# An Overview of Embedded Systems at Microsoft

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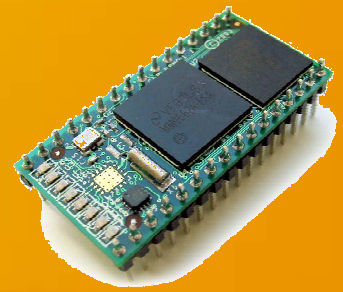

Microsoft Windows Embedded

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Microsoft® Research

# 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

Web Services

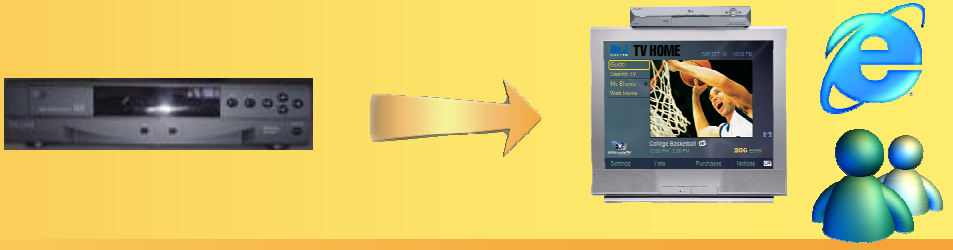
Consumer Electronics

Mobile devices

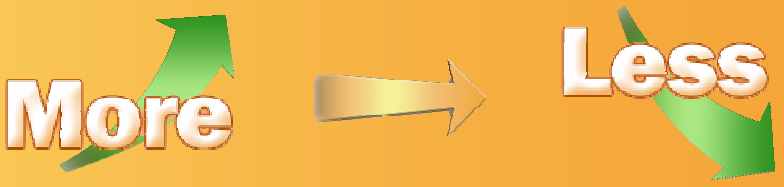
Appliances, screens

# The Device Landscape

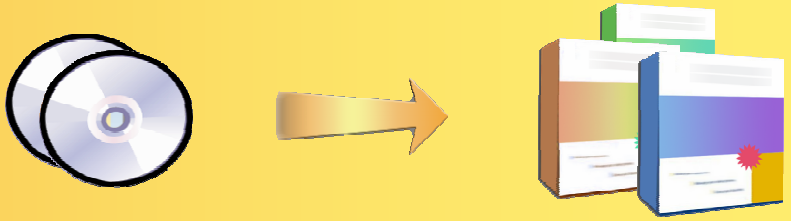
Fixed function to multi-function devices



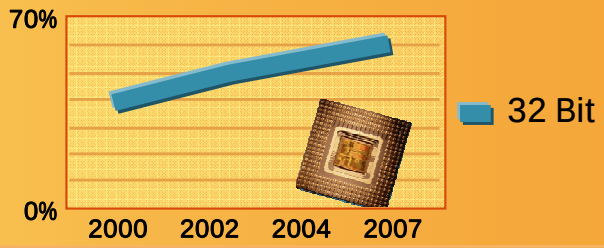

Pressure to do more, with less




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

# Mobile and Embedded Devices

Windows Mobile Smartphone

Windows Mobile Pocket PC Phone

Retail Point-of-Sale

Tablet PC

Windows Automotive

Windows-based Terminals

Medical Devices

Notebook PC

Portable Media Center

VoIP Phones

Mobile Handhelds

Smart Personal Objects

Gateways

Set-top Boxes

Entertainment Devices

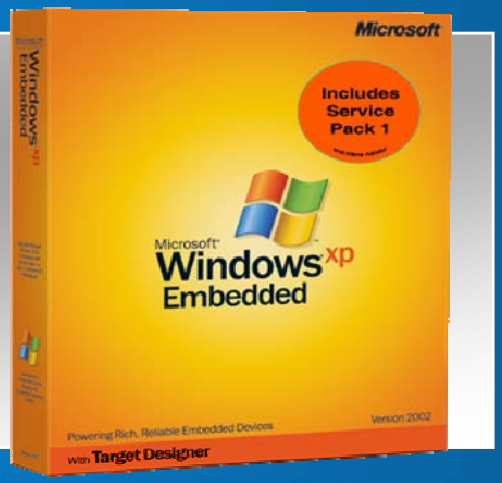
.NET Technology | Windows CE | Windows XP Embedded | Windows XP

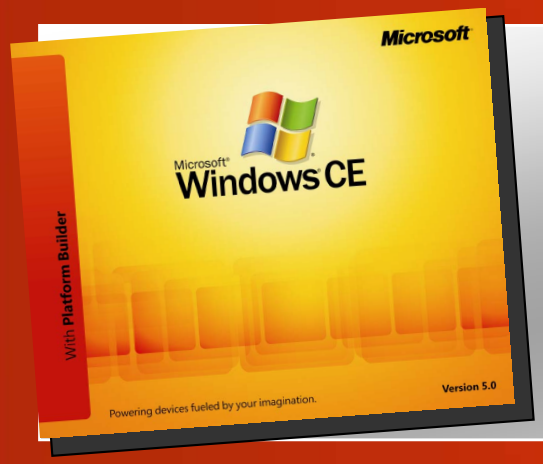
Increasing Functionality

# Windows Embedded Platforms

## Windows XP Embedded

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



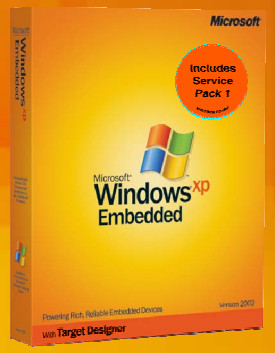




## Windows CE

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



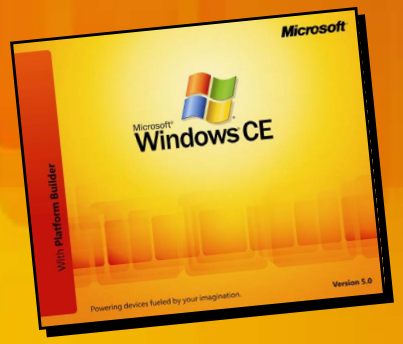

- Componentized version of XP Professional -- brings the full power of Windows to advanced devices
  - Over 10,000 components to flexibly build a customized device
  - Embedded-specific features enable wide range of boot, storage, deployment, and manageability options
- Rapid development
  - Powerful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

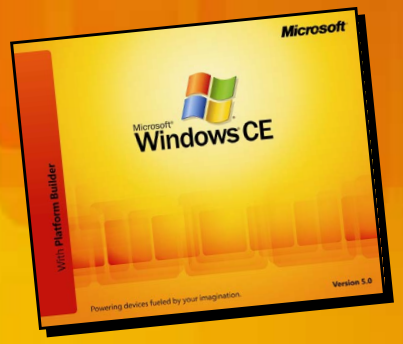
- Enhanced security
  - Windows Firewall component
    - Configurable in Target Designer
  - Hardened Internet Explorer
- New platform technologies supported
  - Bluetooth stack and profile
  - Software Update Service (SUS)
- Other features coming in SP2
  - DirectX9 subsystem APIs
  - .NET Framework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

| Microsoft Windows XP Embedded | | Microsoft Windows CE |
|---|---|---|
| x86 processors | **Processor Support** | Multiple processors |
| Full Win32 API compatibility | **Win32 API Compatibility** | Requires additional effort |
| Basic images from 8MB | **Footprint** | Basic images from 350 KB |
| With 3rd party extensions | **Real-time** | Native |

# Choosing a Device Platform

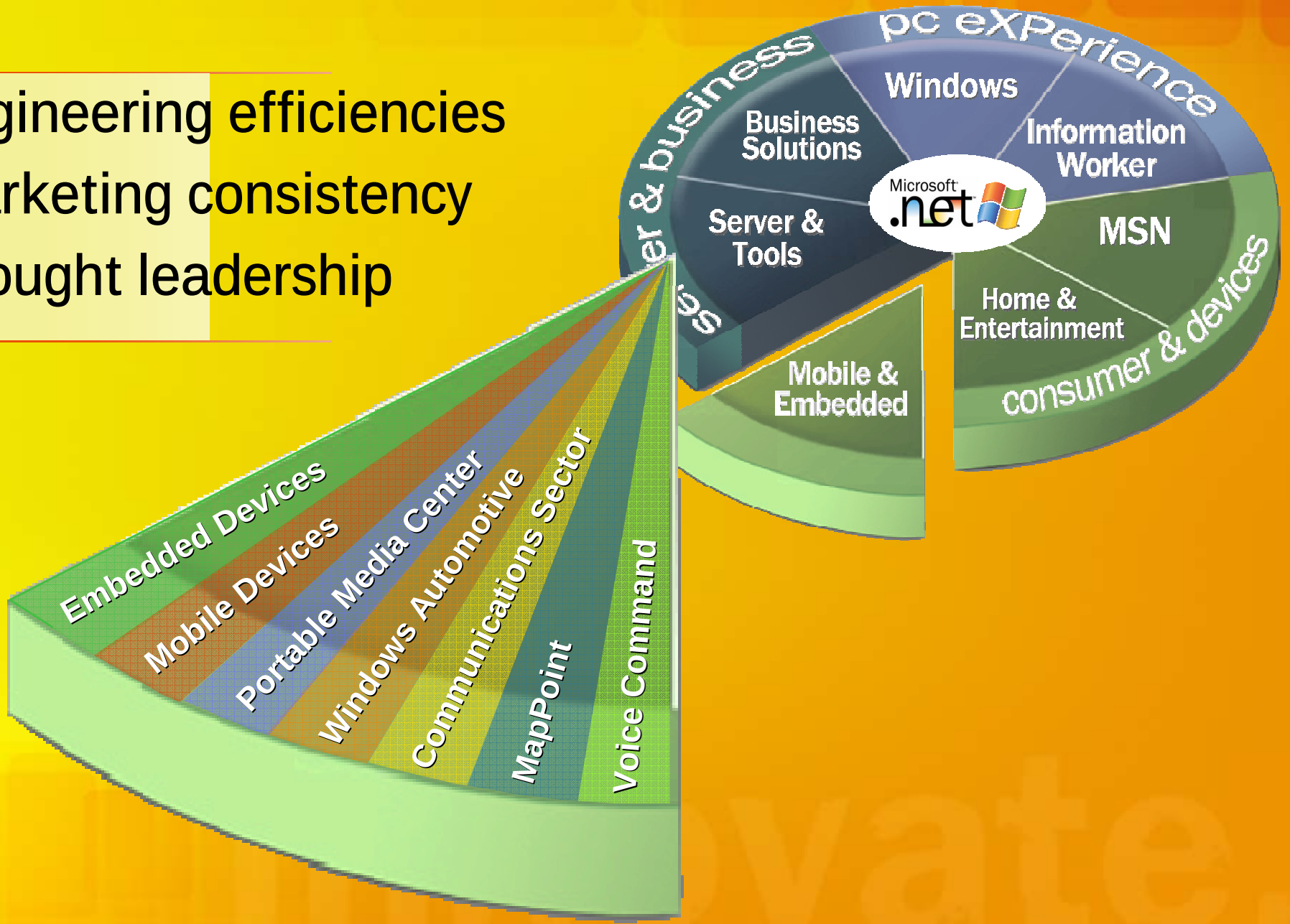
- Retail POS
- ATM
- Advanced STB
- LOB Thin Clients
- Test and Measurement
- Kiosk
- Home Media Gateway
- Medical Systems

- 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

| Automaker | Model |
|---|---|
| BMW | 7 Series |
| Citroen | C5, Xara |
| DaimlerChrysler | S-Class |
| Fiat | Lancia Thesis |
| Honda | Accord |
| Mitsubishi | Airtek, Lancer, Grandis, Dingo |
| Subaru | Lancaster |
| Toyota | Will-CYPHA (G-Book) |
| Volvo | S60, S80, V70, XC |
| Aftermarket | Clarion Joyride, CADIAS |
| Aftermarket | Hyundai ExRide |
| Aftermarket | NexTech Carman-i |

# Portable Media Center (CE 5.0)

*Your entertainment experience where and when you want it.*

| | |
|---|---|
| **TV** | Latest shows sync<br>Faithful to MCE exp.<br>Presets for favorites |
| **Music** | Over 10,000 songs<br>Rich nav, Album Art<br>Highest quality |
| **Music Videos** | New portable experience<br><br>Napster, EMI, others |
| **Home Videos** | Take your MovieMaker Movies with you<br>Over 80 hours video |
| **Movies** | Over 45 movies<br>Rent or own digital copy<br>CinemaNow, others |
| **Pictures** | Over 100,000 pictures<br>"TV out" for display<br>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 !

wecom
Windows Embedded community

WE-DIG

STANFORD UNIVERSITY

WindowsForDevices.com
. . . your Windows® Embedded community

UCIrvine
University of California, Irvine

LANCASTER UNIVERSITY

msdn

DEVBUZZ.COM
Handheld development!

JAMES MADISON UNIVERSITY

University of Nebraska Lincoln

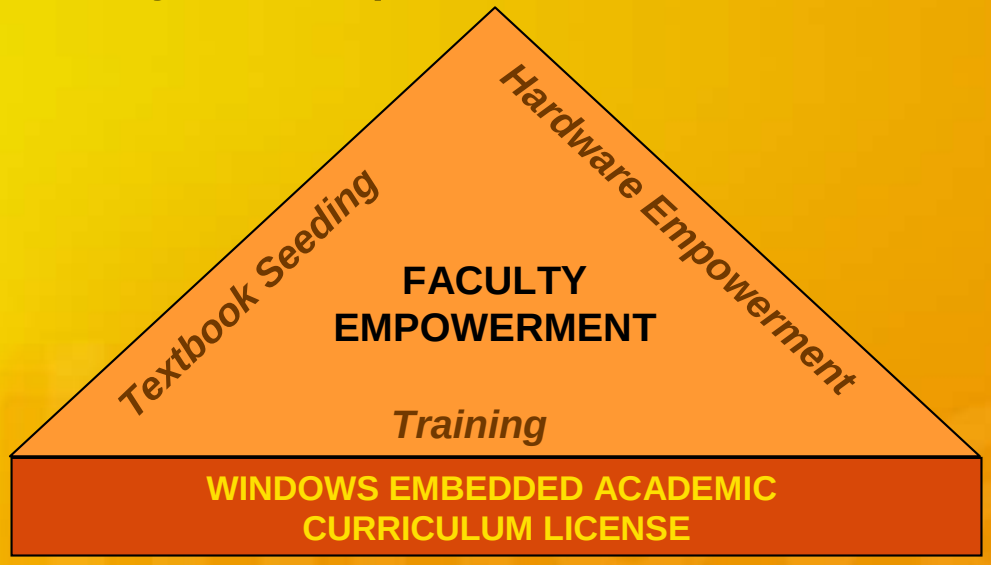
# Customers Make It Happen

## 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

## Extra-Curricular

**Licenses:**

>400 Curriculum Licenses worldwide

**Training:**

Academic Devcon Redmond
TTT, Bangalore
Crash Courses – Cape Town, Maastricht
India WEE, Bangalore, Cambridge

**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

**Reference Books:**

>125 Schools Worldwide

**HEP:**

Over 30 schools engaged
11 Partners worldwide

**Research:**

77 Embedded RFP Projects Worldwide

**Students**

1st Windows ChallengE:

29 Teams
120 Students
25 Professors

# Mobile and Embedded Roadmap

## Today

Windows Mobile 2003 2nd Edition

Pocket PC, Smartphone

Microsoft Windows CE 5.0

Microsoft Windows XP Embedded

Service Pack 1

Service Pack 2

Microsoft Visual Studio .net

## 2005+

"Magneto"

"Next Major Version of Windows CE"

Microsoft Windows

Code Name Longhorn

Embedded

Microsoft 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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  - SPOT (Smart Personal ObjecTs)
- Embedded Systems Research
  - Sensor Networks
  - Robotics

# 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*

# Projects Per Country

- Argentina 1
- Australia 2
- Belgium 1
- Brazil 1
- Bulgaria 1
- Canada 3
- Chile 1
- China 1
- Czech Rep 1
- France 5
- Germany 9
- Hungary 1
- India 4
- Israel 2
- Italy 4
- Korea 1
- Lebanon 1
- Portugal 1
- Singapore 1
- South Africa 2
- Spain 3
- Sweden 1
- Switzerland 1
- Taiwan 5
- UK 8
- USA 17

# 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

# GetEmbedded.net

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# SPOT (Smart Personal Objects)

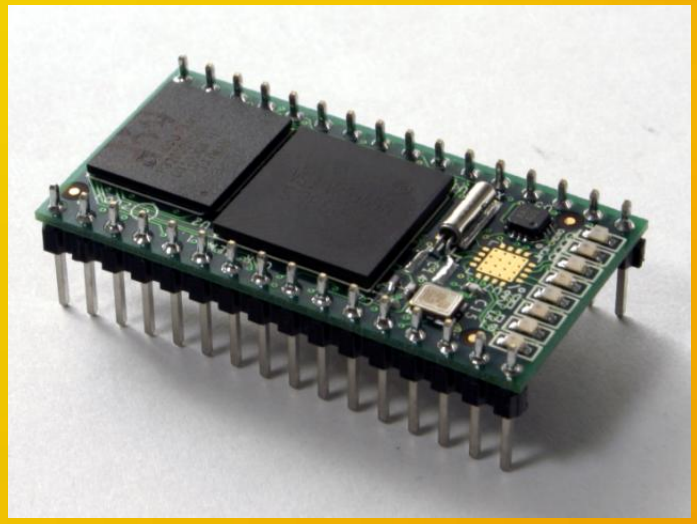
- A new service platform: MSN Direct Watch
- A new embedded platform

- 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

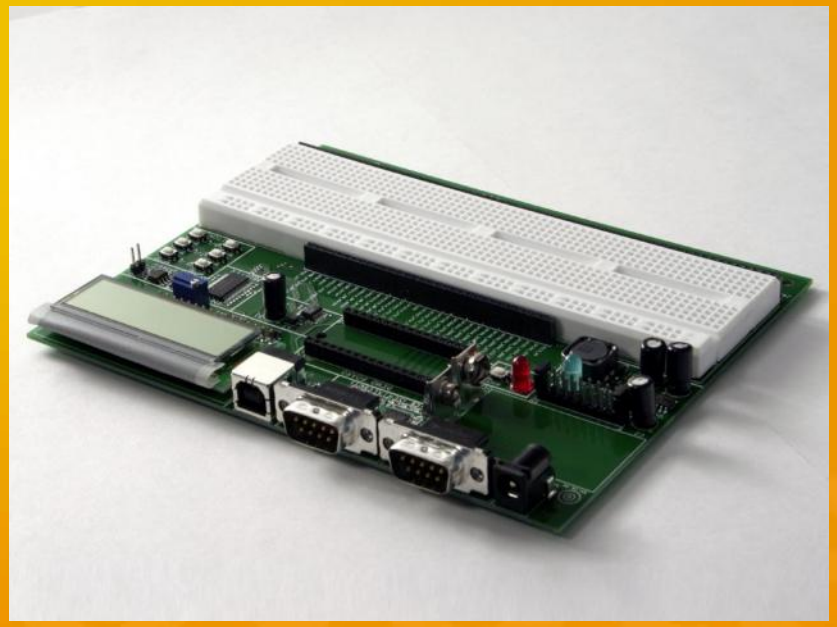
- The client platform core is generic – low power, low cost, low footprint, high capability, secure
- For more info on the watch:
  - http://www.microsoft.com/spot

# SPOT Development Kit

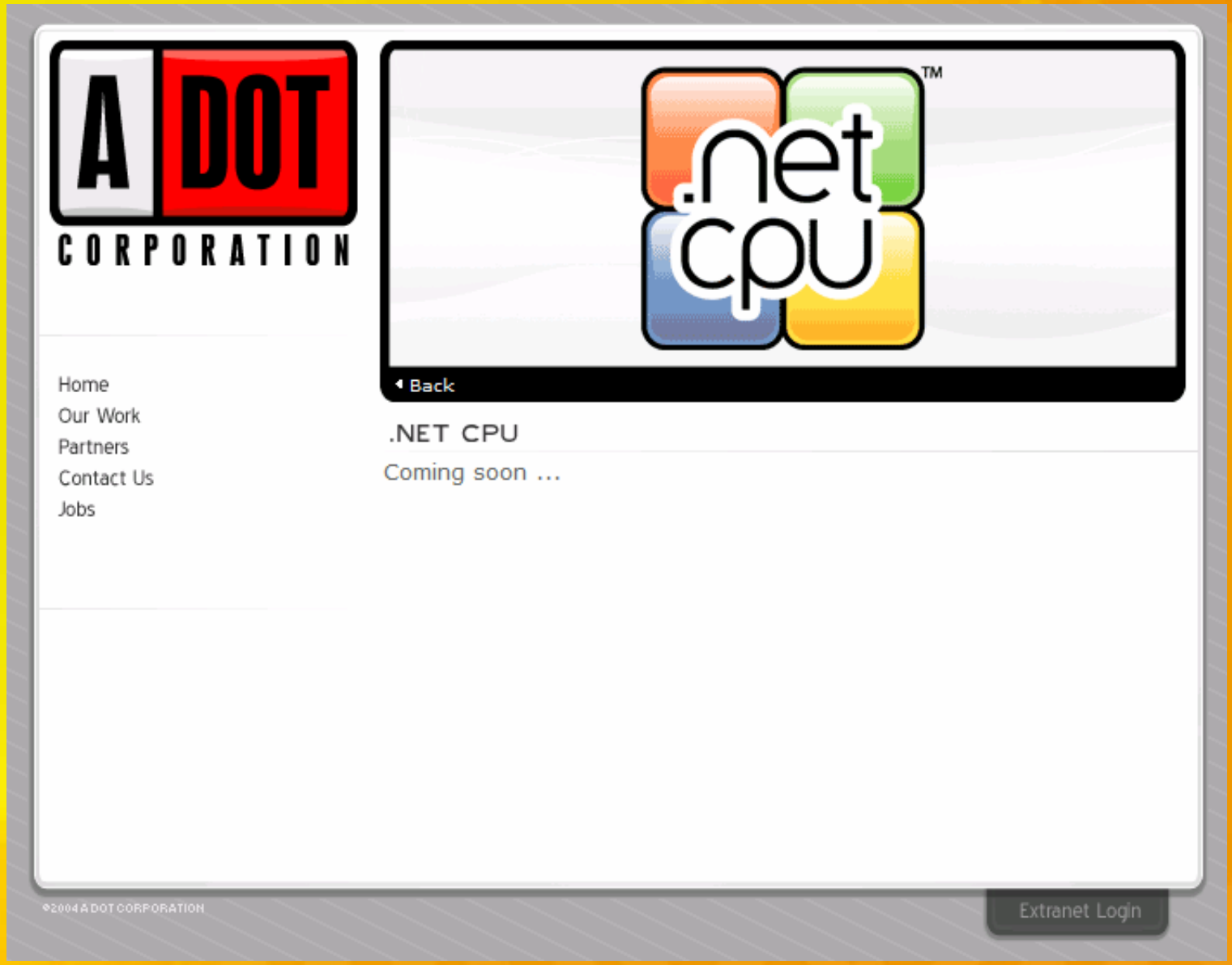
- Full kit contains:
  - “Stamp”
  - Development Board
  - SDK & documentation
  - Visual Studio 2005



- Availability...
  - Beta by end of 2004
  - 3rd party manufacturer



# SPOT – .NET on a chip




http://www.dotcorporate.com/

# Embedded OSs at Microsoft

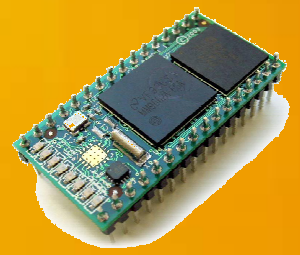
**Common:**

Microsoft .net

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

**SPOT**
**(.NET CPU)**

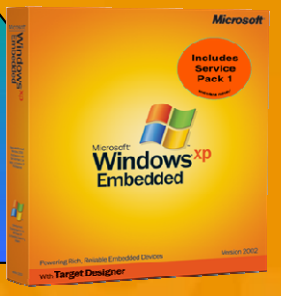
Coming Soon!



**CE**

Hard Real Time

**XP Embedded**



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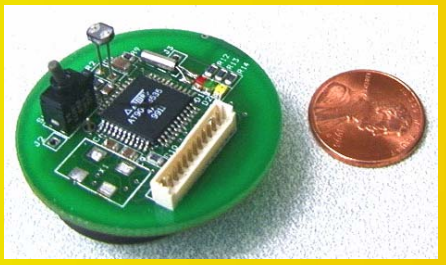
# Sensor Networks

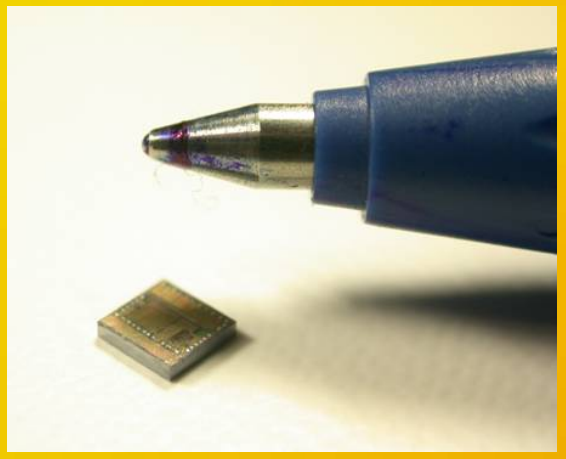
- (See Feng Zhao’s Faculty Summit Presentation)

# 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.



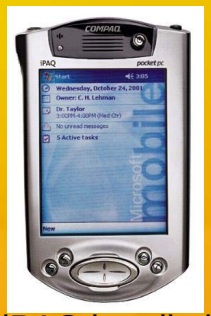
Berkeley WeC mote



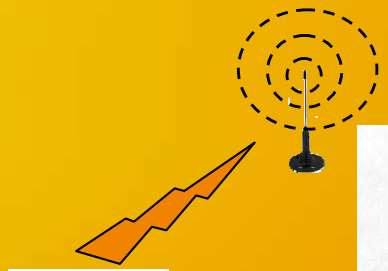
Berkeley Spec mote

Hitachi
mu-chip RFID

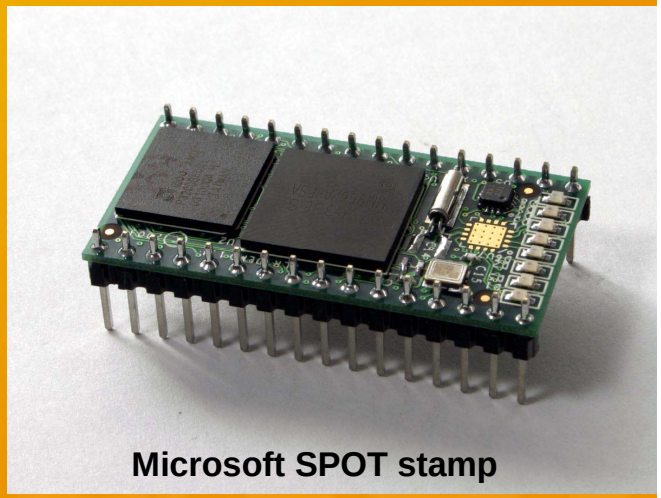
Sensoria WINS NG 2.0



iPAQ handheld

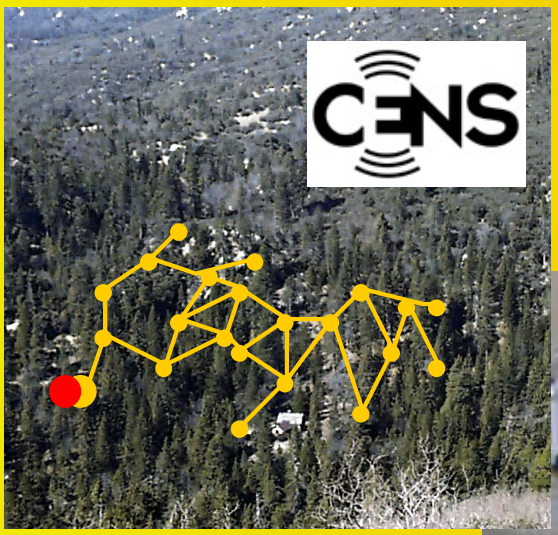


SPOT watch



**Microsoft SPOT stamp**

# Three application classes




Monitoring space:

- E.g., habitat
- Occupancy, condition

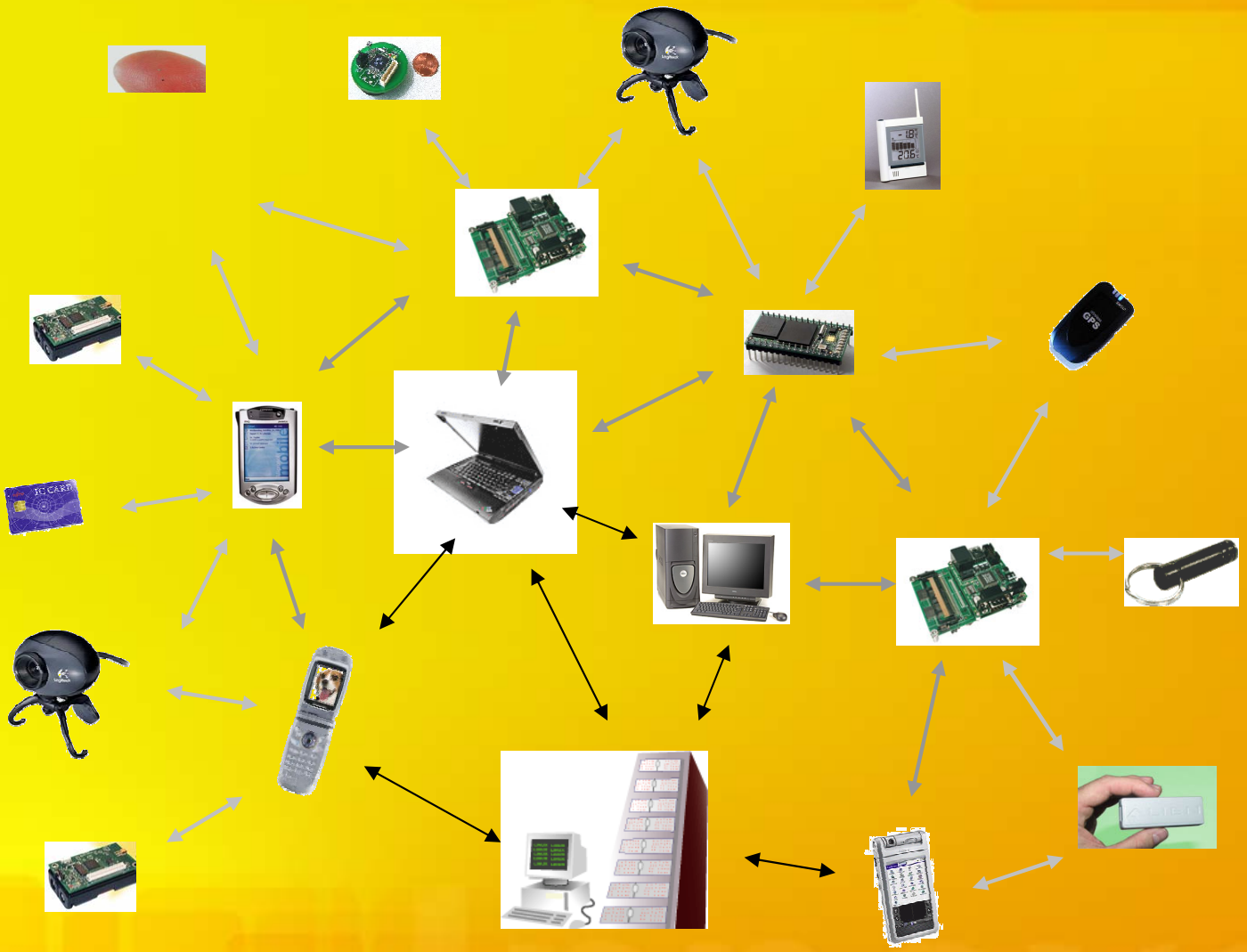
Monitoring activity:

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

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

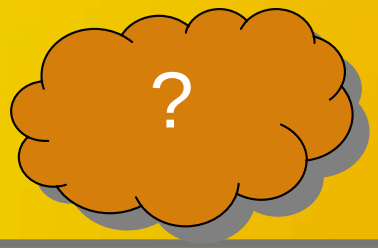
**Internet**

http/Web

Sockets/
streams

**Sensornet**

Database
view




Signal
processing
view

- 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 run-time adaptation to changes and failures
- Be more resource aware and efficient

- View it as a collection of programs
- Explicitly specify where computation is done
- May scale poorly

# 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

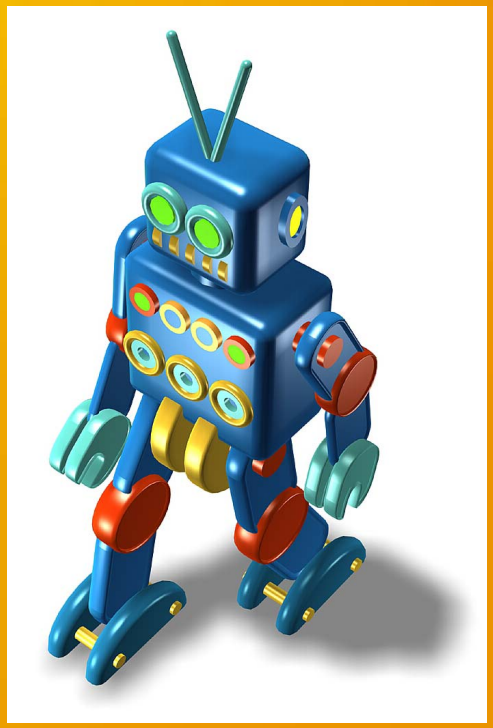
- A perennial hot area of embedded systems
- Robots are increasingly used as teaching tools
- Robots are engaging and gender-equalizing

- 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

| Applications | Application(s) |
|---|---|
| SDK | Robot SDK |
| Windows + CLR | Windows + CLR |
| CPU | CPU |
| Hardware | Mechatronics |
| **Modern PC** | **Modern Robot** |



# Robotics Examples

- Brown
- UPenn
- Cornell (3)
- Georgia Tech
- Humbolt
- Potsdam
- Rome
- Pisa

# For much more information

- http://research.microsoft.com/~stansley
- Donald Thompson
  - Implementing The CLR for Smart Personal Objects
- Feng Zhao
  - Wireless Sensor Networks- Seamless computing across the physical and PC worlds
- Johannes Helander
  - 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
  - http://research.microsoft.com/collaboration/university/hep.aspx - discount hardware
  - 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

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