Toradex Instant Boot

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Windows Embedded

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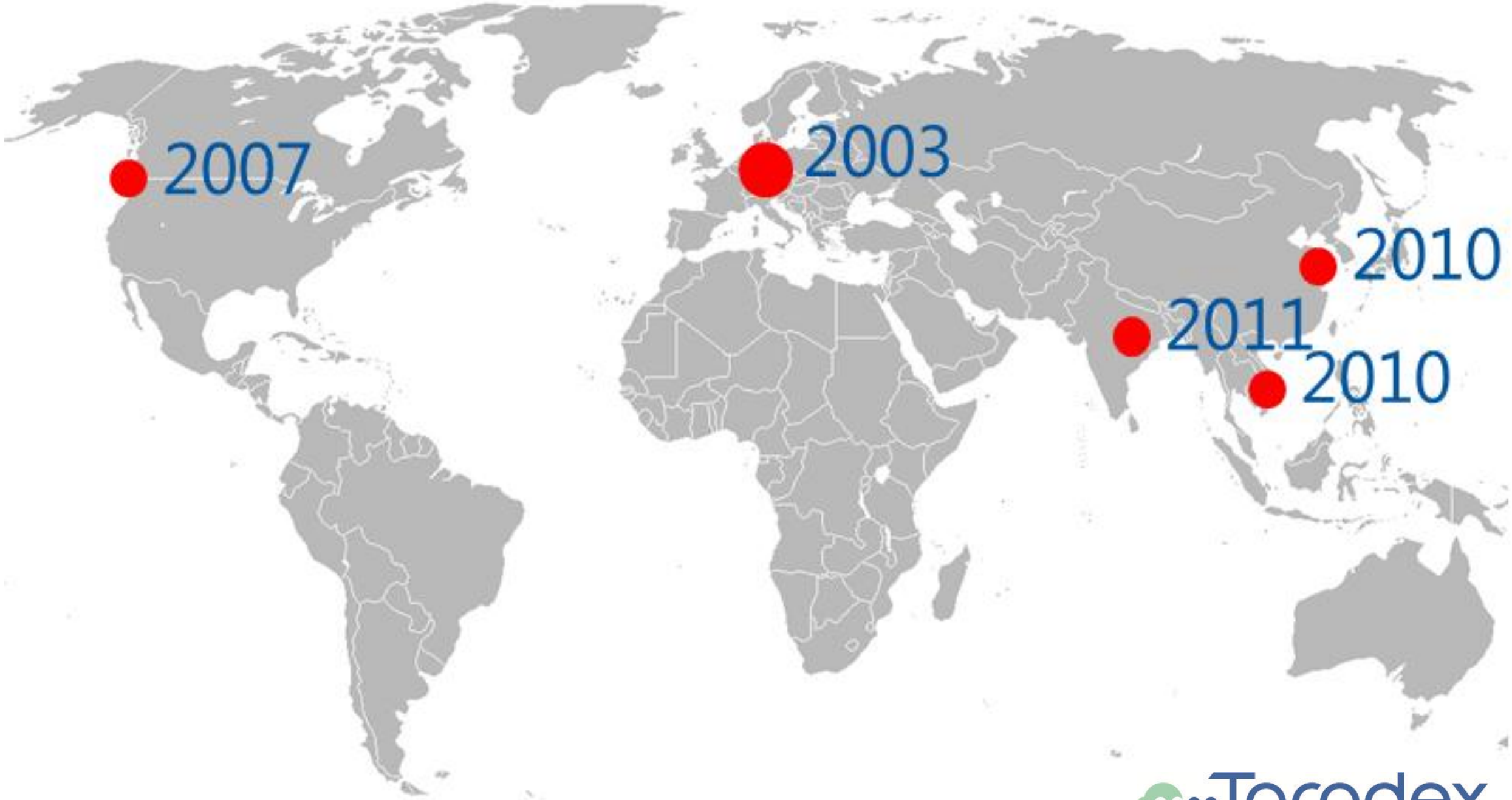
Windows Embedded

Introduction Toradex

Toradex


2007
2003
2010
2011
2010
Toradex

Toradex Approach

Highly Standardized

Over 3000 customers using our standard Colibri modules
All modules share a common pinout and same SW APIs
Upgrade and Downgrade possibilities

Flexible Solutions

Hardware and Software are designed for maximum flexibility
One BSP for very different requirements in the different markets

Optimized HW and SW

Software and Hardware are optimized the get the best out of the available resources
Software and Hardware form the same provider

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Toradex Markets

Very Diverse Markets

Industrial Control
Test and Measurement
Automotive and Transportation
Aerospace
Military
Digital Signage
Medical
Telecommunication
POS
Energy and Power
Surveillance and Security

Military

Automotive

Digital Signage

Colibri ARM Modules

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Colibri ARM Modules Family

Ready to Run

Fast time to Market
Low integration effort
Preinstalled Windows CE

Low Development Risk

Proven Design
Extensive Support and Tools

Scalability

208 MHz up to 1 GHz Quad Core Corex A9
Pincompatibility

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Colibri ARM Modules Family

Get Started

Real World Interfaces
Low Volume Products

Build Your Own

Full Altium Design Data
Review Services
Lots of Add-Ons
Partner Network

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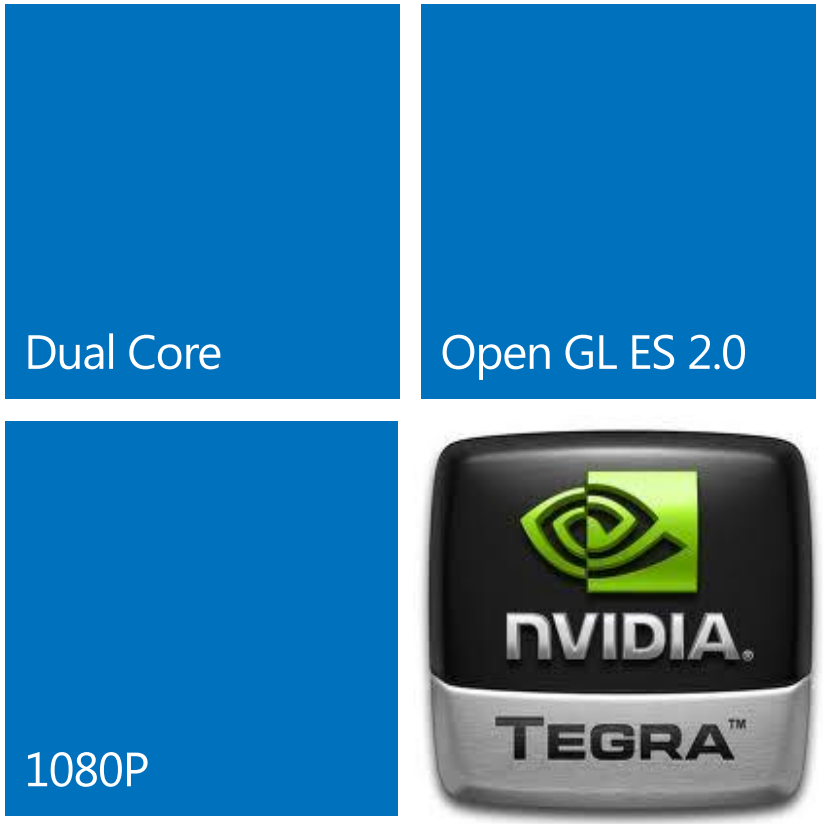
Colibri ARM Modules Family

Colibri T20 with Nvidia® Tegra™ 2

Dual Core Cortex A9 1GHz
Low Power GeForce GPU
256 MB – 512 MB DDR2 RAM
512 MB – 1 GB NAND Flash
Full HD Video Encode and Decode
Dual Screen
Open GL ES 2.0
HDMI, VGA, LCD
GPIOs, I2C, SPI, USB 2.0, Serial Ports, Memory Bus, SDIO, Touch, Ethernet, PWM, Camera Interface, Analog and Digital Audio, …



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Instant Boot Overview

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Instant Cold Boot Overview

What

Zero power consumption no Suspend
Full Hardware/Software initialization no Hibernation

Why

Longer battery life
Instantly ready to use
Great user experience

How

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Original Boot Sequence

Power Up

Apply 3.3V PMIC starts power sequencing
Predefined order e.g CPU voltage, core voltage ..
System waits until real-time oscillator is stable 235ms
Deassert reset to start first instruction in CPU

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Power Up

PMIC Initial Delay 100ms to 10ms

Change default startup behavior HW optimization

PMIC Sequencing 15ms no change

Can't do much about this

RTC Stabilization 235ms to 0ms

Not required

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Original Boot Sequence

Copy Bootloader

Bootrom starts executing on the low power auxiliary ARM7 CPU
Bootrom initializes DDR2 RAM
Bootrom initializes NAND flash controller
Bootrom copies Bootloader from NAND flash to RAM
Bootrom jumps to Bootloader code in RAM

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Copy Bootloader

Bootrom Init 10ms no change

Hardcoded in Rom

Copy Bootloader 140ms to 75ms

Bootrom only copies mini Bootloader
Mini Bootloader loads real Bootloader with optimized Flash accesses

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Original Boot Sequence

Initialize Bootloader

Bootloader is still on the ARM7 Core
Bootloader initializes Cortex A9 Cores
Bootloader initializes various interfaces like serial port, SPI, PWM, I2C, …
Bootloader initializes display controller
Bootloader shows splash screen
Bootloader waits for user input

Initialize Bootloader

HW Init 100ms to 10ms

Reduce KernelRelocate size
Only initialize HW that is really used
Minimize I2C accesses to PMIC

Splash Screen 150ms to 40ms

Optimal initialization of the display controller
Use compressed splash screen in 8bpp
Avoid copying Splash Screen multiple times

Serial Debug Output 100ms to 0ms

Omit output

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Original Boot Sequence

Copy Image

We're still in the Bootloader running from Cortex-A9 CPU
Bootloader copies the Windows Embedded Compact 7 Image from NAND flash to RAM
The Windows Embedded Compact 7 Image has a typical size of ~30 MB
Typical NAND flash read speed: 15 MB/s
Bootloader jumps to Windows Embedded Compact 7 in RAM

Copy Image

Copy Image to RAM 2000ms to 130ms

Remove not needed components
Move Files to FlashDisk or BinFS
Use optimal Flash Timings
Use Flash cache read +20% speed
Increased speed form 15MB/s to 23MB/s
Compress Image to save 50% of space and read time

Decompress Image add 70ms

Use compression optimized for fast decompressing
Decompression could be done while copying from flash

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Original Boot Sequence

Initialize Windows Embedded Compact 7

Kernel initializes translation tables, enables MMU and caches,…
Kernel calls OEM functions (OEMInitDebugSerial / OEMInit)
Kernel initializes multicore operations
Kernel loads file system (FileSys.dll)
File system initializes object store and registry
File system loads device manager (Device.dll)

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Initialize Compact 7

Kernel Initializations 10ms no change

Not much we can do about that

Serial Output 190ms to 0ms

Disable serial output

FileSystem Init 2800ms to 40ms

File system initialization takes very long (Especially on a large Object Store)
On systems with large L2 caches it's even worse
Use a caching optimization in file system

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Original Boot Sequence

Load Drivers

Device Manager will iterate through the registry and load the drivers one by one sequentially
Drivers loaded by Device Manager are: NandFlash, USB Host/Function, Serial, Audio, Ethernet
GWES (Graphics, Windowing and Events Subsystem) is launched
GWES loads a few other drivers like display and touch

Load Drivers

Device Manger Driver Load 500ms to 30ms

Disable unwanted drivers
Disable drivers that are rarely needed, will be loaded on demand
Optimize HW accesses
Avoid redoing stuff already done in the bootloader
Initialize drivers parallel (Bus Enum 2)

GWES Drivers Load 2500ms to 20ms

Avoid DDC (Display Data Channel) communication retries
Initialize touch asynchronously

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Original Boot Sequence

Start Shell

The default shell on Windows Embedded Compact 7 is the Explorer.exe
The Explorer loads a startup sound and a desktop background
Explorer.exe requires a number of other libraries to be loaded: OLE, Imaging library, HTML, …
All the dependencies sum up to several megabytes

Start Shell

Explorer Loading 350ms removed

Most embedded systems use a custom shell

Simple Demo Shell add 10ms

The shell should be kept small demo is only 12KB
Additional features can be loaded in the background
Additional features can be loaded on demand form the Flash

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Original 12 Seconds
Now 480ms

Demo

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