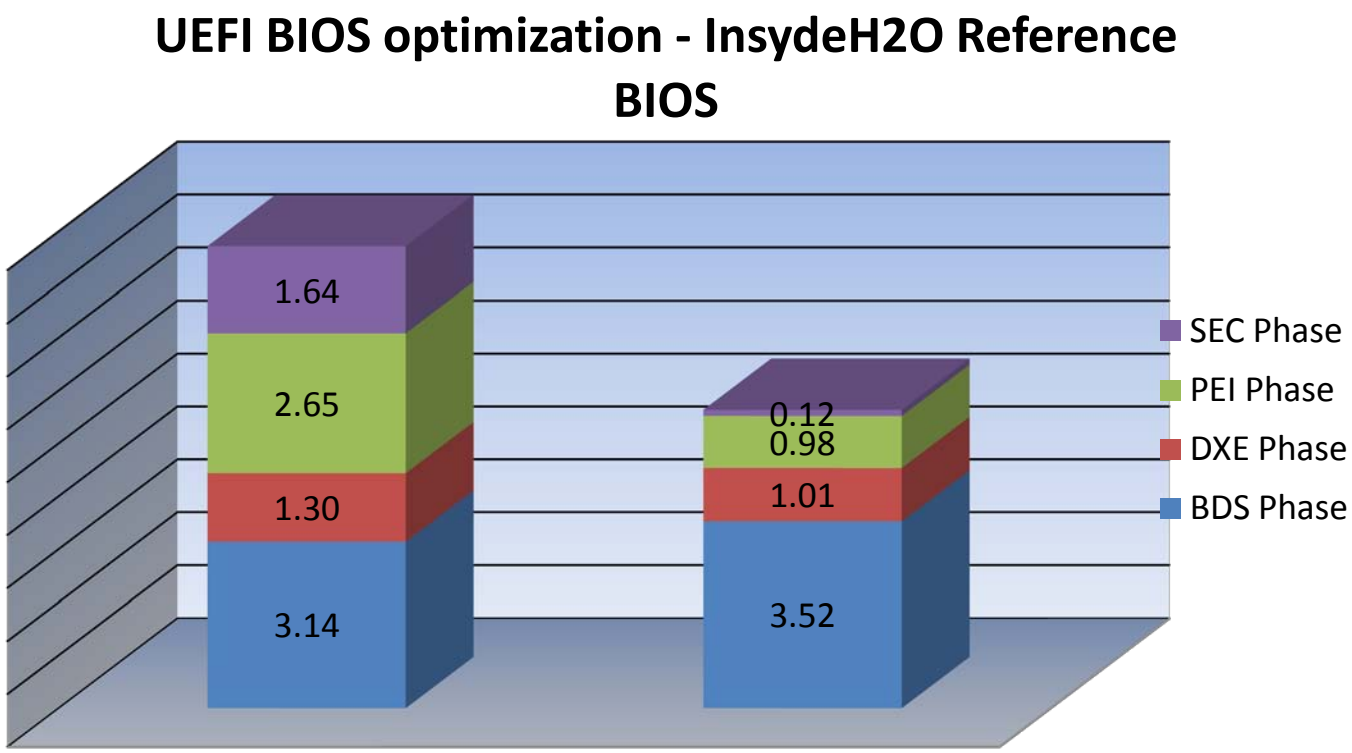


Source: Insyde software, Mobile Reference platform

- Improvements made in all phases of POST
- 25% reduction in boot time.
- System still passes Microsoft WLK 1.4 tests

Reference board improvements

Task	Before (sec)	After (sec)
SEC Phase	1.64	0.12
PEI Phase	2.65	0.98
DXE Phase	1.30	1.01
BDS Phase	3.14	3.52
Total	**8.72**	**5.64**



Source: Insyde software, Mobile Reference platform

- SEC and PEI Phase are highly optimized.
- 66% reduction in boot time.
- System still passes Microsoft WLK 1.4 tests

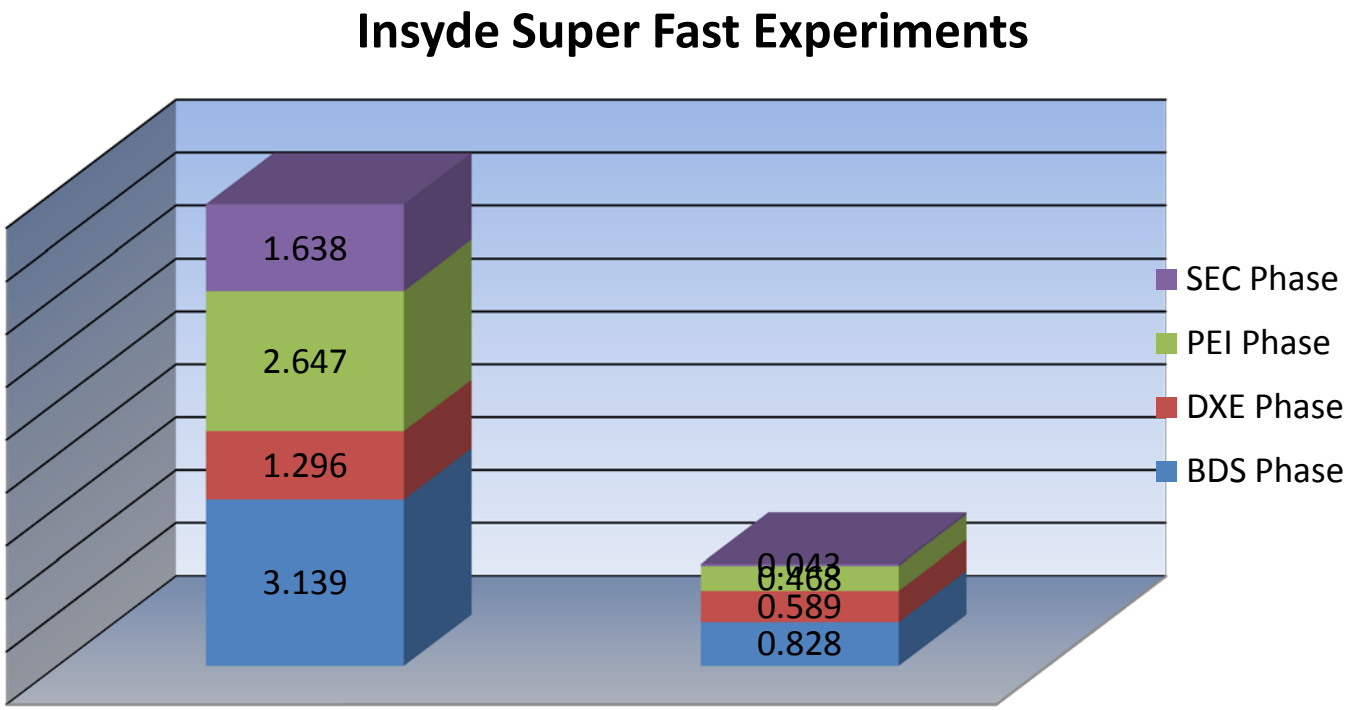
1 – InsydeH2O Calpella Tag 3.59.33.1039

Calpella is the codename for the mobile platform based on the Intel® 5 series-M chipset

Arrandale is the codename for a two core mobile processor used on the Intel® 5 series chipset based platforms codenamed Calpella.

“Break the rules” improvements

Task	Before (sec)	After (sec)
SEC Phase	1.64	0.04
PEI Phase	2.65	0.47
DXE Phase	1.30	0.59
BDS Phase	3.14	0.83
Total	**8.72**	**1.93**



Source: Insyde software, Mobile Reference platform

- Highly optimized for a <2 second boot.
- System does NOT pass Microsoft WLK 1.4 tests

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DEMO

- Demo showing Windows® 7 booting **with** boot optimization on a notebook
- Windows Vista® on another notebook **without** the boot optimization

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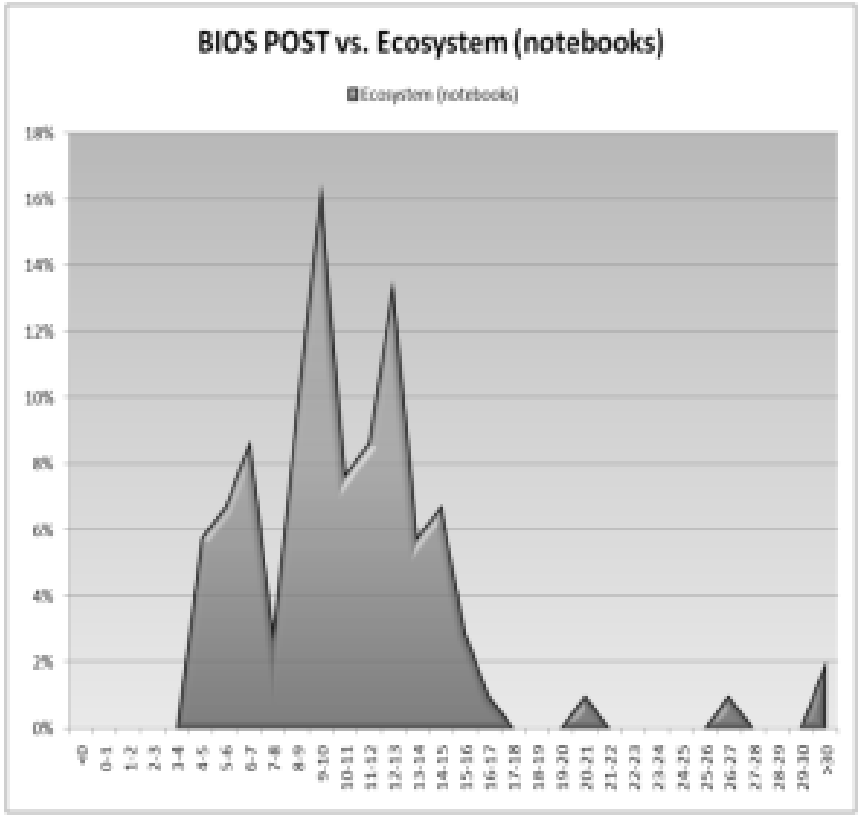
Why fast POST for Windows® 7

- In a recent audit of Windows 7 notebooks, 34% booted in 35 sec or less
  - Not including post times
- Since Windows 7 boot times are faster than Vista SP1 on any HW, long POST times are more noticeable and undesirable for end users



"Source: Microsoft Windows OEM Engineering Services"

Microsoft

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Other Windows® 7 Considerations

- 64-bit OS & 4 GB
  - 4 GB RAM machines became common in Windows Vista® SP1 timeframe
  - 64-bit OS required to support 4 GB RAM
  - Verify that there are no issues accessing 64-bit ISOs from CD-ROM or DVD
- Solid State Drive (SSD) compatibility
  - SSDs now becoming popular for high-end machines with Windows® 7
  - Verify that there are no race conditions or other compatibility problems
  - Verify both boot and hibernate use cases

Microsoft

Other Windows® 7 Considerations

- Memory Type Range Register (MTRR)
  - Ensure that MTRRs for each CPU is restored after S3 resume
  - If you don't, both firmware and OS resume code in HAL will run w/o caches enabled
  - In Windows® 7 because we always scan and validate the contents of the first 1Mb of physical memory when resuming from S3 as opposed to Vista where this scan does not occur by default
  - Adds ~400 milliseconds
  - Please note that this problem also will adversely impact the time it takes to synchronize the processor TSCs (new for Windows® 7) as this code depends on the processors caches being enabled.

Microsoft

Other Windows® 7 Considerations

- ACPI runtime firmware accessing memory from an AcpiReclaimMemory memory region
  - ACPI defines AcpiReclaimMemory as memory that can be reclaimed by OS after it copies memory out of it
    - Typically used by the platform for ACPI tables
  - Windows® 7 does not currently reclaim this memory and does not currently verify that ACPI firmware does not attempt to access this memory

Microsoft

Other Windows® 7 Considerations

- Wrong device paths in EDD
  - Legacy BIOS provides a mechanism to know the physical path to a HDD
    - e.g., PCI Express* Bus/Device/Function, IDE controller, master
  - Windows® 7 does not depend on this behavior
    - majority of Legacy BIOS implementations populated this information incorrectly.

Microsoft

Summary

- Since Windows 7* boot times are much faster, Faster firmware POST times are required
- Faster POST improvements are achieved by Selecting the best performing hardware and reducing the POST time features
- Beware of other Windows 7 considerations
- UEFI by design can help improve on boot time performance

Next Steps

- Work with your BIOS teams to push for POST improvements
- Specify POST times to your ODMs
- Specify minimum hardware performance standards to your ODMs
- Make use of the latest UEFI and PI Specifications to help your design make improvements in boot times
- Download the Microsoft White paper: http://www.microsoft.com/whdc/system/platform/firmware/FirmwareEnhance_Win7.mspx.

Additional resources on UEFI:

- Other UEFI Sessions – Next slide
- Visit UEFI Booth #136 & Insyde SW #312
- More web based info:
  - Specifications and Implementation sites: www.tianocore.org, www.uefi.org, www.intel.com/technology/efi
  - Link to Microsoft UEFI Support and Requirements: http://www.microsoft.com/whdc/system/platform/firmware/uefireg.mspx
- Microsoft Boot Optimization White Paper: http://www.microsoft.com/whdc/system/platform/firmware/FirmwareEnhance_Win7.mspx.
- Technical book from Intel Press: "Beyond BIOS: Implementing the Unified Extensible Firmware Interface with Intel's Framework" www.intel.com/intelpress

IDF 2009 UEFI Sessions

EFI#	Company	Description	Time	RM	D
P001	Dell, HP, IBM, Intel, Microsoft	Using UEFI as the Foundation for Innovation	10:15	2005	T
S001	IBM, Intel	Intel Advanced Technology in the Enterprise: Best Security Practices	16:15	2001	W
S002	Dell, Intel, Insyde SW	Secure FW Lockdown through Standardized UEFI Management Protocols	17:15	2001	W
S003	Intel, AMI	Best Technical Methods for UEFI Development -Reducing Platform Boot Times -Firmware Debugging: UEFI and USB for platform forensics	11:10	2002	Th
S004	Microsoft, Insyde SW, Intel	UEFI Boot Time Opt. Under Microsoft Windows 7	13:40	2002	Th
S005	Phoenix, Intel	Transitioning the Plug-In Industry from Legacy to UEFI: Real World Cases	14:40	2002	Th
Q001	Intel, All	UEFI Q & A session	15:40	2002	Th

✓ DONE

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