

ECEN 5803

Mastering Embedded Systems Architecture

Windows Embedded

Windows Embedded Compact 7

Like Linux, this is a OS that is **usually built from scratch**, by selecting the desired **components** and adding them into the build process.

CE includes C/C++ and C# **cross compilers, a build system, and extensive debug tools** that run on a desktop PC. These tools can be used by either OS or application developers. A browser, WordPad, messenger, media player, and several games are also included.

The desktop PC is typically connected to the target system for development work. A special GUI-based tool called **Platform Builder** is used to generate new OS kernels. Several different families of popular embedded processors are supported including **X86, ARM, SHx, MIPS**.

Is Windows Compact Embedded a Real-time Operating System?

- A. Yes
- B. No
- C. Soft real-time only

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The CE architecture is designed around two modes of privilege,

- Kernel
- User

The fundamental system components providing basic services to the operating system run in the privileged Kernel mode, while user processes (applications) and dlls run in the unprivileged User mode. Privileged components include

- the kernel,
- device manager,
- file system manager,
- GWES (Graphics, Windows, and Events Subsystem)

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The top level in the block diagram consists of the user applications running on the device. User applications are typically developed in C/C++ or C#.

Windows CE supports a subset of the desktop Windows Win32 API system call interface. This means that applications developed for CE can be recompiled to run on desktop windows, but the reverse is not true.

The standard GUI and user interfaces have a look and feel similar to the desktop Windows OS.



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Applications can be developed that run on a CE-based device along with the kernel OS development as a subproject, or applications can be developed based on an imported Software Development Kit (SDK).

Applications developers using an SDK can work at the application programming interface (API) level and do not need to understand the low-level details of OS and driver development for the new device.



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All applications based on CE consist of a process and one or more threads:

- A process is a single instance of a running application.
- A thread is the basic unit that the CE OS allocates processor time to. A thread can execute any part of the process code, including parts that are being executed by another thread.

The OS provides process and thread API functions and structures to perform operations such as creating and terminating a process or thread and retrieving information about a process or thread. A number of synchronization methods are provided including mutexes, events, and semaphores.



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DLLs

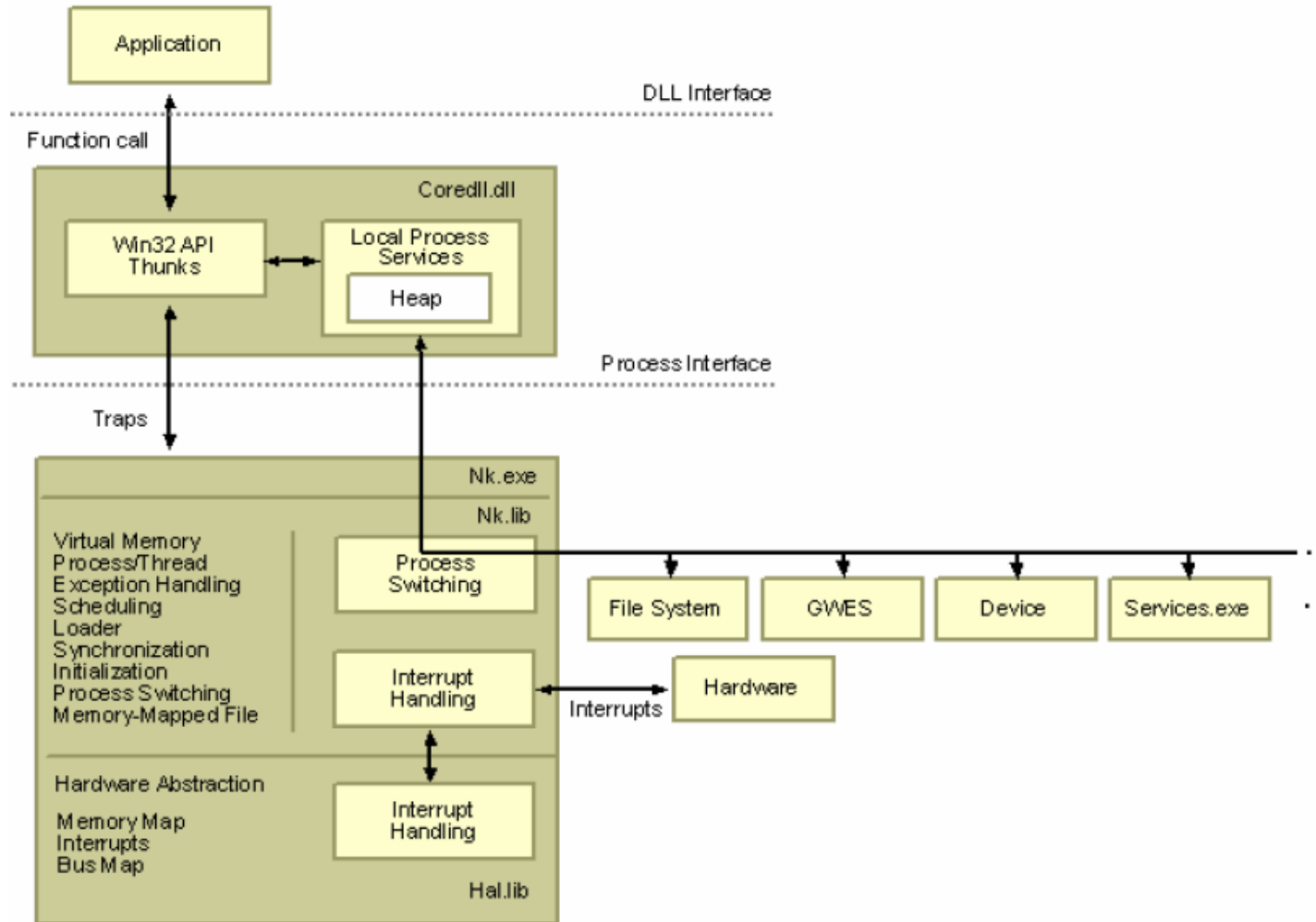
Many APIs are implemented in dynamic-link libraries (DLL). Dynamic linking allows a module to include only the information the system needs at load time or run time to locate the code for an exported DLL function. Dynamic linking differs from static linking, in which the linker copies a library function's code into each module that calls it.

.NET Compact Framework provides support for C# and Visual Basic applications running in CE.



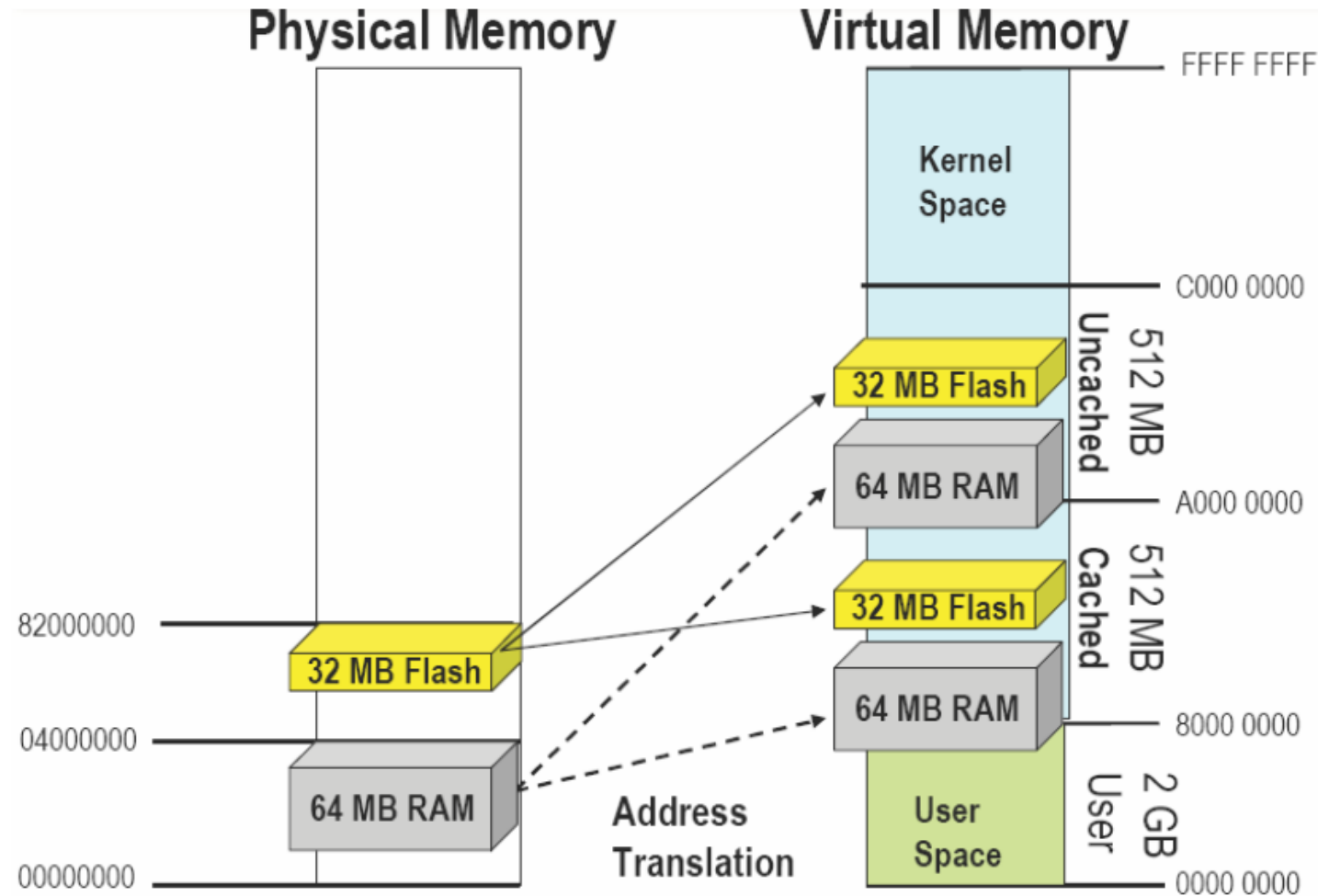
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Windows Embedded Compact 7 – Kernel Architecture



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Windows Embedded Compact 7 – Virtual Memory Address Translation



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Windows Embedded Compact 7 Performance Measurement

Windows CE development platform also has several practical and powerful tools to verify if the system is meeting real time requirements and better debug the system. Among them, Kernel Tracker, ILTiming and OSBench are really useful.

The RTOS showed good stability in the frequencies measurement, even for the worst conditions. In addition, the input frequency was slowly improved until the maximum output value of the external generator (1MHz) was obtained, without causing any damage or problem in the running system. Meanwhile, the maximum input frequency that the system measured correctly was 50KHz. From this value, it is possible to compute the worst case response time of Windows CE which is 20 μ s (1/50KHz).

- Even with all the ping floods and overloads, there was no situation that the system crashed requiring a reboot. In the worst overload scenario, the system stopped answering requests for some seconds, but right after it went back to normal operation. The conclusion is that Windows CE Embedded 6.0 is a very robust and reliable operating system to execute real time tasks, with the advantage of offering several powerful development tools.

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Windows Embedded Compact 7 Performance Measurement

Table 1. Worst times measured during the experiments. A: Response Time (1/maximum sustained frequency), B: Latency, C: Latency Jitter

Test	Win CE	Neutrino	μ C/OS-II	RTAI	VxWorks
A	20 μ s	20 μ s	1,92 μ s	5 μ s	3,85 μ s
B	99 μ s	35,2 μ s	3,2 μ s	11,4 μ s	13,4 μ s
C	88,8 μ s	32 μ s	2,32 μ s	7,01 μ s	10,4 μ s

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Windows Embedded Compact 7 – Processes and Threads

All applications in CE consist of a process and one or more threads:

- A process is a single instance of a running application.
- Processes enable users to open and work in several applications at the same time. For example, a user can edit a file in an application while another application is recalculating a
- As a preemptive multitasking operating system, CE supports multiple processes running simultaneously within the system.

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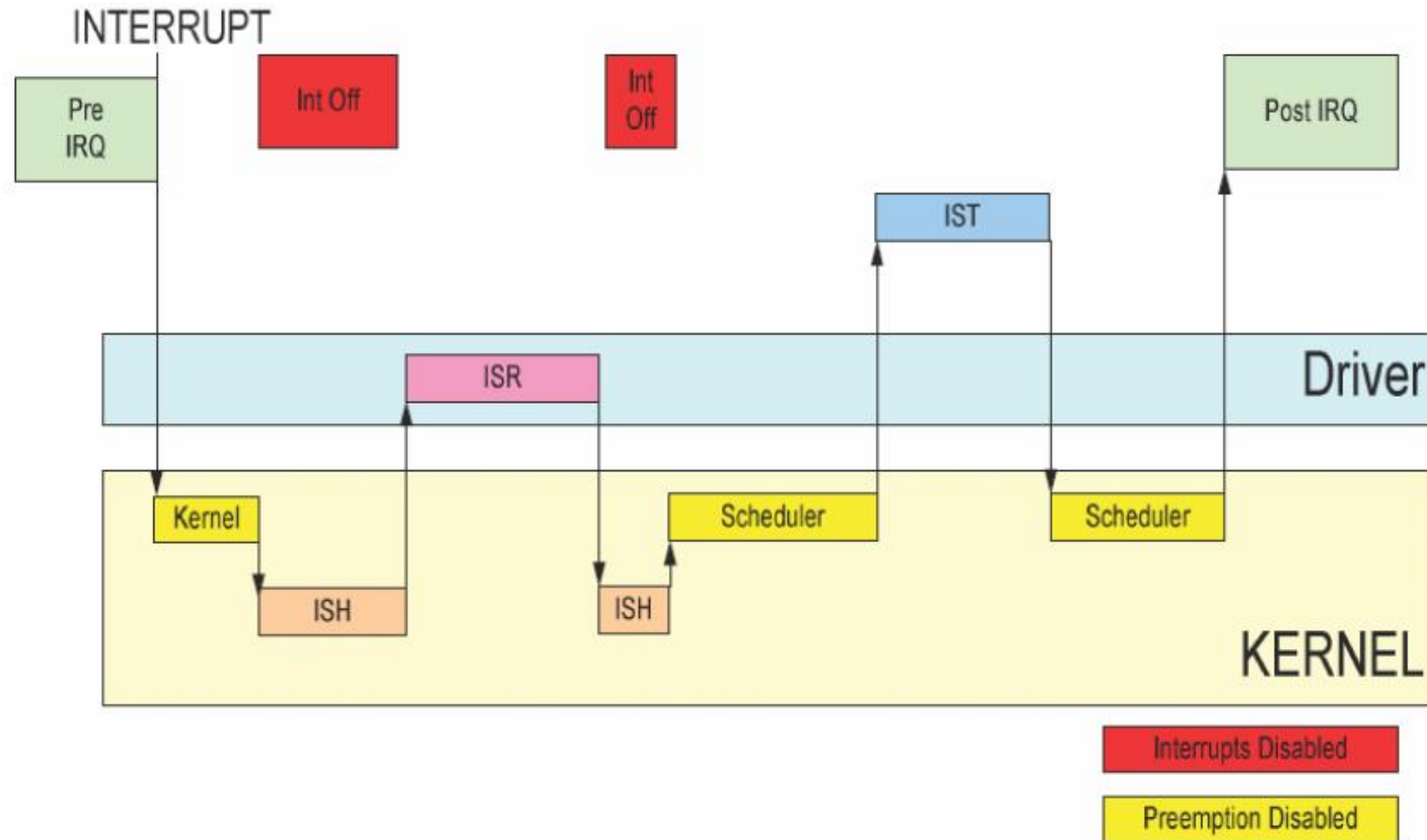
Windows Embedded Compact 7 – Processes and Threads

A thread is an independent portion of a process and is the basic unit that the OS allocates time to.

- Threads enable an application to perform more than one task at a time, even though applications cannot execute more than one thread at a time.
- A thread can execute any part of the process code, including parts that are being executed by another thread.
- Although one thread is designated as the primary thread for the process, a process can also create an unspecified number of additional threads.
- Available system resources limit the number of threads.
- CE provides 256 priority levels that you can set on a thread

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Windows Embedded Compact 7 – Interrupts



Windows CE response time to event

- A. 100 ms
- B. 99 μ s
- C. 20 μ s
- D. 1 μ s
- E. 1 ms

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Windows Embedded Compact 7 –

The OS Build System and Platform Builder

In CE, the tool used to generate a new custom operating system kernel is called Platform Builder.

In CE 6.0, it runs under Visual Studio 2005 with SP1.

In Compact 7, it runs under Visual Studio 2008.

In Compact 2013, it runs under Visual Studio 2012, 2013, or 2015.

In Platform Builder, the designer selects the various OS features and device drivers needed from the catalog items using the mouse to select the items needed. Then the user selects Build from the top level menu to build a new OS kernel using the selected OS features. The new OS can be then run and debugged on an ARM emulator or can be quickly downloaded to a target device attached to the PC using network, USB, or serial connections.

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Windows Embedded Compact 7 – Downloads

Platform Builder for Windows Embedded Compact 7 is a plug-in for Visual Studio 2008 and requires the following to function: Visual Studio 2008, Visual Studio 2008 Service Pack 1, .NET Compact Framework 3.5, and Visual Studio 2008 Update for Windows Embedded Compact 7

.NET Compact Framework 3.5 - <http://www.microsoft.com/en-us/download/details.aspx?id=65>
<https://www.microsoft.com/en-us/download/details.aspx?id=7873> – for Visual Studio 2008, <https://www.microsoft.com/en-us/download/details.aspx?id=38794> Windows Embedded Compact 7 180 day evaluation

You need Visual Studio 2008 Service Pack 1 which is available for download from the following URL:

<http://www.microsoft.com/downloads/en/details.aspx?FamilyID=27673C47-B3B5-4C67-BD99-84E525B5CE61>

Visual Studio 2008 update for Windows Embedded Compact 7

<http://www.microsoft.com/download/en/details.aspx?id=11935>

Install .NET compact Framework 3.5, then Visual Studio 2008, then SP1, then Win CE 7 Platform Builder.



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Windows Embedded Compact 7 Evaluation Edition toolkit is valid for 180 days from the day of installation.

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Windows Embedded Compact 2013 – Downloads

Platform Builder for Windows Embedded Compact 2013 is a plug-in for Visual Studio 2013 and requires the following to function:

Visual Studio 2012 or 2013

.NET Compact Framework 3.5 - <http://www.microsoft.com/en-us/download/details.aspx?id=65>

<https://docs.microsoft.com/en-us/visualstudio/releases/vs2013-community-vs> or <http://go.microsoft.com/?linkid=9863609> for Visual Studio 2013. Also see <https://www.c-sharpcorner.com/UploadFile/d0e913/visual-studio-community-2013-how-to-install-and-setup/>

You may need to join the Visual Studio Dev Essentials site to get access to these files.

Download WinCE2013 Platform Builder from <https://www.microsoft.com/en-us/download/details.aspx?id=39268> and <https://www.microsoft.com/en-us/download/details.aspx?id=38819> for the application builder

Install .NET compact Framework 3.5, then Visual Studio 2012 or 2013, then Win CE 2013 Platform Builder.





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Windows Embedded Compact 2013 – Downloads

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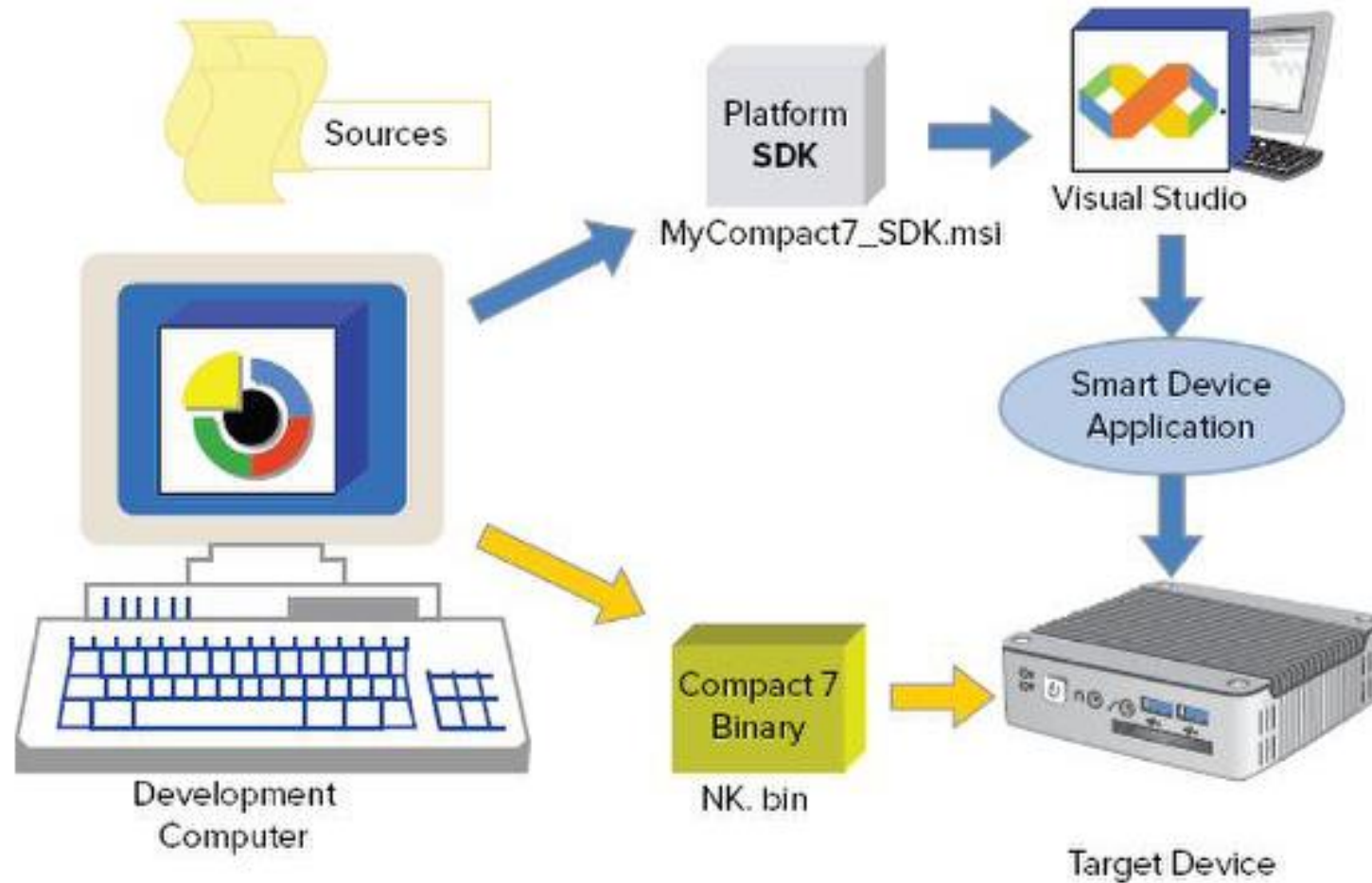
Windows Embedded Compact 7 – Development Environment

Virtual PC is great for learning how to use Platform Builder.

Platform Builder for Compact 7 provides the necessary resources, including Virtual PC BSP and a sample virtual machine, needed to work through OS design project and application development exercises. Using Virtual PC, you can work through the exercises to download an OS runtime image to the virtual machine and deploy an application to the virtual machine with Compact 7 OS launched.

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Windows Embedded Compact 7 – Development Environment





Windows 10 IoT

Windows Embedded for small processors

An overview of Windows 10 IoT Core

📅 01/18/2018 • ⌚ 2 minutes to read • Contributors 👤 🔄

What is Windows 10 IoT Core?

Windows IoT Core is a version of Windows 10 that is optimized for smaller devices with or without a display that run on both ARM and x86/x64 devices. The Windows IoT Core documentation provides information on connecting, managing, updating, and securing your devices, and more.

Getting Started

To get started with Windows 10 IoT Core, we've created a [Get Started walkthrough](#) for [prototyping](#) and [commercializing](#) devices that leverage Windows 10 IoT Core.

Helpful resources

[Read our documentation](#) to learn more about Windows 10 IoT Core.



Windows 10 IoT

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Windows IoT Core Downloads and Tools

Get the tools you need to build with Windows 10 IoT Core

For new users, make sure to check out the [Get Started](#) section.

Essentials

Download Windows 10 IoT Core

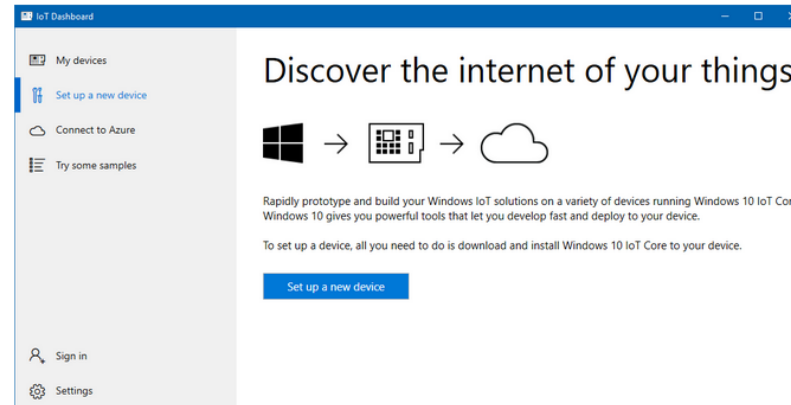
The IoT Dashboard is an essential tool for users to get started with Windows 10 IoT Core.

If you are planning to ship your device for commercial use, for optimal security, you must ship with a custom FFU. To learn more, refer to our [IoT Core Manufacturing Guide](#).

[Get Windows 10 IoT Core Dashboard](#)

By downloading and using the Windows 10 IoT Core Dashboard you agree to the [license terms](#) and [privacy statement](#) for Windows 10 IoT Core Dashboard.

[Release notes](#)



IoT Core ISO

Windows 10 IoT Core for
Raspberry Pi 2 & 3

Download Windows 10 IoT Core Creators
Update ISO for Raspberry Pi 2 & 3.

Windows 10 IoT Core for
Dragonboard 410c

Download Windows 10 IoT Core Creators
Update ISO for Dragonboard 410c board.

Windows 10 IoT Core for
MinnowBoard Turbot/MAX (x64)

Download Windows 10 IoT Core Creators
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Windows CE Lifecycle

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Products Released	Lifecycle Start Date	Mainstream Support End Date	Extended Support End Date	Product Distribution End Date
Microsoft Windows CE 5.0	31/08/2004	10/13/2009	10/14/2014	31/08/2019
Windows Embedded CE 6.0	11/30/2006	04/09/2013	04/10/2018	28/02/2022
Windows Embedded Compact 7	03/15/2011	04/12/2016	04/13/2021	28/02/2026
Windows Embedded Compact 2013	08/11/2013	10/09/2018	10/10/2023	31/05/2028
Windows 10 IoT Core 2019 LTSC	13/11/2018	09/01/2024	09/01/2029	Awaiting