

Introduction to Windows CE 6.0 on the OMAP35x

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Welcome to the “Building Solutions Using Windows Embedded CE 6.0” training course.

Agenda

- BSQUARE and TI
- About the OMAP 35XX Offering
- Microsoft Operating System Family
- Characteristics of CE 6.0
- OS Tools
- OS Internals



About Bsquare

- The leading software solutions provider to the global embedded device community
- Committed to delivering quality, lowering project risk and reducing time to market
- Full service resource for everything [Windows® CE](#) and [Windows Mobile®](#)
 - Largest distributor of Microsoft Windows Embedded operating systems in North America
 - Provider of Windows Embedded tools & runtime licenses.
 - Works with device makers to provide software & hardware development, systems integration services, reference designs, board support packages, middleware, QA & applications.



2

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Windows CE (also known officially as Windows Embedded Compact post version 6.0, and sometimes abbreviated WinCE) is Microsoft's operating system for minimalistic computers and embedded systems. Windows CE is a distinctly different operating system and kernel, rather than a trimmed-down version of desktop Windows. It is not to be confused with Windows XP Embedded which is NT-based. It is supported on Intel x86 and compatibles, MIPS, ARM, and Hitachi SuperH processors.

About Bsquare

- Contracted by TI to provide a comprehensive WinCE BSP for OMAP™ 3 through TI & facilitate faster time to production for your OMAP™ 3 WinCE customer.
 - This BSP source code can be used free-of-charge as a fast-forward starting point by any TI OMAP™ 3 customer, any 3rd Party or any VAR worldwide to accelerate your customer's time to production.



Operating Locations



BSQUARE offers a world-class team of trusted advisors with proven consulting, engineering & training experience

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Large, Loyal Customer Base



Established Relationship with TI

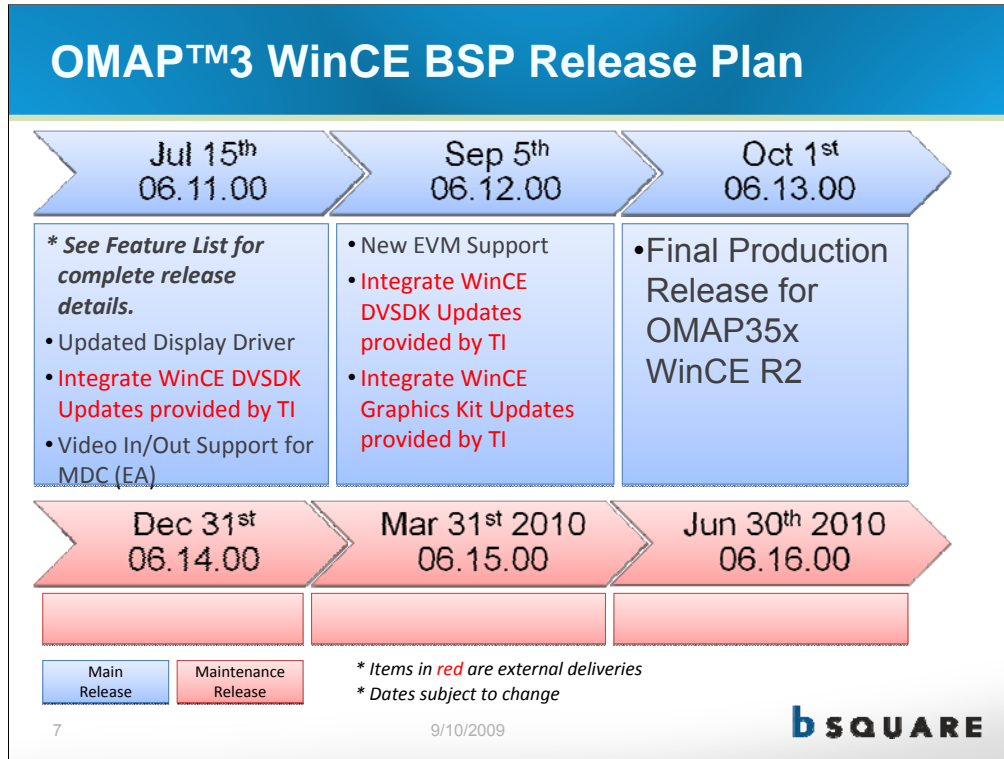
- Pre-Dates Windows Mobile
- Worked with TI team in Redmond, WA on WM platform for OMAP 2
- Delivered Windows CE 5.0 BSP for TI on OMAP 2
- Providing Windows CE 6.0 BSP for OMAP 35XX EVM
- Contracted by TI to provide a comprehensive Windows CE BSP for OMAP™ 3 through TI & facilitate faster time to production for your OMAP™ 3 WinCE customer.
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Each project will vary in terms of which tasks need to be done, in which order, and who on the project team is responsible for each task.

Custom design (High level applications, gui, etc)

For this class we will do all except customize or create drivers



New EVM (august):

- Full ES3.1 Support
- ISP1507 Support
- TPS65960 PM Driver Support
- New Ethernet Driver Support
- USB PHY Support for EHCI
- Video In/Out Support (GA)

Unknown:

- ARM VFP Support**
- Rotation Support
- New WinCE Directory Structure
- Power Management Specification**
- Integrate WinCE Graphics Kit 1.3 Updates provided by TI**
- USB ISO Device Mode Support for ISP1504**

OMAP™3 WinCE BSP Feature List

- **Tools**
 - Visual Studio 2005 Plug-in
 - EVMFlash Tool
 - WinCE 6.0 R2 Pro (*compiled in with Visual Studio Tools*)
- **System**
 - Bootloader
 - OEM Abstraction Layer (OAL)
 - SD Boot
 - Power Management Framework
 - Ethernet (KITL and NDIS)
 - DVI Support
- **Peripheral Drivers**
 - SDIO drivers (*tested with Summit Data WLAN card*)
 - USB 2.0 Host with OTG
 - *Bsquare's SDIO HX support***
- **Multimedia Capabilities**
 - DirectShow Filters
 - Codec Engine Inter-processor Communication support
 - DSPLink Integration
 - Accelerated Imaging Codec (includes encode/decode support for JPEG)
 - Accelerated Audio Codec (includes decode support for AAC)
 - Accelerated Video Codec (includes encode/decode support for MPEG4, H.264 and decode only support for MPEG2)
- **Graphics Capabilities**
 - Accelerated 3D Graphics with OpenGL ES1.1, Open GL ES2.0 and OpenVG 1.0.1/1.1* support using POWERVR SGX™
 - *Flash® Lite™ 3.1***

For a detailed view of the feature list, ask your local Bsquare sales representative.
** Available for purchase from Bsquare

POWERVR SGX™ graphics engine is licensed from Imagination Tech. Ltd.

This is the most interesting list
The complete list is found in the release.

OMAP™3 WinCE BSP Production Tested

- The OMAP35x WinCE BSP is Production Tested
- BSQUARE defines production tested as two full independent QA passes
 - All appropriate bugs found and fixed after final QA pass
 - All BSP related drivers are tested
- BSQUARE's BSP shipped with 100% CETK pass results
 - The CETK is Microsoft CE Test Kit which is a tool that tests device drivers and is required to pass Microsoft certification
- All released features of the OMAP™ 3 BSP have passed this level of testing, unless noted
- PREfast is run before shipping
 - PREfast is a static analysis tool that identifies defects in C/C++ programs.

9

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100% pass results on application tests

See <http://msdn.microsoft.com/en-us/library/ms933794.aspx> for more information

OMAP35x WinCE BSP Delivery/Availability

▪ Download from the web: Now

- Broad access to Binary BSP DEMO and the DVSDK w/BSP source (requires SD card or reflashing the board) Available via www.ti.com/omapsoftwareupdates
- BSP DEMO also available through the OMAP35x EVM tools folder
- Customers without access to www.ti.com/omapsoftwareupdates can request a software evaluation of the WinCE demo at: <http://www.go-dsp.com/forms/TIDigitalMediaSWCM/index.htm>

▪ In the box (TMDXEVM3530 Kit w/dual boot): Q3 2009

- Based on ES3.1 OMAP silicon
- Boots and runs WinCE out-of-the-box
- DVSDKs included: WinCE, Linux (activated through MyRegisteredSoftware)
- Dev tools: Code Sourcery Eval, Platform Builder Eval & RVDS Eval

10

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The WinCE BSP Demo and the full DVSDK with BSP source is available today freely for OMAP35x Registered Users. Registered users simply go to the omapsoftware updates extranet site to access the software through TI's new software management portal: myregisteredsoftware.

EVM customers who did not register their board can still access the Demo and DVSDK source product by requesting the software through TI's external software request form.

By the end of Q1 next year, TI will roll out the new OMAP35x kit based on the ES 3.1 OMAP silicon. This new kit will include both WinCE and Linux DVSDKs products and user-selectable boot mode to allow developers to easily demonstrate and eval either OS out of the box. The kit will also include various IDE tool choices such as ARM's RVDS (real view Development suite), Microsoft's Platform Builder and Code Sourcery's Professional Tools Evaluation.

OMAP35X WinCE BSP Support

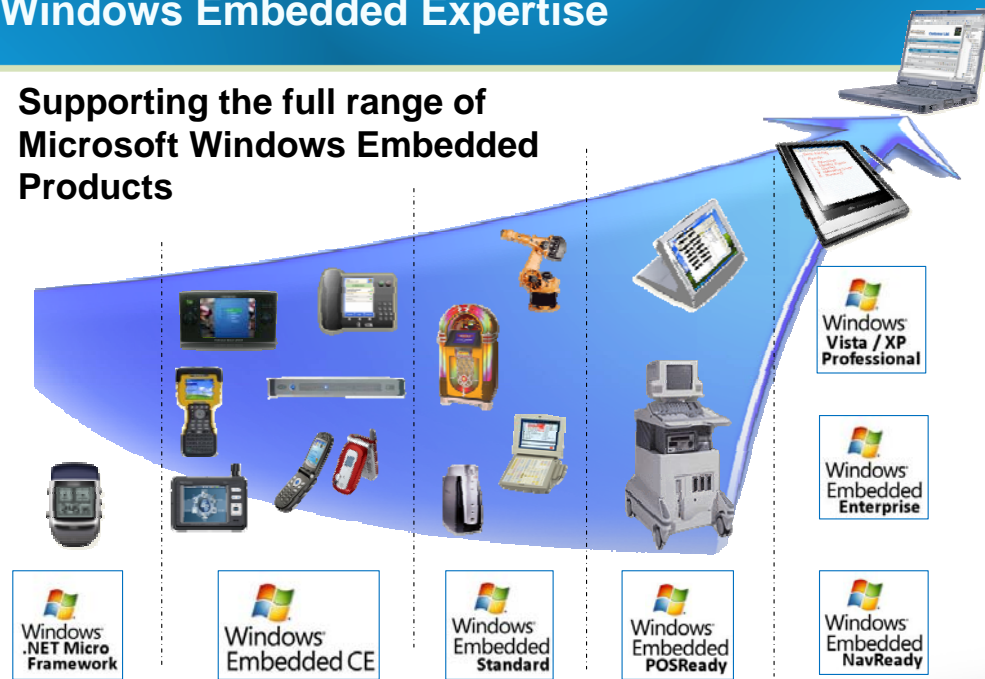
- **BSQUARE's Bronze Level Support is Free ☺**
 - BSQUARE will provide a maximum 8 hours of free support for each BSP installed on the TI OMAP35x EVM.
- **All support hours must be used within 60 days of initial BSP installation or 30 days from first request for support services--whichever comes first.**
 - Access to Online Technical Support Portal with Knowledge Base of FAQs are hosted at <http://www.bsquare.com/omap3>
 - Give users email access to highly experienced support engineers with real-world answers
- **Silver, Gold & Platinum levels of support are available for purchase by BSP & EVM customers.**

Microsoft Embedded Operating System Family

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Windows Embedded Expertise

Supporting the full range of
Microsoft Windows Embedded
Products



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Which Embedded Operating System?

- Windows Embedded CE 6.0
 - CE 6.0 provides the tools and source code access developers need to build, deploy, and debug small footprint devices.
 - Multiple CPU Family Types
 - Designed for Battery Powered / Consumption Conscious Devices



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Which Embedded Operating System?

32-bit, real-time, multitasking OS

Highly componentized

- Delivered as a granular set of components
- Use Platform Builder tools to configure an image

Scalable

Footprint scales with functionality selected

Wide variety of CPU support

Runs on x86, ARM, MIPS and SH4

Supported

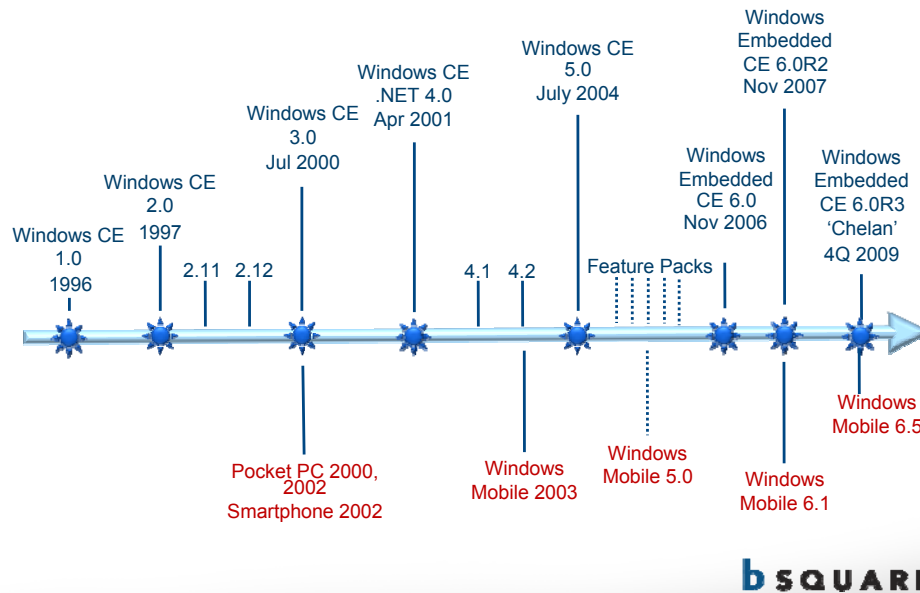
- 10 year support policy from Microsoft



Windows Embedded CE 6.0

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History Of Windows CE And Mobile



Windows CE was first introduced in 1996. Some major milestones along the way were CE 3.0 CE 4.2, CE 5.0, and CE 6.0 and the incorporation of the Platform Builder IDE into Visual Studio 2005.

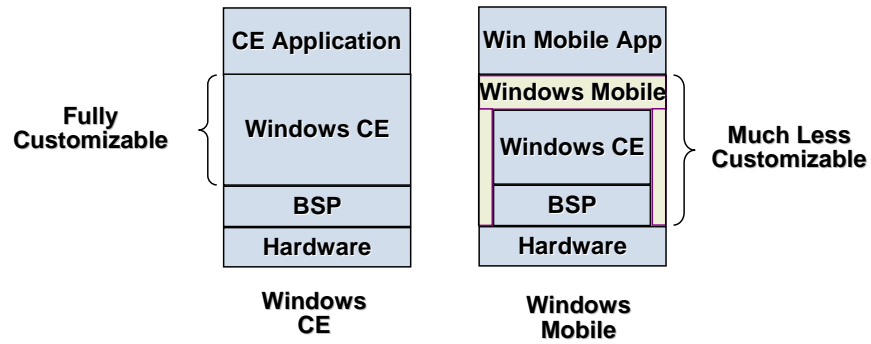
Which Microsoft Embedded Operating System?

- Windows Mobile
 - CE based
 - Windows Mobile includes a number of wireless industry specific programs and is sold by Microsoft to the largest phone equipment manufacturers.
 - Windows Mobile is available in different configurations for Pocket PCs (Professional) and Smartphones (Standard)



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Windows CE vs. Windows Mobile



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Fundamentals of CE 6.0

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Fundamentals of Windows Embedded CE

Suitability / Portability / Platform Support

- A preemptively multitasked, real time operating system designed for “small” devices
 - Virtual Memory
 - Multithreaded
- Based on WIN32 API set
 - Extensions for small portable devices
 - Over 2,000 functions
- Desktop applications may need modifications



Fundamentals of Windows Embedded CE

Pre-Built Technologies

- Set-top boxes
- Thin clients
- Digital media adapters
- Voice-over-IP (VoIP) phones
- Navigation devices
- Medical devices
- Portable media players
- Home gateways
- Digital cameras
- Networked digital televisions
- PDAs
- GPS Handhelds



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Fundamentals of Windows Embedded CE

Windows Embedded CE Professional

- CE Core Plus
- Windows Messenger, WordPad
- Remote Desktop Protocol, Internet Explorer

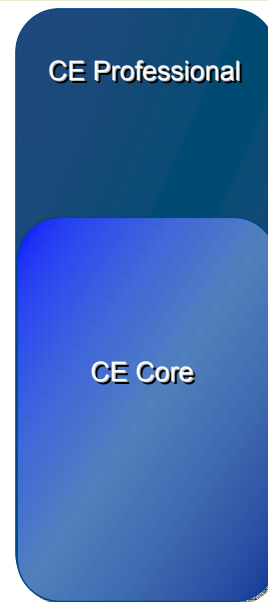
Targeted toward devices requiring rich user interface, multimedia and browsing capabilities, including set-top boxes, mobile handhelds and digital media players.

Windows Embedded CE Core

- Baseline Windows CE operating system & Kernel
- Filesystem
- Networking and communications stacks
- multimedia functions

Targeting gateways, entry-level VoIP phones, industrial automation equipment, and consumer electronic devices such as CD players, digital cameras, and networked DVD players.

<http://www.microsoft.com/windowseembedded/en-us/products/windowsce/component-library.mspx>



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WSD - Microsoft Web Services on Devices (WSDAPI), which is an unmanaged code implementation of the Devices Profile for Web Services (DPWS) protocol standard.

WSD is a plug-and-play technology (like USB). Consumer devices such as printers, scanners, mobile telephones, organizers, external hard disks, MP3 players, etc. are connected via USB to the PC, which then recognizes and operates them.

Automatic recognition takes place by means of exchanging so-called "profiles" for these devices. In WSD, Microsoft has expanded plug-and-play technology to the field of "Ethernet-based devices". A field where this feature would be useful is home and industrial automation.

Fundamentals of Windows Embedded CE

▪ Real Time System Support

- A real-time system responds to events.



- Must respond to external inputs & produce new outputs in limited amount of time.
- Response time needs to be bounded.



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Hard real time vs. Soft real time

Soft – can miss deadlines every now and then like a set top box or a dvd player

Hard – missing any deadline is considered a failure – life threatening

Operating System Features Features of CE 6.0

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CE 6.0 Features

- Multimedia
 - DirectShow
 - Windows Media Player
 - Digital Rights Management
- Networking
 - UPnP, TCP/IPv6, SMB/CIFS, VPN
 - Cellular, Bluetooth, 802.11
 - VoIP and Networking
- File Systems
 - Cache Manager
 - UDFS
 - exFAT

Microsoft
SQL Server
Windows CE Edition



Microsoft
.NET Compact Framework

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CE 6.0 Features

- Security
 - Authentication
 - Cryptography
 - Credential Manager
- Internationalization
 - Local Services
 - Multilingual User Interface
- Application and Service Development
 - .NET Compact Framework
 - ATL
 - MFC8
 - COM
 - DCOM
 - Location Framework



CE 6.0 R2 – New Features

■ New Features in CE 6.0 R2

- More Device Drivers (SATA, MLC flash, SDHC)
- Remote Desktop Protocol 6.0
- Internet Explorer 6.0
- VoIP stack and apps suite
- Web Services on Devices (WSDAPI)
- Windows Media Player updates
- File system update



VoIP Upgrades

Windows Embedded CE has supported VoIP functionality since Windows Embedded CE 4.2 with both a VoIP “stack” that provides the basic voice over IP communication as well as a predefined operating system configuration complete with the VoIP stack and a suite of applications created to provide a solution for a Windows Embedded CE powered VoIP phone. Over the years, the VoIP support has been upgraded to improve the features of the stack as well as improve the accompanying applications. This effort has continued in Windows Embedded CE 6.0 R2. The VoIP updates in R2 are in both the basic “VoIP stack” and the suite of applications that provide a complete solution for OEMs building VoIP based products. Improvements to the VoIP stack are centered on added features to the phone software. The new release provides support for video calls, multiparty conferencing, and back-end server compatibility. The VoIP application suite has been upgraded as well. The VoIP suite includes five applications; the home application, the phone application, the settings application, the information application, and finally a bootstrap application. Each of the applications in the suite also use a set of common code implemented as a set of stand-alone DLLs. The effort to improve the VoIP functionality extends beyond just the Voice over IP project. Microsoft has provided the complete source code to the VoIP application suite. This source is in the \wince\public tree and therefore OEMs are free to modify and use this source code in any Windows Embedded CE based system whether it is a VoIP device or not. This suite of applications provides a great foundation for embedded application suites regardless of the type of system.

Web Services on Devices

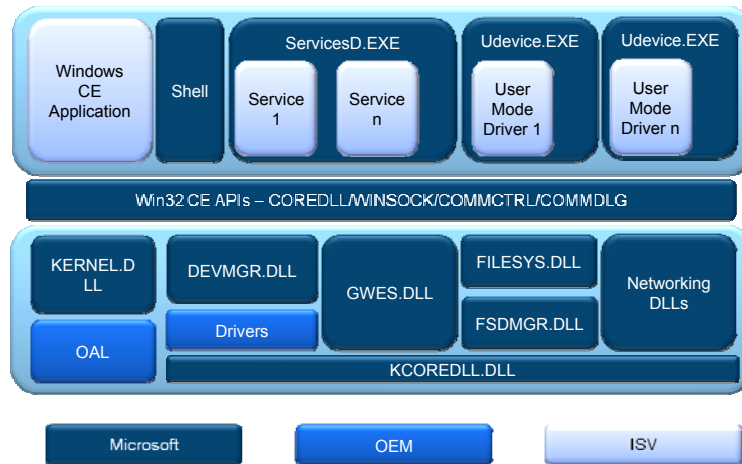
Windows Embedded CE 6.0 R2 has added support for Web Services on Devices, which is a methodology for detecting network attached devices and the web services they provide. WSD is a Microsoft implementation of the “Devices Profile for Web Services” standard. Web Services on Devices provide a method for a discovery protocol to take place between new devices plugged into a network and the devices currently on the network. As a device is attached to the network it broadcasts a “hello” message to announce its availability. Other devices and Vista-based PCs” can then interrogate the new device to discover what web services it provides.

The Windows Embedded CE implementation of WSD allows it to provide web services. The implementation depends on New Features in Windows Embedded CE 6.0 R2. It provides the complete Web Services on Devices API (WSDAPI) that is provided on Windows Vista. The web services on Windows Embedded CE are still limited to native (not managed) code and there is no WSD client for Windows XP based PCs.

Operating System Internals System Architecture

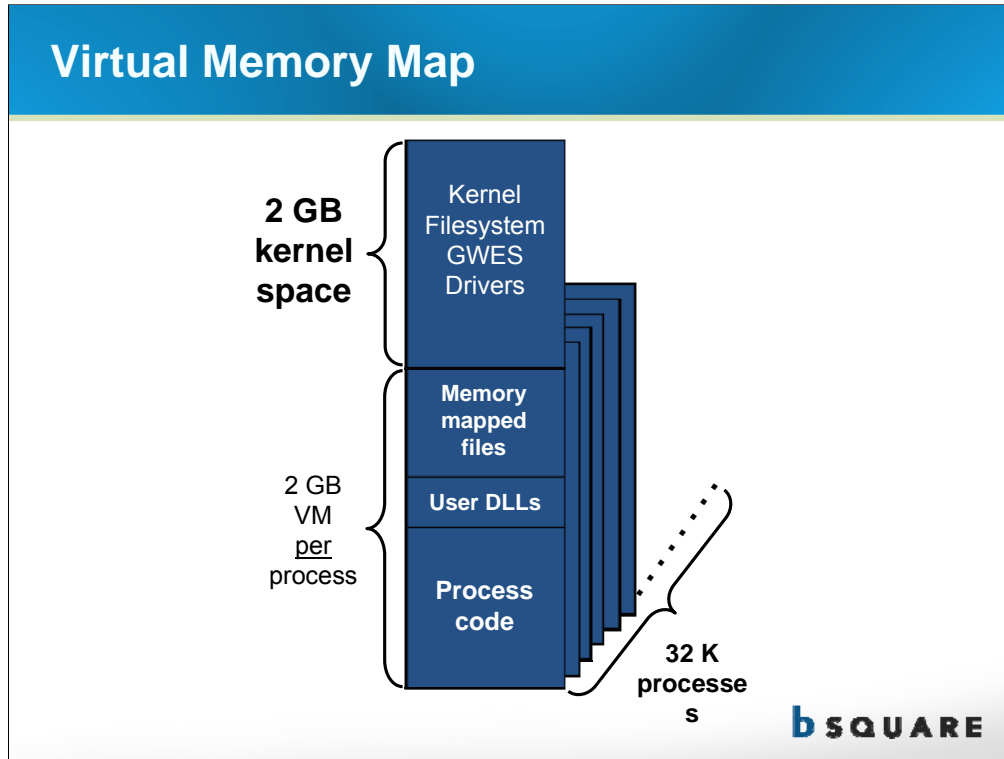
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CE 6.0 Architecture – Overview



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Now we can view CE 6.0's system architecture. You can immediately see a difference on the slide. Instead of the kernel coredll.dll hosting everything there is a new layer. This topmost layer is what we now call User Space. Services, Drives, and Applications running in user space are hosted by other processes such as ServicesD.exe or Udevice.exe. These modules can't access certain kernel functions and can not access physical memory directly. This means you might have to change some existing drivers and applications to use new APIs that act as wrappers to the existing physical memory allocation APIs and other functions, however, it also means that if your driver or application crashes it won't crash the Kernel.



The kernel memory space resides in the upper 2GB of the virtual memory map. The kernel memory area remains resident for all processes, there is only one kernel area. The user memory space resides in the lower 2GB of the virtual memory map. Each process has its own unique 2GB space, the kernel maps in the correct user space each time a process switch occurs. The combination of the 2GB kernel area and the process specific 2GB user area make up the entire 4GB virtual address space.

Note that only a single user process is valid at any point. User processes have unique memory mappings and can't corrupt memory in another user process. User processes are also prevented from accessing the kernel memory area. Components in the kernel area have access to the entire address space and can access any valid memory location.

Some significant new features in this version of the operating system:

2 GB of Virtual Memory per process

- Approximately 32,000 processes, practically limited by amount of physical memory

Benefits of the new Virtual Memory Layout in CE6 compared to previous versions

The number of processes is not limited to 32.

The amount of memory available to each process is not limited to 32 MB.

Switching processes on ARM and x86 is faster because it is simpler to make use of the hardware page tables.

The time to switch processes for MIPS and SHx remains about the same.

Translation look-aside buffer (TLB) miss handling is faster on MIPS and SHx because of simpler address space access checking.

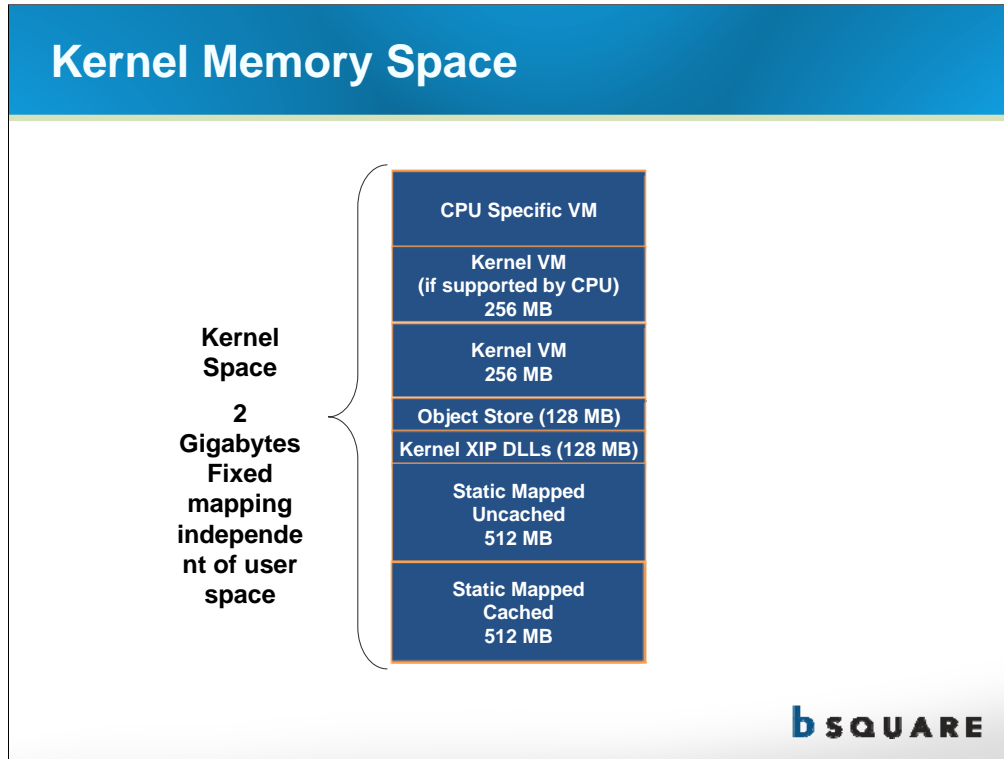
The time to handle TLB misses on ARM and x86 remains about the same.

Tradeoffs of the new Virtual Memory Layout in CE6 compared to previous versions:

Instead of the virtual memory for every process being accessible at all times, the virtual memory for the kernel process and the current process are accessible at all times. Therefore, accessing the memory of another process, particularly buffer parameters that are passed to a server, is no longer as simple as mapping a pointer.

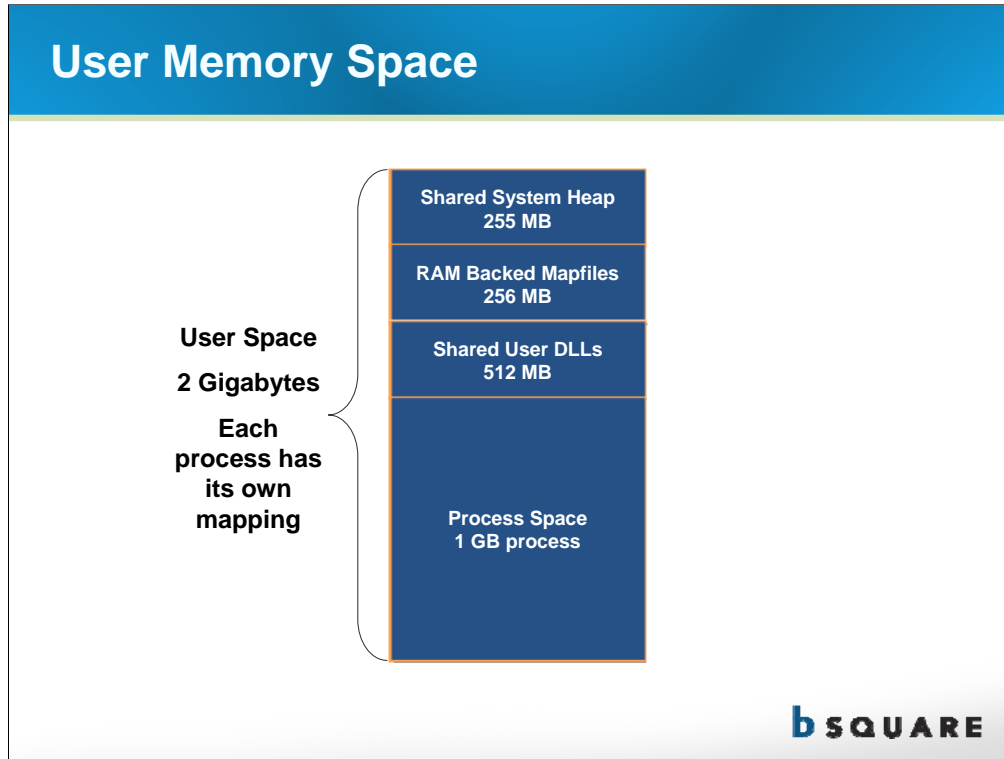
More complicated reference counting.

More complicated interprocess communication (IPC) and buffer passing.



The kernel memory space is in the upper 2GB of the virtual memory map, and is resident at all times for all processes. This area contains the components that provide much of the base system services.

Range	Size	Description	Comments
0xF0000000 - 0xFFFFFFFF	256 MB	CPU specific VM	System call trap area. Kernel data page.
0xE0000000 - 0xEFFFFFFF	256 MB	Kernel VM, CPU dependent	Kernel space virtual memory, unless disallowed by the CPU, such as SHx.
0xD0000000 - 0xDFFFFFFF	256 MB	Kernel VM	Kernel space virtual memory, shared by all servers and drivers loaded in kernel.
0xC8000000 - 0xCFFFFFFF	128 MB	Object store	based storage for file system, CEDB databases, and -based registry. Legacy data store.
0xC0000000 - 0xC7FFFFFF	128 MB	Kernel XIP DLLs	XIP DLLs for the kernel and all servers and drivers loaded in the kernel.
0xA0000000 - 0xBFFFFFFF	512 MB	Statically mapped Uncached	Direct access to physical memory bypassing the CPU cache.
0x80000000 - 0x9FFFFFFF	512 MB	Statically mapped Cached	Direct access to physical memory accessed through the CPU cache.

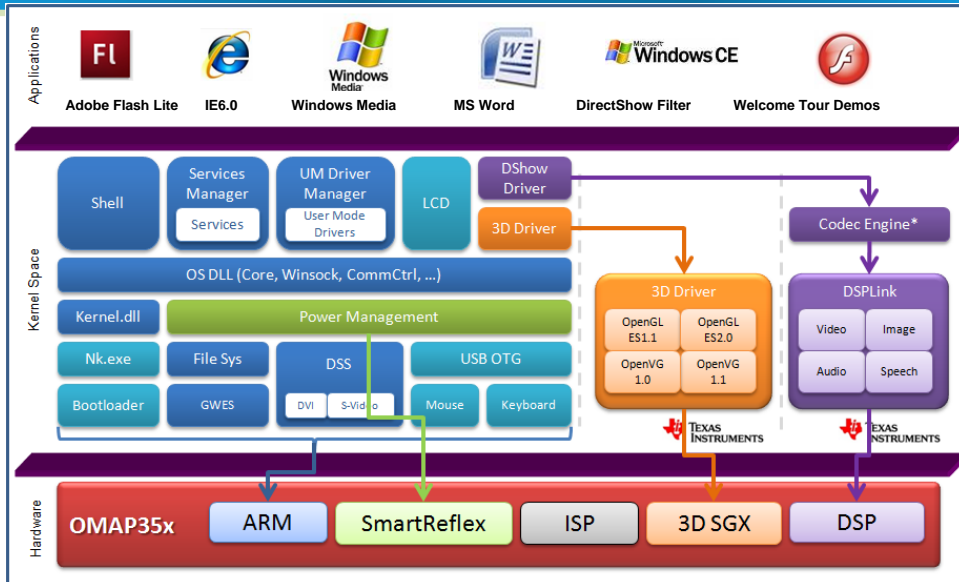


When a process initializes, the OS maps the following DLLs and memory components: DLLs and ROM DLL read/write sections are loaded bottom up starting at 1GB. DLLs are controlled by the loader, which loads all the DLLs at the same address for each process. The stack, the heap, and the executable (.exe) file are created and mapped from the bottom up starting at 64KB. Virtual memory allocations occur in the first 1GB after the executable code and data. The bottom 64 KB of memory always remains free.

Under low-memory conditions on some Windows CE-based devices, the OS might prompt the user for permission to take some object store RAM for use as program RAM to meet the RAM requirements of an application. The OS can also scavenge some unused stack space.

RAM backed map files are memory mapped file objects that do not have an actual file underneath them. This region provides backward compatibility for applications that used RAM-backed map files for cross-process communication, expecting all processes to map views at the same virtual address. Every process that opens the same RAM backed memory mapped file will get the same pointer value. File backed memory mapped files will be allocated from the virtual memory area of the process, and differ for each process.

OMAP35x WinCE BSP Architecture



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Tools for Platform Development Visual Studio 2005 and CE 6.0

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CE 6.0 and Visual Studio 2005



Integrated into Visual Studio 2005

- One familiar environment for application and OS development
- ARM Device emulator integrated into Platform Builder
- New USB download transfer
- Integrated device emulator
- Easy to test images
- Editors
- Help you code faster
- Updated Compilers
- Improved performance from CE 5.0

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CE 6.0 is run within Visual Studio 2005. Installation should be in the order above.

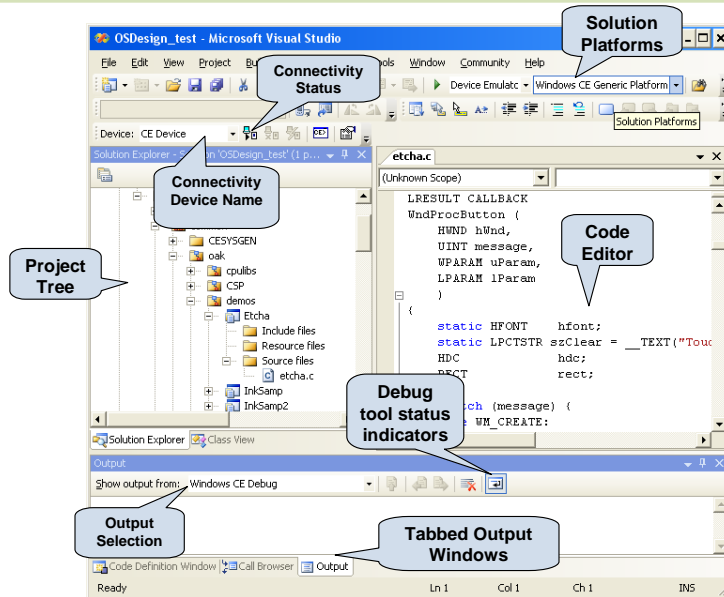
SP 1 must be installed to fully utilize the functionality of the Software Developers Kit (SDK).

Will be giving evals

Need VS SP. Will need to download

Need vista sp if running that

Visual Studio 2005 Platform Builder



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CE 6.0 Build Options

- Platform Builder from within Visual Studio 2005
 - GUI based Integrated Development Environment (IDE) tool for configuring and building OS Run-time images
- Command-line build
 - Behind the scenes, the IDE uses the command-line build system to perform builds.
 - Some developers prefer to work from the command line
 - The command line build can be used for overnight build automation.



Terminology

- **Catalog**
 - Container for available OS features, modules and components that can all be catalog items
- **OS Design**
 - Collection of Catalog Items, Custom Application Projects, Board Support Package (BSP) and Configuration files to generate an OS Run-Time Image
- **OS Design Template**
 - A pre-defined set of components, implemented as an XML file, used by the New OS Design wizard to create a new OS Design



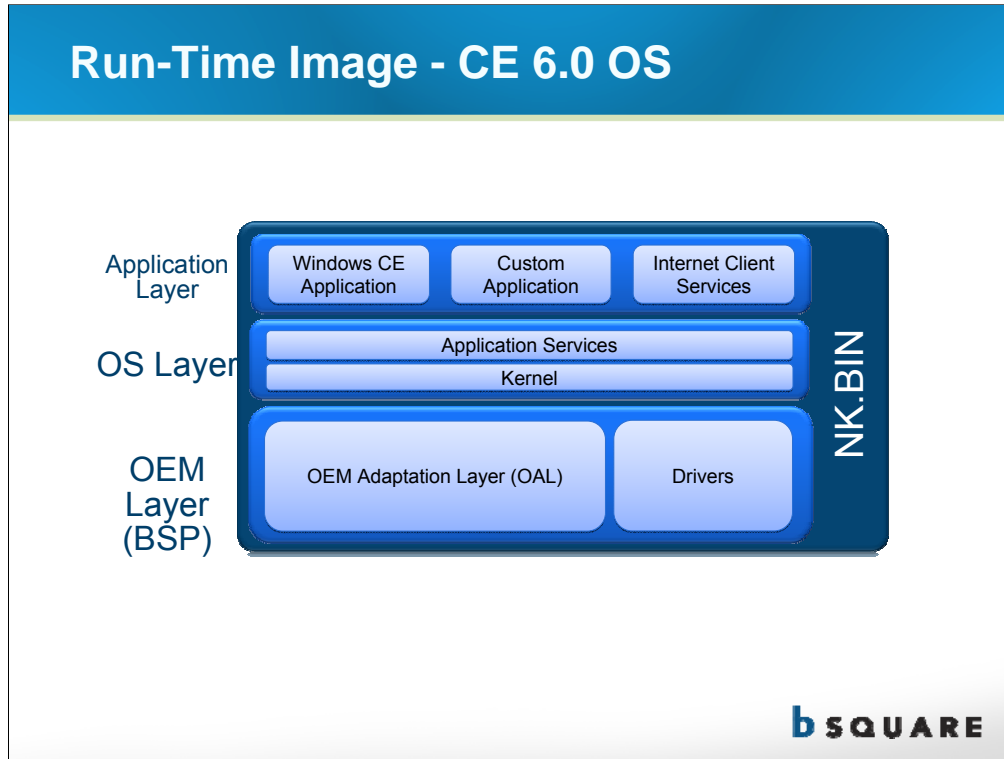
OS Design – An OS Design is defined as a Project in Visual Studio. Projects are parts of Solutions.

Terminology

- OEM Adaptation Layer (OAL)
 - Low level hardware platform specific library - abstracts the hardware architecture from the kernel
- Board Support Package (BSP)
 - OAL + drivers + configuration files for a particular hardware platform “Board”
- OS Run-Time Image
 - Everything in the OS Design is built into a file containing ROM data & code (usually NK.BIN)



The OAL provides the abstraction needed for CE to run on a number of processors and hardware platforms. This unique layer is typically created by the hardware OEM.



So where do these different terms and components fit in to the CE run-time image. At a very high level, the CE Operating System can be broken into three levels: Application layer, Operating System layer and the OEM layer.

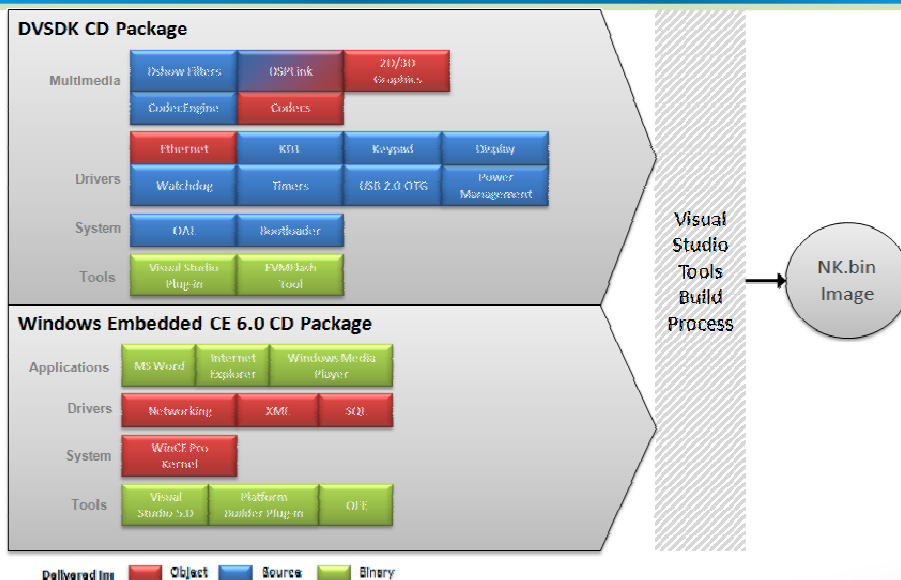
These 3 layers, via the build process, make up the run-time image – the final OS Design image (usually NK.bin)

CE 6.0 can allow the addition of 3rd party applications, drivers, etc. which can be added at runtime and are not part of the original run-time image.

Win CE Application (Calculator)

Managed code vs native

How a WinCE Image Comes Together



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This process to build is the same for all processors

Ethernet driver in object relates to the specific device on the EVM.

QFE – Quick Fix Engineering

At a very high level, the CE Operating System can be broken into three levels: Application layer, Operating System layer and the OEM layer.

These 3 layers, via the build process, make up the run-time image – the final OS Design image (usually NK.bin)

CE 6.0 can allow the addition of 3rd party applications, drivers, etc. which can be added at runtime and are not part of the original run-time image.

Win CE Application (Calculator)

Managed code vs native

Training News!

New! For a limited time, students attending 2542 Building Solutions using Windows Embedded CE 6.0 R2 will receive a free* TI OMAP35x Evaluation Module (EVM), a \$1495 value. For more information, go to http://www.bsquare.com/training_support/training.asp

The upcoming WinCE BSP training class schedule is:

- September 14-18, 2009 Bellevue, WA
- September 28-October 2, 2009 Boston, MA

** Onsite training sessions at customer locations are available on request



For More Information



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Thank you!

(Questions?)



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