An Overview of Embedded Systems at Microsoft

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Contents

Our embedded device perspective

Embedded Systems Products
- Windows CE & Windows XP Embedded
- Windows Mobile
- Applications in teaching & research
- SPOT (Smart Personal ObjecTs)

Embedded Systems Research
- Sensor Networks
- Robotics
- ...

Our Device Perspective

Enable information and experiences to span:

- Vertical Enterprise Applications
- PCs and Servers
- Communication and capture devices
- Consumer Electronics
- Mobile devices
- Appliances, screens

Web Services
The Device Landscape

- Fixed function to multi-function devices
- Pressure to do more, with less
- Shift from proprietary to commercial software
- 8 and 16-bit to 32+ bit
Microsoft’s Mobile And Embedded Strategy

Focus
- Provide 32-bit software building blocks
- Integration between devices, PCs, servers and Web
- Enable rich applications and services

Business Model
- Low-cost, easy to use software
- Partners for services
- Shared success model
Windows Mobile Smartphone

Windows Mobile Pocket PC Phone

Windows Automotive

Portable Media Center

VoIP Phones

Mobile Handhelds

Set-top Boxes

Smart Personal Objects

Gateways

Medical Devices

Retail Point-of-Sale

Windows-based Terminals

Entertainment Devices

.NET Technology

Windows CE

Windows XP Embedded

Windows XP

Increasing Functionality
Windows Embedded Platforms

Windows XP Embedded
The most complete embedded platform enabling advanced devices by delivering the power of Windows in componentized form.

Windows CE
Windows CE integrates reliable real-time capabilities with advanced Windows technologies to rapidly build a wide range of innovative, small-footprint devices.
Windows XP Embedded

Quick facts

- Componentized version of XP Professional – brings the full power of Windows to advanced devices
  - Over 10,000 components to flexibly build a customized device
  - Embedded-specific features enable wide range of boot, storage, deployment, and manageability options

- Rapid development
  - Powerful Tools for building custom devices
  - Extensive support for Win32 and low-cost PC hardware

- Reliable
  - Built on the robust Windows XP Kernel
  - Embedded specific capabilities to increase reliability in devices
Windows XP Embedded With SP2

Quick facts

- Enhanced security
  - Windows Firewall component
    - Configurable in Target Designer
  - Hardened Internet Explorer
- New platform technologies supported
  - Bluetooth stack and profile
  - Software Update Service (SUS)
- Other features coming in SP2
  - DirectX9 subsystem APIs
  - .NET Framework 1.1
  - Enhanced Write Filter (EWF) improvements
  - Comprehensive documentation update
Windows CE

Quick facts

- Integrated reliability
  - Componentized, hard real-time operating system
  - System wide reliability and manageability
  - Extensive wireless support for secure connectivity

- Greater productivity
  - Native Windows integration
  - Powerful development and emulation environments
  - Broad driver and CPU support - x86, MIPS, SH 3/4, ARM

- Shared success
  - Low upfront investments
  - Broad source access and design flexibility
  - Knowledgeable worldwide partner base
Windows CE 5.0

Quick facts

Tools Updates
- Combined IDE and command line build tools
- Rapid O/S development for novice and power users

Operating System Updates
- Over 300 operating system updates over version 4.2
- Includes
  - Kernel (64 Interrupts, watch dog timer, EDB, others)
  - Multimedia (DirectX Mobile, DRM, Image Library, drivers, WM Codecs)
  - Drivers (PQD Drivers and BSP, USB 2.0, SDIO)
  - Internationalization (MUI updates for Asian Language)
  - Browser (Popup Window Blocker, RPC, Theming, TV Lens)
  - Networking (Native 802.11, Bluetooth PAN, HID, Headset, Peer to Peer)
  - Security (Windows Security Push, LASS, Cryptography)
Embedded Platform Differences

- x86 processors
- Full Win32 API compatibility
- Basic images from 8MB
- With 3rd party extensions

Processor Support
- Multiple processors
- Requires additional effort

Win32 API Compatibility
- Basic images from 350 KB

Footprint
- Native

Real-time
Choosing a Device Platform

- **Retail POS**
- **ATM**
- **Advanced STB**
- **LOB Thin Clients**

- **Test and Measurement**
- **Kiosk**
- **Home Media Gateway**
- **Medical Systems**

- **Mobile Handheld**
- **VoIP Phones**
- **Basic Thin Clients**
- **Medical Devices**

- **Set-top Box**
- **Consumer Electronics**
- **In-vehicle Navigation**
- **Industrial Automation**

- **Pocket PC**
- **Smartphone**
- **Portable Media Center**
Where We Fit In, What You Gain

- Engineering efficiencies
- Marketing consistency
- Thought leadership
## ABU: Real Devices In The Market

<table>
<thead>
<tr>
<th>Automaker</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMW</td>
<td>7 Series</td>
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<tr>
<td>Citroen</td>
<td>C5, Xara</td>
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<tr>
<td>DaimlerChrysler</td>
<td>S-Class</td>
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<td>Fiat</td>
<td>Lancia Thesis</td>
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<tr>
<td>Honda</td>
<td>Accord</td>
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<tr>
<td>Mitsubishi</td>
<td>Airtek, Lancer, Grandis, Dingo</td>
</tr>
<tr>
<td>Subaru</td>
<td>Lancaster</td>
</tr>
<tr>
<td>Toyota</td>
<td>Will-CYPHA (G-Book)</td>
</tr>
<tr>
<td>Volvo</td>
<td>S60, S80, V70, XC</td>
</tr>
<tr>
<td>Aftermarket</td>
<td>Clarion, Joyride, CADIAS</td>
</tr>
<tr>
<td>Aftermarket</td>
<td>Hyundai ExRide</td>
</tr>
<tr>
<td>Aftermarket</td>
<td>NexTech Carman-i</td>
</tr>
</tbody>
</table>
Portable Media Center (CE 5.0)

Your entertainment experience where and when you want it.

TV
- Latest shows sync
- Faithful to MCE exp.
- Presets for favorites

Music
- Over 10,000 songs
- Rich nav, Album Art
- Highest quality

Music Videos
- New portable experience
- Napster, EMI, others

Home Videos
- Take your MovieMaker
- Movies with you
- Over 80 hours video

Movies
- Over 45 movies
- Rent or own digital copy
- CinemaNow, others

Pictures
- Over 100,000 pictures
- “TV out” for display
- Slideshows and music

PhotoStories
- Playback of Photostories

Windows Media: Anytime, Anywhere
- Innovative Hardware Design
  - HDD based, 1”-1.5gig to 1.8“-40gig
  - 2.2 to 3.5” screen
  - USB 2.0
  - Composite TV Out
- Premiere Entertainment experience
  - Best video WMV 9 (4:3 and 16:9)
  - Highest quality audio, including WMA Lossless
  - Content security with WM10 DRM
  - Rich consumer friendly UI
- Best of class transfer with Windows Media Player
  - MTP – no click synchronization, surprise interrupt
  - Video, television, audio, pictures all transferred
  - Playlists, album art, content ratings
- Great partners
  - OEM: Creative, Samsung, iRiver
  - Target prices of $499US
  - Regions: US, EU, Japan, Korea, Taiwan, China
  - Content – CinemaNow, MLB, WMA Audio Sites
  - Retail – Best Buy, Circuit City
Partners Make It Happen

Partners

- Over 2,500 Windows Embedded Partners worldwide
- Exponential growth in China, Taiwan, India
- Gold partners in all major regions
- Industry experts
- Demonstrating value across product line
Community Makes It Happen

Community

- Newsgroups, blogs, chats, webcasts, user groups
- 100+ mobile and embedded MVPs
- Windows Embedded Developers’ Interest Group
- Over 250,000 downloads of shared source
- Academic engagements – 300+ schools worldwide
- Get Involved!

Get Involved!
Customers Make It Happen

Customers

- 1,000s of design wins
- #1 in embedded market share 2003 (Gartner, VDC) – 30%
- #1 in revenue 2001-2003 (VDC and IDC)
- Industry and strategy shaping feedback
Windows Embedded Academic Program

What is WEMAP?
- No cost program to enable academic development on the Windows Embedded platform

Program Goals
- Deepen our relationship with academia in both research and teaching
- Engage directly with students in order to enhance their understanding of our products and technologies
Current Initiatives: Summary

Curriculum

- Licenses:
  - >400 Curriculum Licenses worldwide
- Reference Books:
  - >125 Schools Worldwide

Extra-Curricular

- Training:
  - Academic Devcon Redmond
  - TTT, Bangalore
  - Crash Courses – Cape Town, Maastricht, India WEE, Bangalore, Cambridge
- Research:
  - 77 Embedded RFP Projects Worldwide

US Examples of Curriculum Deployment:
- UNL – Establishing a model embedded systems laboratory
  - California Polytech, Pomona – 5 courses using Windows CE
  - California State, Northridge – 4 courses using Windows CE
- Georgia Tech
- Wisconsin - Madison

Students

- 1st Windows Challenge:
  - 29 Teams
  - 120 Students
  - 25 Professors

HEP:

- Over 30 schools engaged
- 11 Partners worldwide
Mobile and Embedded Roadmap

Today

Windows Mobile 2003 2nd Edition
Pocket PC, Smartphone

Microsoft Windows CE 5.0

Windows xp Embedded
Service Pack 1
Service Pack 2

2005+

“Magneto”

“Next Major Version of Windows CE”

Longhorn Embedded

Visual Studio.net

Visual Studio 2005
Futures

Windows CE – v/ Next
- Tool updates
  - updated build system
  - Integration with Visual Studio 2005 “CoreCon”
  - More “Wizards”
  - Longhorn Technologies

Longhorn Embedded
- Componentized Longhorn
  - Embedded becomes the core of Longhorn
  - Easy SKU creation (MCE, Home, Pro, Tablet)
- Embedded Enabling Features
  - Tool updates

Visual Studio 2005
- Will combine native and managed development in one IDE
- Upgraded MFC and ATL libraries
- .NET Compact Framework 2.0
  - Huge upgrade
- Coming soon…
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Microsoft Research & Windows Embedded
Innovation Excellence Awards
University Projects, 2003-2004

[Also known as our “Embedded RFP”]
Embedded Systems RFP FY04

- $1.7M awards total
- 77 projects worldwide in 26 countries
- 75 universities
- 62 research projects, 12 teaching projects

Projects started - Summer 2003
Projects completing - Summer 2004
Wrap-up workshop - Fall 2004 (September 7 & 8)

Overall theme: Innovative Embedded Research & Teaching
<table>
<thead>
<tr>
<th>Country</th>
<th>Projects</th>
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<tbody>
<tr>
<td>Argentina</td>
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<tr>
<td>Australia</td>
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<td>Belgium</td>
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<tr>
<td>Brazil</td>
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<td>Bulgaria</td>
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<td>Canada</td>
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<td>Chile</td>
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<td>China</td>
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<td>Czech Rep</td>
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<tr>
<td>France</td>
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<td>Germany</td>
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<td>Hungary</td>
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<td>India</td>
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<td>Israel</td>
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<td>Italy</td>
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<td>Korea</td>
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<td>Lebanon</td>
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<td>Portugal</td>
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<td>Singapore</td>
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<td>South Africa</td>
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<td>Spain</td>
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<td>Switzerland</td>
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<tr>
<td>Taiwan</td>
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<tr>
<td>UK</td>
<td>8</td>
</tr>
<tr>
<td>USA</td>
<td>17</td>
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</tbody>
</table>
Embedded Systems RFP
Final Workshop
Embedded Systems RFP
Bonus Training Event
Post-RFP is the best part!

- Results become available & publishable
- Dissemination is key
- Successful project criteria:
  1. Papers – list of publications
  2. Posters – used at final workshop
  3. Web page – project URL to a webpage
  4. Demo – demo/video

- Curriculum objects to go into Curriculum Repository
- Central list of project web pages, posters, research results
- Special issue of IEE Magazine
- Special MSR research seminar
- Posters usable at internal and external events, e.g. TechFest, DevCon, RoboNexus – attractive as posters, but also great handouts
- GetEmbedded.net
Welcome at www.getembedded.net

Get Embedded .NET: Welcome

Welcome to GetEmbedded.NET (GEN). This community site is currently dedicated to the winners of the Innovation Excellence Awards for Windows Embedded. This site is created, maintained, and populated by those winners.

Winners...

If you are a winner of an award, you should have received an email on how to register and login to this site. If you have not received this email, or are having issues logging in, please email support.

For other visitors to this site, we regret that we can only let you this far. But don’t worry, we’re working to open the site up in the future so everyone can take part. In the mean time, get familiar with the global Windows Embedded Community. If you are a student or professor, you should definitely check out the Windows Embedded Academic Program, which includes information on the newly created Hardware Empowerment Program.

Site information

Contact Us | Site Feedback | Legal Notice | Sitemap
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  - Robotics
SPOT (Smart Personal Objects)

- A new service platform: MSN Direct Watch
- A new embedded platform

MSN Direct – Smart Watch
- A new, specialized wireless service delivering customized personalized information through enabled watches that combine fashion and technology
- Timely, glanceable information available at the flick of the wrist
- News, weather, sports, stocks, plus personal messages and appointment reminders
- DirectBand – Public FM radio subcarrier broadcast, always connected

- The client platform core is generic – low power, low cost, low footprint, high capability, secure

- For more info on the watch:  
  [http://www.microsoft.com/spot](http://www.microsoft.com/spot)
**SPOT Development Kit**

- Full kit contains:
  - “Stamp”
  - Development Board
  - SDK & documentation
  - Visual Studio 2005

- Availability…
  - Beta by end of 2004
  - 3rd party manufacturer
SPOT – .NET on a chip

http://www.dotcorporate.com/
Embedded OSs at Microsoft

**Common:**
- 32bit processors
- High capability compared to microcontrollers
- Visual Studio .NET
- Massive COTS ecosystem

**XP Embedded**

**CE**

**SPOT (.NET CPU)**

Coming Soon!
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Sensor Networks

(See Feng Zhao’s Faculty Summit Presentation)
A new class of computing platforms

Gordon Bell’s Law: Technology advances enable a new, lower-priced, higher-volume computing platform or class to form every decade.
Three application classes

Monitoring activity:
- E.g., parking garage, roadway traffic
- Spatio-temporal pattern

Monitoring space:
- E.g., habitat
- Occupancy, condition

Monitoring objects:
- E.g., asset tracking
- Location, ID, property
Blurring the boundary between digital & physical worlds

Characteristics:
- Heterogeneous devices
- Disparate capabilities
- Physically embedded (energy, size, noise, real-time events, …)
- Dynamic topology
- Large scale
- Inherent uncertainties (in systems and environment)
- Concurrent user queries

Desired properties:
- Easy to program, deploy, and manage
- Robust to failure
- Responsive
- Re-taskable
- Scalable
- Secure
Programming Sensor Net: Finding the happy median

### Internet
- View the net as a collection of data
- User interacts with it by sending queries
- Little control over where computation is done
- View it as a collection of services
- Explicitly program services and provide runtime adaptation to changes and failures
- Be more resource aware and efficient

### Sensornet
- View it as a collection of services
- View it as a collection of programs
- Explicitly specify where computation is done
- Be more resource aware and efficient

---

**Internet**
- http/Web
- Web services
- Sockets/streams

**Sensornet**
- Database view
- Signal processing view
- ?
Blurring the boundary between the digital and physical worlds

What we are doing @MSR:

Connect sensor networks with PC ecosystems
- Make sensors visible to PCs and physical information available to people 24/7
- Bring services (e.g., web services) to small devices

Develop platform and tools for networks of embedded devices
- Deal with uncertainties in both systems and environments
- Moving from “building unreliable systems from reliable parts” to “building reliable systems from unreliable parts”

http://research.microsoft.com/nec
http://research.microsoft.com/invisible
Robotics

(See RoboNexus Presentation)
Robotics at Microsoft

- A perennial hot area of embedded systems
- Robots are increasingly used as teaching tools
- Robots are engaging and gender-equalizing

Our Robot Platforms initiative aims to achieve a far better robot experience for educators leveraging Windows and .NET

Our Robotics Curriculum initiative aims to encourage the teaching of computer science, engineering and other disciplines through the excitement of robotics
What’s a platform?
PC vs. Robot

<table>
<thead>
<tr>
<th>Modern PC</th>
<th>Modern Robot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td></td>
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<tr>
<td>SDK</td>
<td></td>
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<tr>
<td>Windows + CLR</td>
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<tr>
<td>CPU</td>
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<tr>
<td>Hardware</td>
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<tr>
<td>Application(s)</td>
<td></td>
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<tr>
<td>Robot SDK</td>
<td></td>
</tr>
<tr>
<td>Windows + CLR</td>
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<tr>
<td>CPU</td>
<td></td>
</tr>
<tr>
<td>Mechatronics</td>
<td></td>
</tr>
</tbody>
</table>
Robotics Examples

- Brown
- UPenn
- Cornell (3)
- Georgia Tech
- Humboldt
- Potsdam
- Rome
- Pisa
For much more information

- [Donald Thompson](http://research.microsoft.com/~stansley) - Implementing The CLR for Smart Personal Objects
- [Feng Zhao](http://research.microsoft.com/~stansley) - Wireless Sensor Networks: Seamless computing across the physical and PC worlds
- [Johannes Helander](http://research.microsoft.com/~stansley) - XML Web Services for Invisible Computing
Resources

Join the Windows Embedded Academic Program (WEMAP)
- Send mail to wemap@microsoft.com or visit us online at:
  http://www.microsoft.com/windows/embedded/academic

Look for our special academic community initiatives
- http://www.microsoft.com/windows/embedded/community
- Existing thriving community activities: newsgroups, mail lists, regular chats, webcasts…

Download or order the fully comprehensive evaluation kit (or get MSDNAA)
- http://msdn.microsoft.com/embedded/
- http://www.msdnaa.net

Extensive online documentation in the online help and MSDN, plus source code

Microsoft Research University Relations – Embedded Systems
- http://research.microsoft.com/ur/us/embsys/ - update imminent to form a portal
- Academic case studies to be posted

For students:
- http://www.imaginecup.net