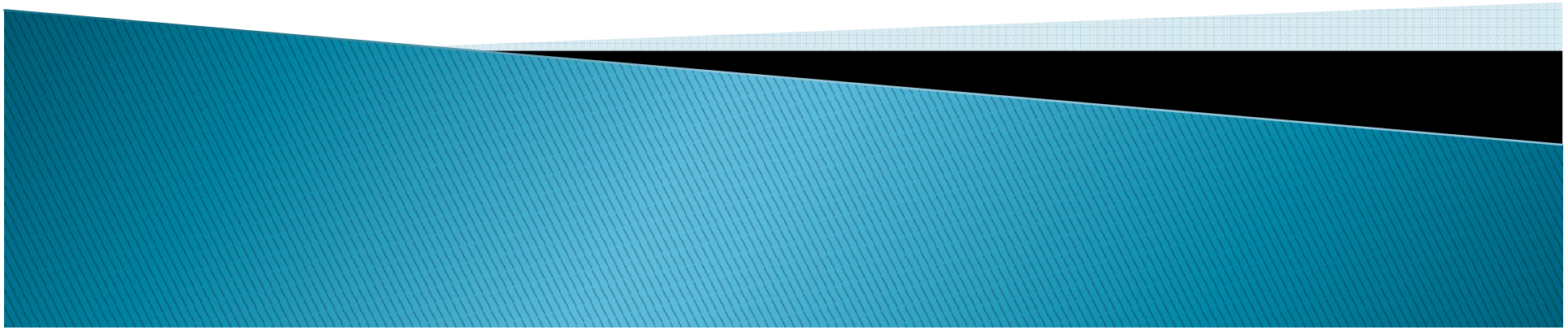
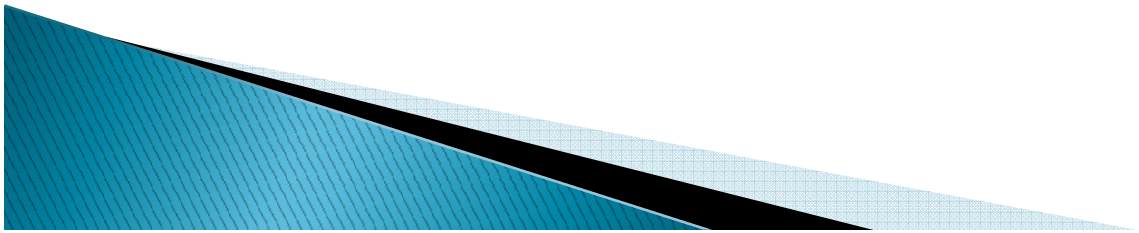
Windows CE Programming

Jeffrey Ting



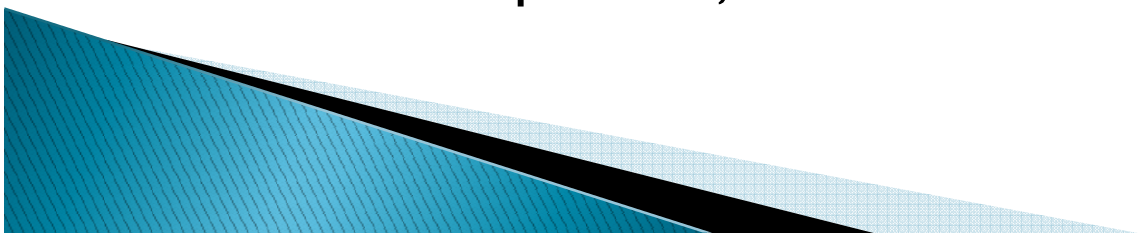
Windows CE History

- 1993
  - Microsoft “Windows At Work” modular platform for embedded devices: photocopiers, fax machines, telephones, printers, etc.
  - Microsoft WinPad Project: touchscreen, stylus, mobile, compact computing device.
- 1994
  - Projects merged into Project Pegasus.
  - 32-bit design.
  - RISC architecture.
  - Brand new operating system, similarity with Win32.



Windows CE History

- 1995 – Pegasus Reference Platform released:
  - Pocket form factor. Two AA batteries. <500g.
  - QWERTY keyboard.
  - LCD touch screen. 480x240 pixels. 4 greyscales.
  - Stylus.
  - Minimum of 4 MB ROM and 2 MB RAM.
  - Infrared port.
  - RS-232 Serial port.
  - PCMCIA slot.
  - Speaker.
  - Either SuperH 3, or MIPS 3000/4000 processors.

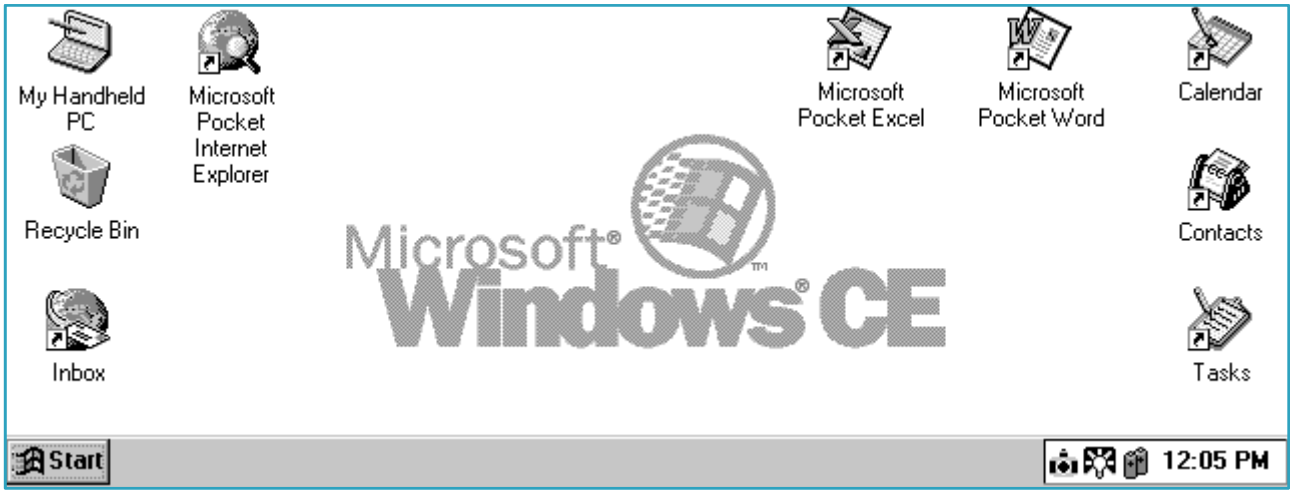


Windows CE 1.0

- 1996
  - Casio, Compaq, HP, LG Electronics, Hitachi, NEC, and Philips signed up to produce Windows CE 1.0 devices.
- 1997
  - Handheld PCs running Windows CE 1.0 became available.

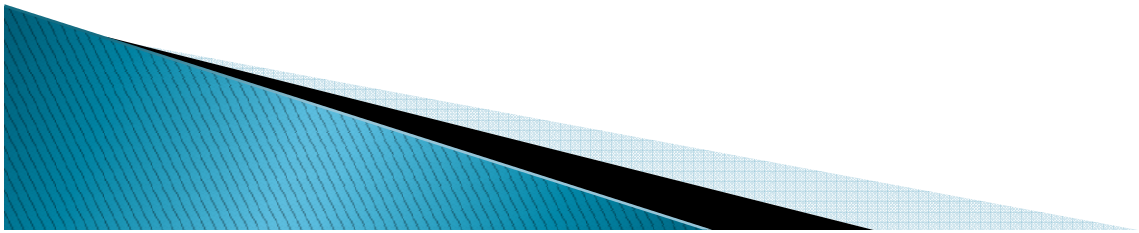
Windows CE 1.0

- Shipped with Pocket Internet Explorer, Pocket Excel, Pocket Word, Calendar, Contacts, and Tasks.
- Synchronized with desktop Office programs.
- Windows CE 1.0 Screen Shot:



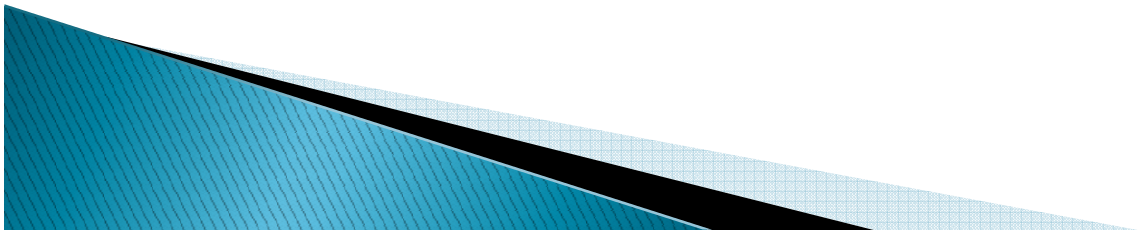
Windows CE 2.0

- Late 1997 – Windows CE 2.0 released.
  - Architecture changed from Handheld PC OS to modular embedded OS.
  - OEMs could choose which bits of Windows CE to include.
  - No more reference platform: Any shape, size or display.
  - Processors supported expanded to include: AMD Elan SC400, DEC SA1100, IBM PPC 4036C, Intel x86, Motorola PowerPC 82x, Philips DR 31500, Toshiba TX3912



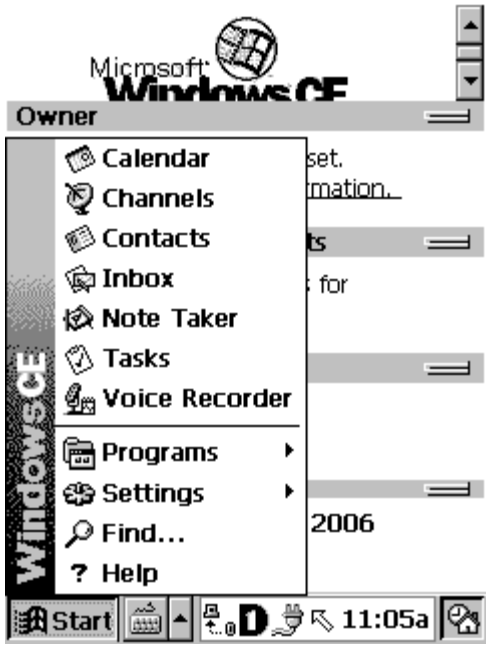
Windows CE 2.0

- 24-bit colour displays with True Type fonts.
- Windows CE 2.01 – Larger storage sizes. Palm-size PC form factor introduced – No keyboard, Greyscale display. No Pocket Office.
- Windows CE 2.10 – Networking enhancements. Multiple different file systems support. Larger storage size. Software Input Panel. USB support. External storage support.
- Windows CE 2.11 – Support for Asian languages. Palm-size PCs gained colour. Windows CE Services replace HPC Explorer on the desktop for synchronization.
- Windows CE 2.12 – Pocket Internet Explorer replaced by IE 4.01 SP2 browser.



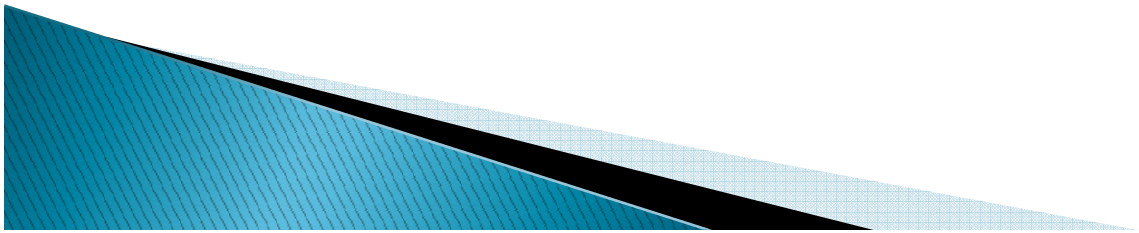
Windows CE 2.x

Windows CE 2.X Palm-size PC

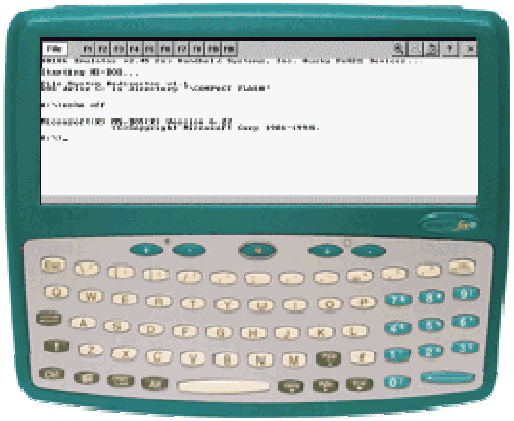


Windows CE 3.0

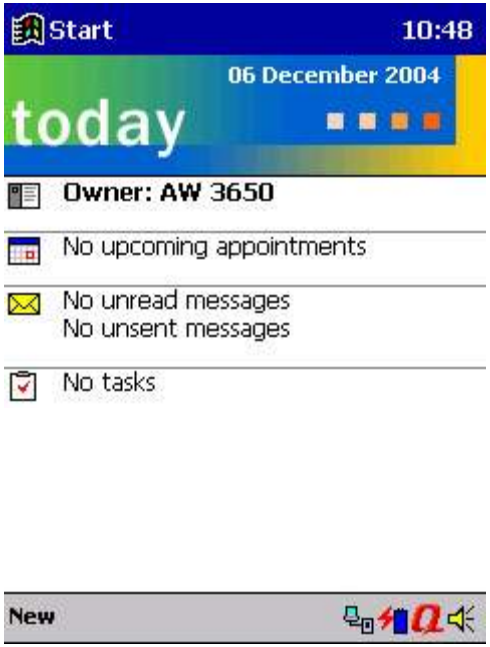
- 2000 – Palm-size PC become Pocket PC 2000.
  - Major UI changes.
  - Taskbar and Start button removed. 3D look removed.
  - Permanent menu bar across the top.
  - Pocket Office introduced in Pocket PC.
- Handheld PC form factor become HPC2000.
- Media Player and Remote Terminal Client software added.
- ActiveSync 3.0 desktop software introduced.
- Marketing mainly behind PPC2000 for consumers.
- HPC2000 being targeted at device manufacturers.
- HPC2000 for Automotive introduced.
- HPC2000 for Smartphone introduced in 2002.



Windows CE 3.0 – HPC2000

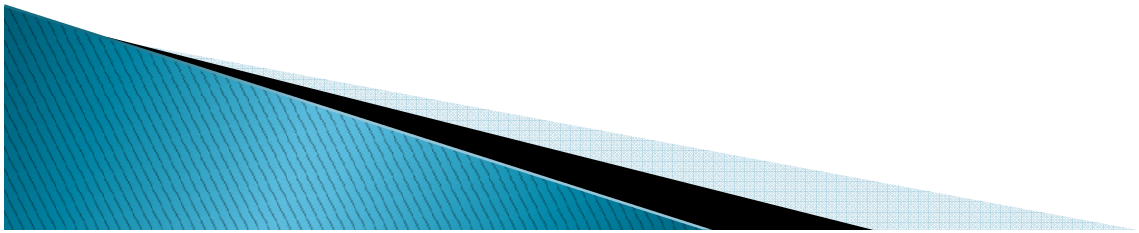


Windows CE 3.0 – PPC 2000



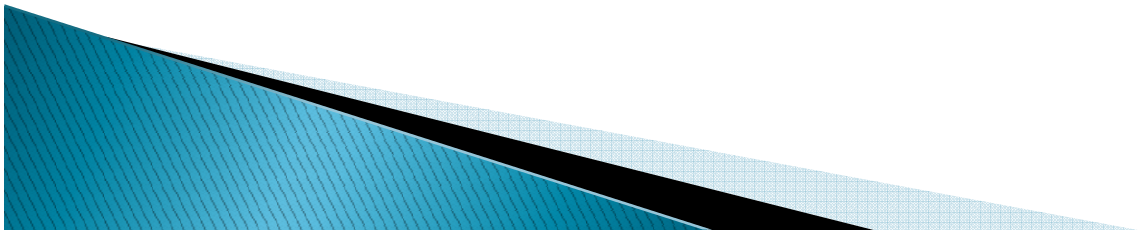
Windows CE 3.0 – PPC2002

- Introduce in Oct 2001 with additional support for Smartphones – phones without touchscreen
- Enhanced UI with theme support
- WAP in Pocket Internet Explorer
- Virtual Private Networking support
- Synchronization of folders
- MSN Messenger
- Windows Media Player 8 with streaming capability
- Microsoft Reader 2
- Palm OS beaming Compatibility



Windows CE 4.0 .Net

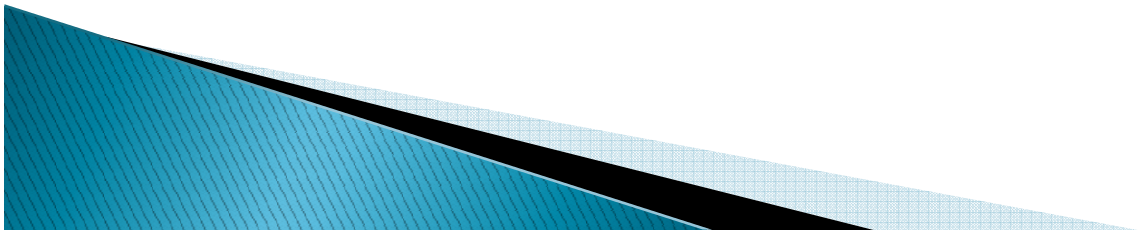
- 2002 – Released as Windows CE .Net
- Supports.Net Compact Framework
- Pocket PC2002 became Windows Mobile 2003
- Support for external keyboards
  - Enhanced Bluetooth support
  - Enhanced Pocket Outlook with vCard and vCal support
  - Windows Media Player 9.0 with streaming optimization
  - SMS reply options for Phone Edition
  - MIDI file support as ringtones in Phone Edition
- 2004 – Windows Mobile 2003 Second Edition
  - Portrait and Landscape switching for Pocket PCs
  - Single-Column layout in Pocket Internet Explorer
  - VGA (640×480), 240x240, and 480x480 Screen resolution
  - Wi-Fi Protected Access support



Windows CE 4.0 .Net

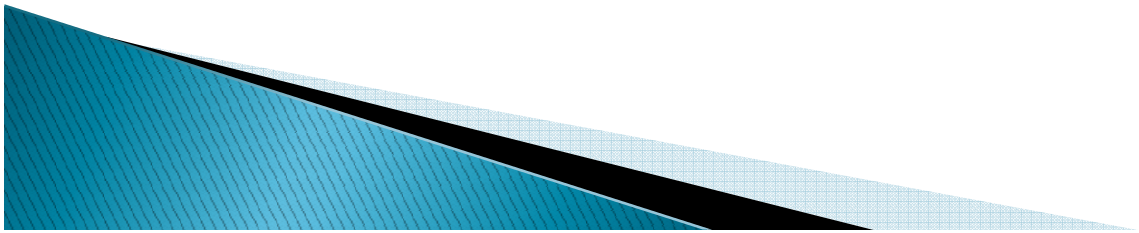
Windows Mobile 5.0

- Released 2005. Support .NET Compact Framework 1.0 SP2
- Powered by Windows CE 5.0
- Supports Microsoft Exchange Server "push“ with DirectPush.
- New version of Office called "Office Mobile"
- PowerPoint Mobile
- Graphing capability in Excel Mobile
- Tables and graphics insertion in Word Mobile
- Windows Media Player 10 Mobile
- Photo Caller ID
- DirectShow support
- Global Positioning System (GPS) management interface
- Persistent storage (PS) support in Pocket PCs



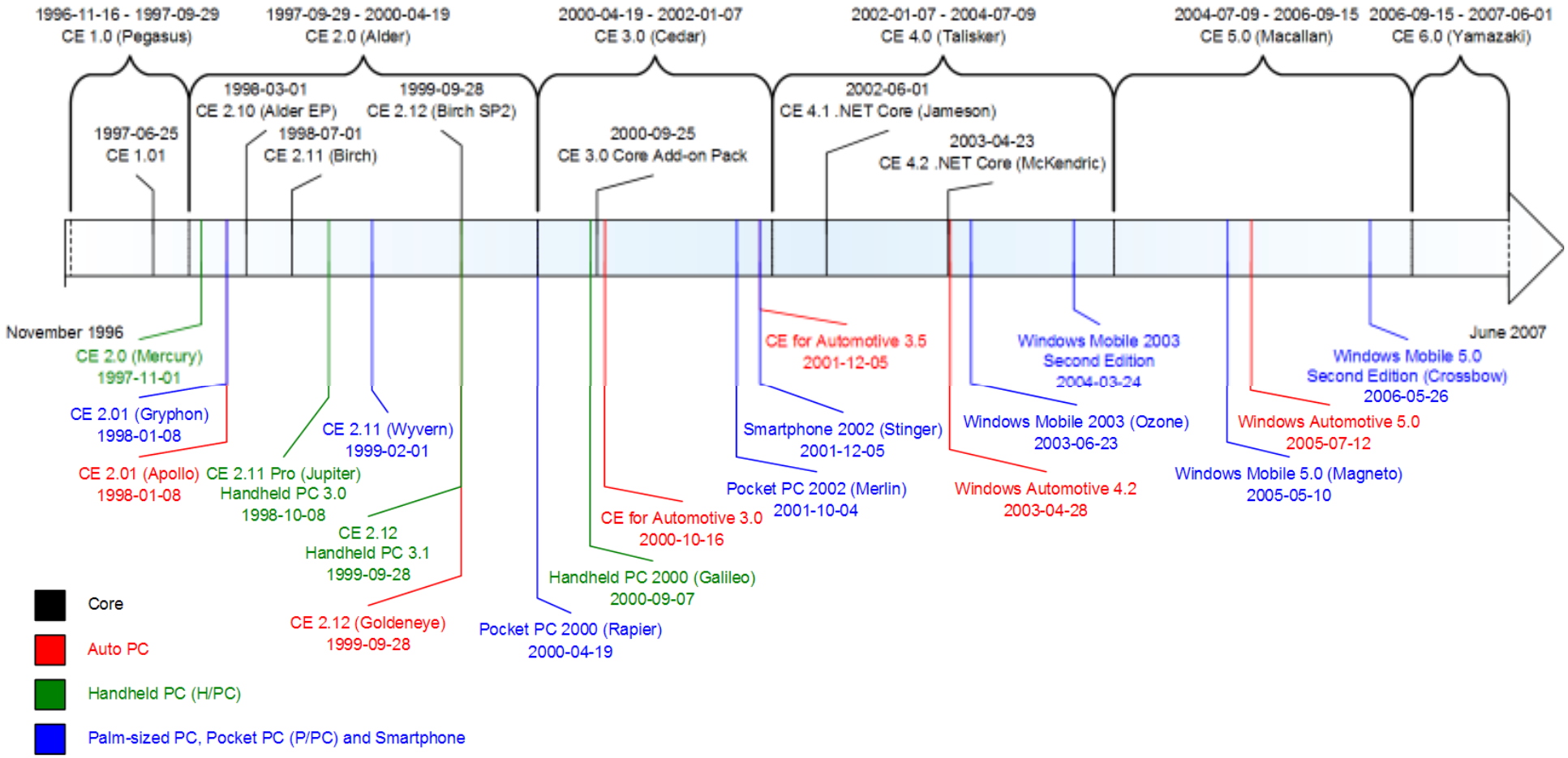
Windows Mobile 6.0

- Released on February 2007 as "Windows Mobile 6 Standard" for Smartphones, "Windows Mobile 6 Professional" for Pocket PCs with phone functionality, and "Windows Mobile 6 Classic" for Pocket PCs without phones
- Powered by Windows CE 5.2
- 320x320 and 800x480 (WVGA) screen resolution support
- Operating System Live Update
- VoIP support
- Windows Live
- Storage Card Encryption
- Internet Sharing
- HTML email support in Outlook Mobile
- AJAX, JavaScript, and XMLDOM support on Internet Explorer Mobile
- .NET Compact Framework v2 SP2
- Microsoft SQL Server 2005 Compact Edition
- OneNote Mobile
- Office Mobile 6.1 support for Office 2007 document formats

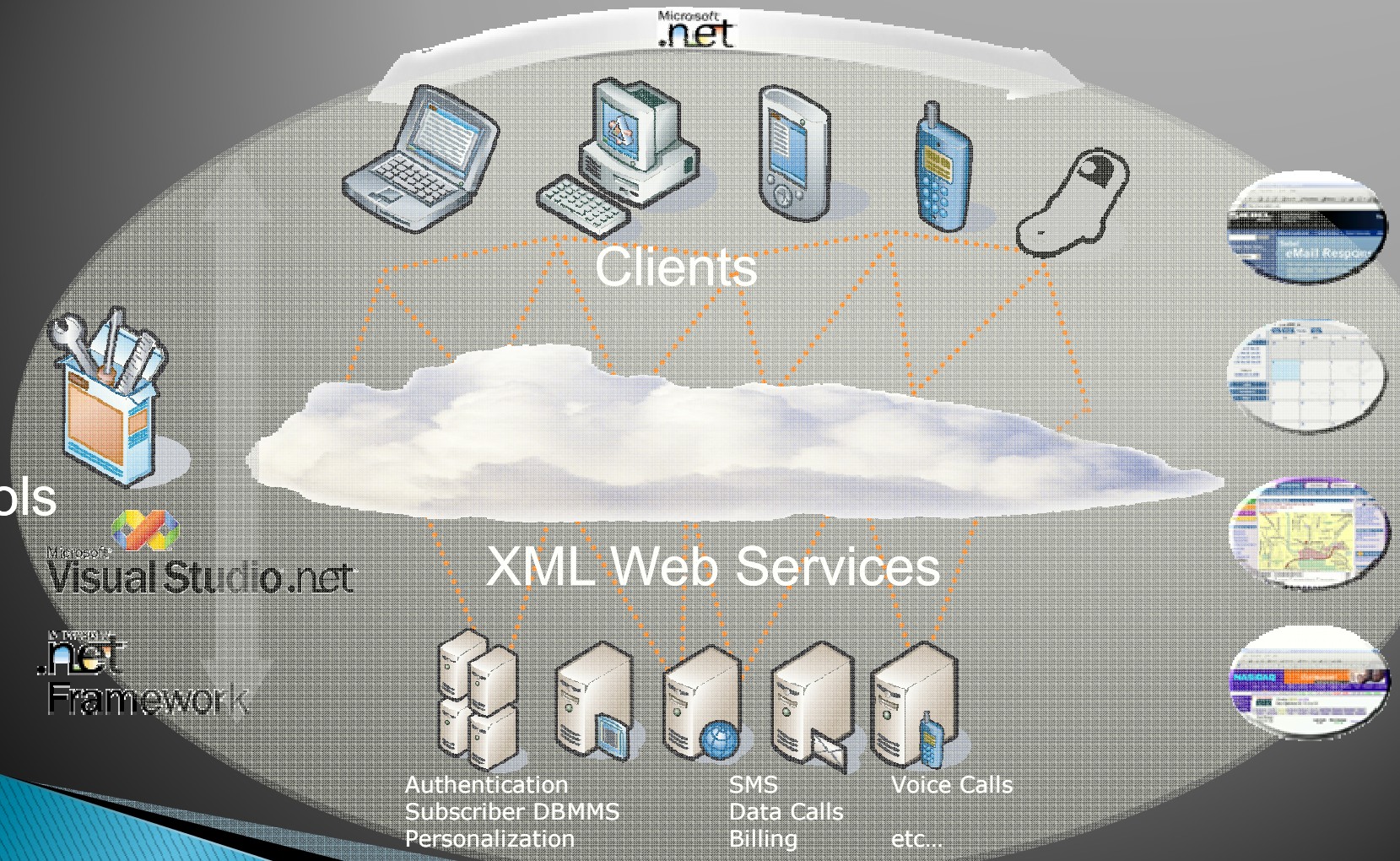


Windows CE Timeline

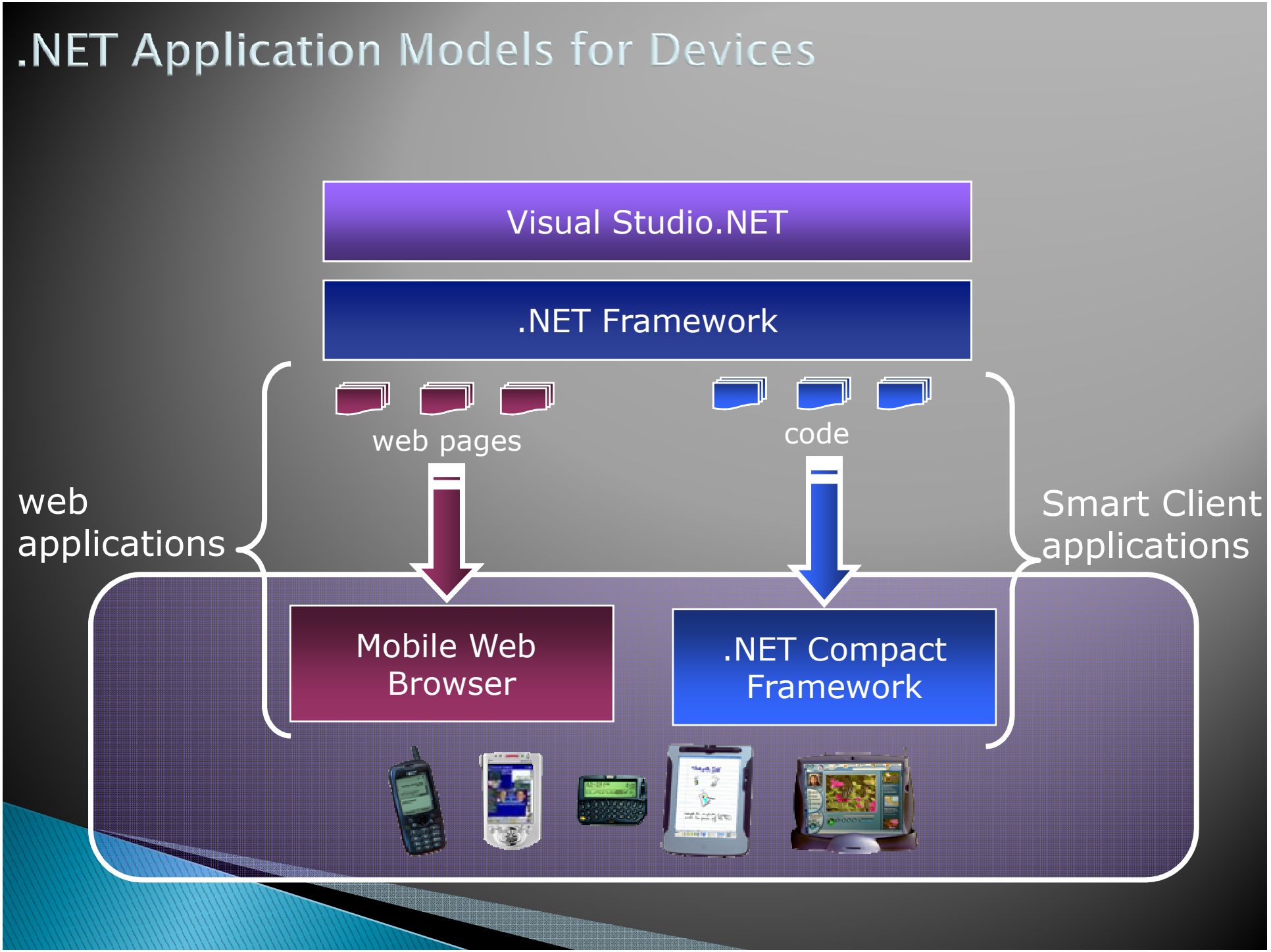
Source: "A Brief History of Windows CE" (http://www.hpcfactor.com/support/windowsce/), *HPC:Factor*, retrieved May 21, 2007



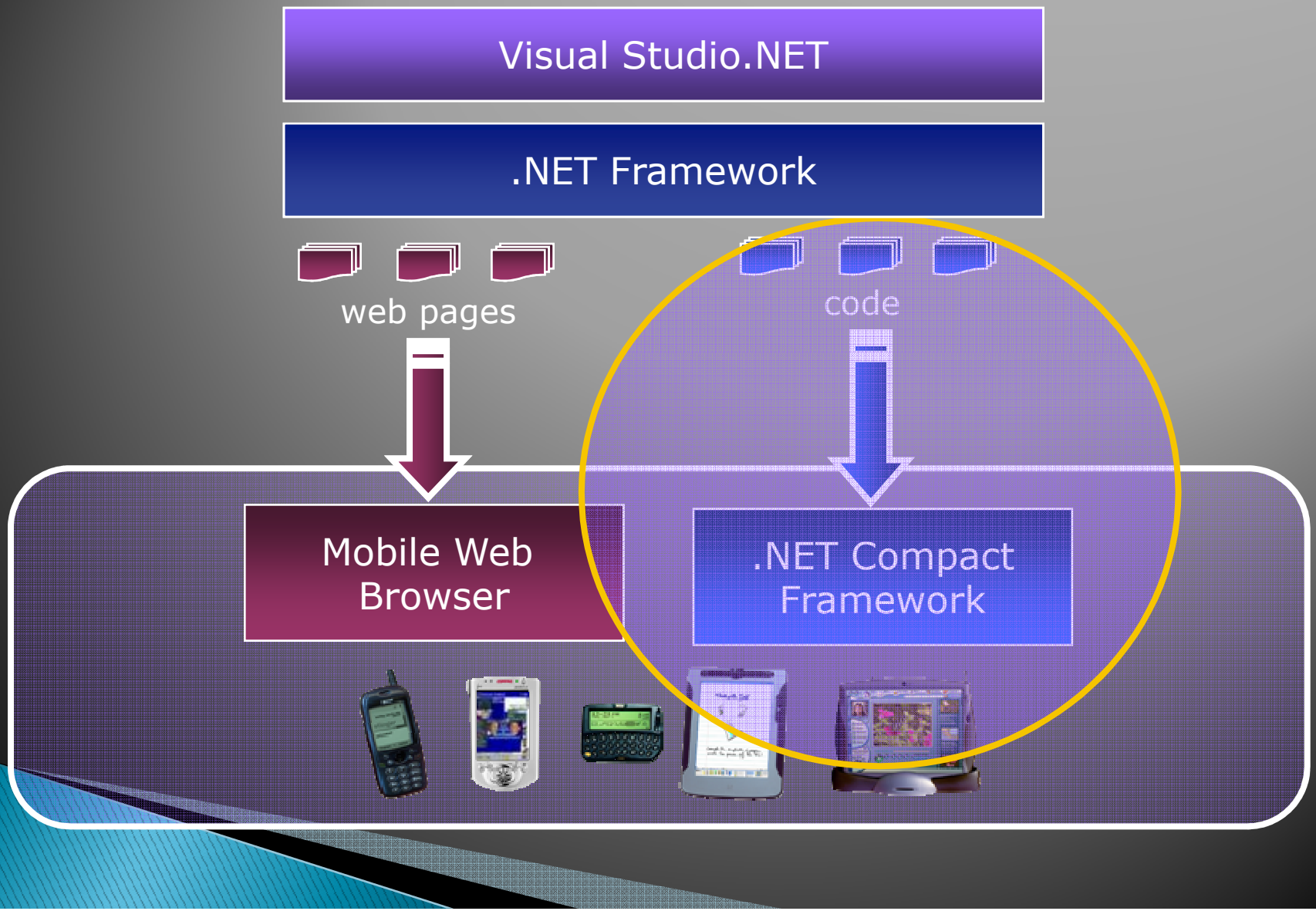
The Mobile Device Universe



.NET Application Models for Devices

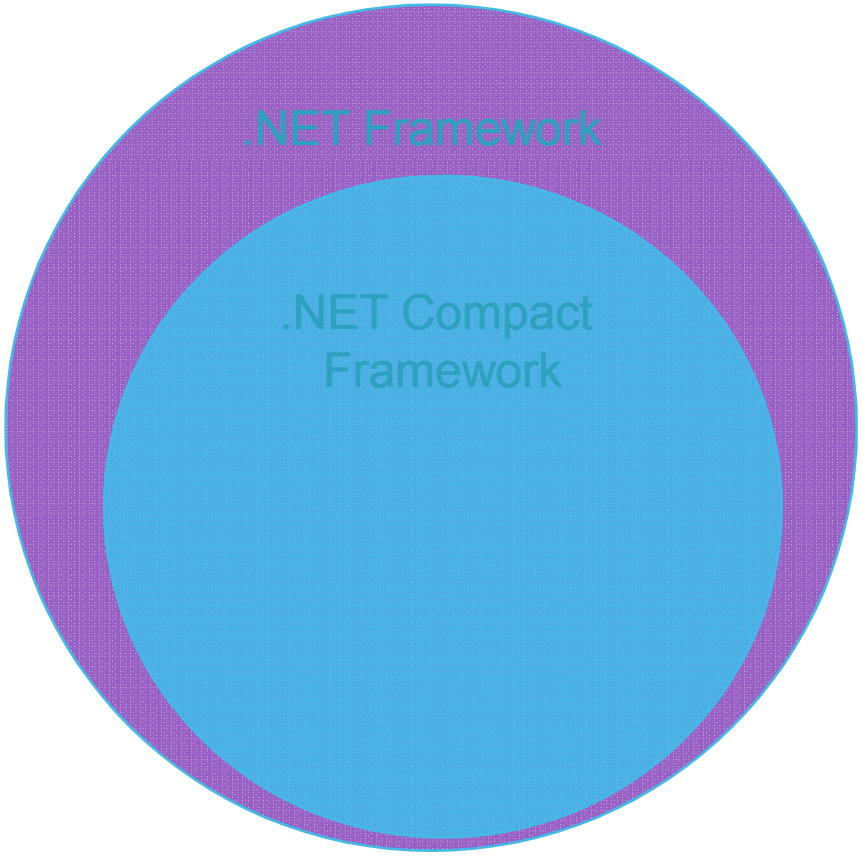


Smart Client Applications



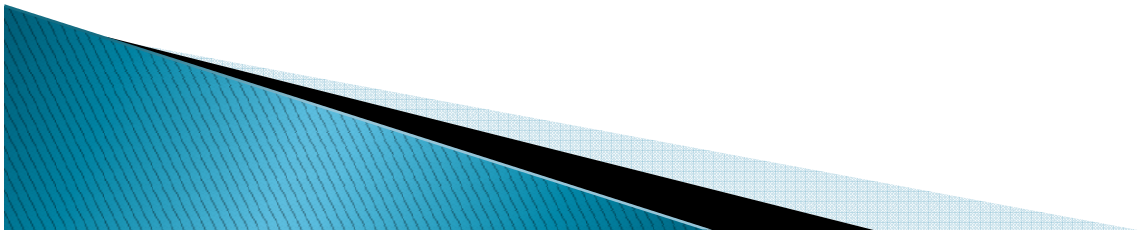
.Net Compact Framework Goals

- Compatibility
  - Strict compatibility with .NET Framework
  - Subset functionality
- Subsetting for devices
  - Give the developer a known target
  - Enable skills and code transfer
  - Size/functionality
    - Reduce OEM cost
    - Provide critical mass needed for “real apps”

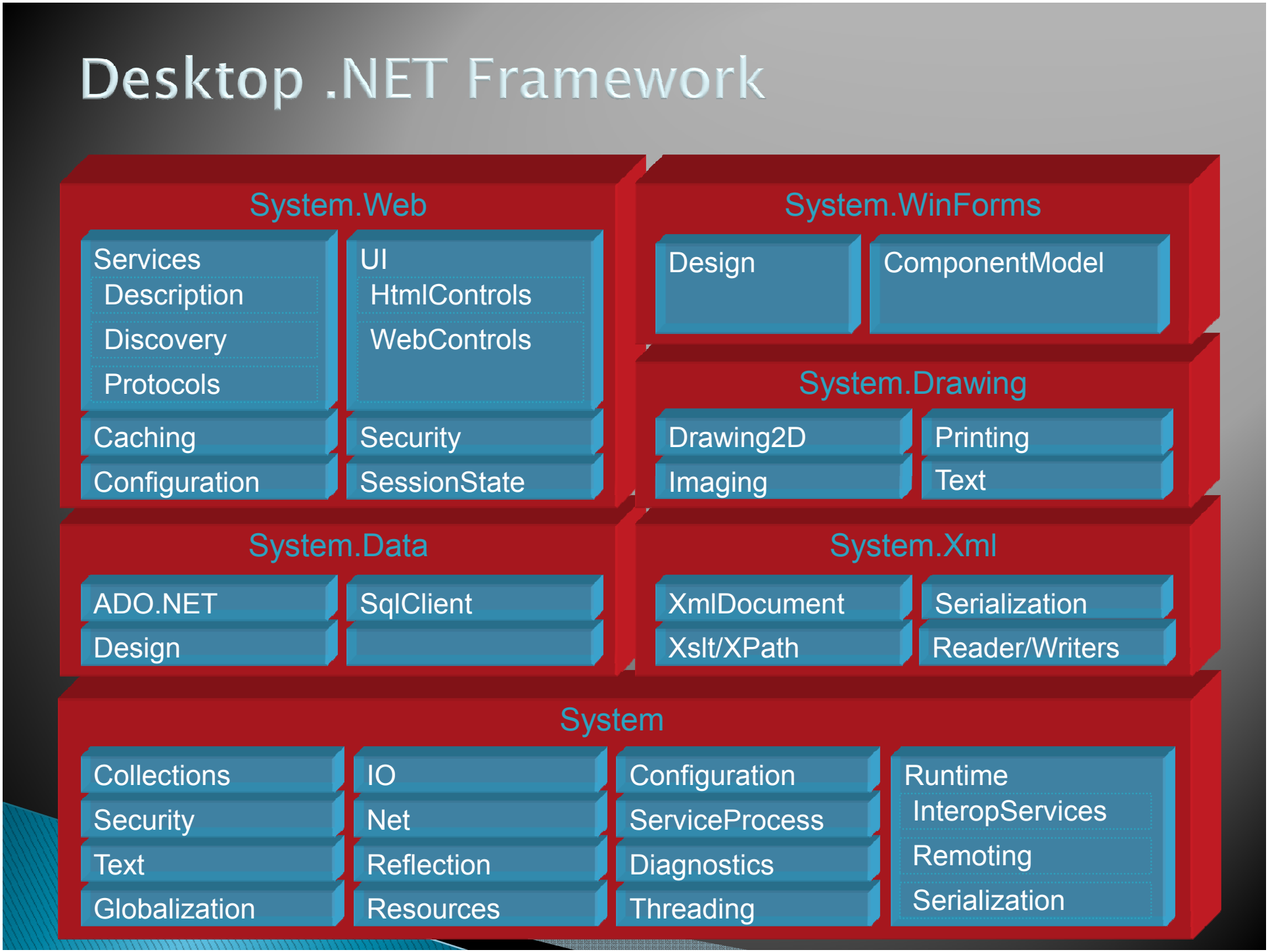


.NET Compact Framework

- Lightweight version of .NET Framework
- Designed for resource-constrained devices
- Compatible with VS.NET, C#, VB.NET
- Runs applications securely on-device
  - High performance JIT compiler
  - Guarantees robustness and security
  - Highly interactive, offline, and networked experiences
  - Makes it easy to consume web services
- Tunable size and performance



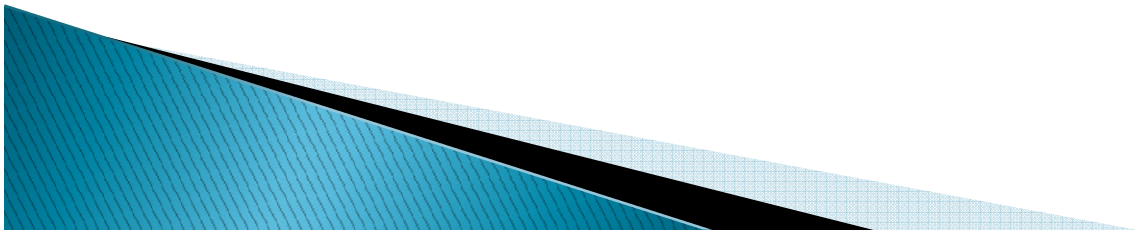
Desktop .NET Framework



.NET Compact Framework

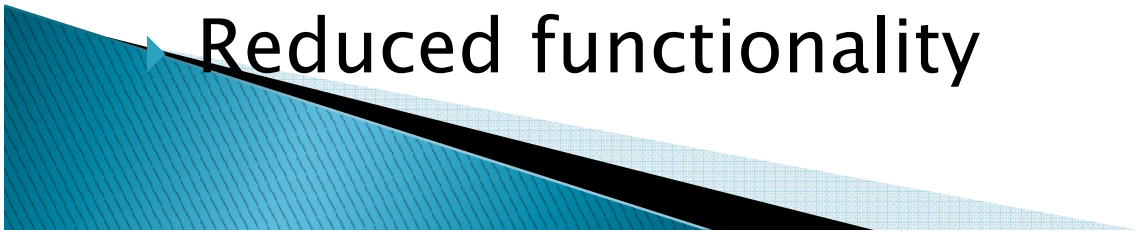
.NET CLR Common Features

- Verifiable type safe execution
  - No uninitialized variables, unsafe casts, bad array indexing, bad pointer math
- Garbage Collection
  - No ref-counting, no leaks
- JIT compilation
- Error handling with exceptions
- Common type system
  - Call, inherit, and source-level debug across different languages



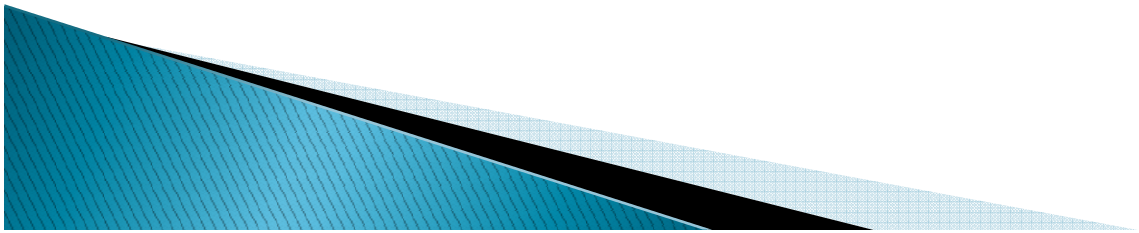
Compact CLR Differences

- COM Interop
  - Support for calling native DLLs
  - Support for calling a COM object through DLL wrappers
  - No support for writing a COM / ActiveX object in C# or Visual Basic
- No Install-time JIT (nGen)
- No Reflection Emit
  - No runtime dynamic types
- No Remoting
  - Client web services is fully supported
- No Generic Serialization
  - Datasets can be serialized to XML
- Reduced functionality



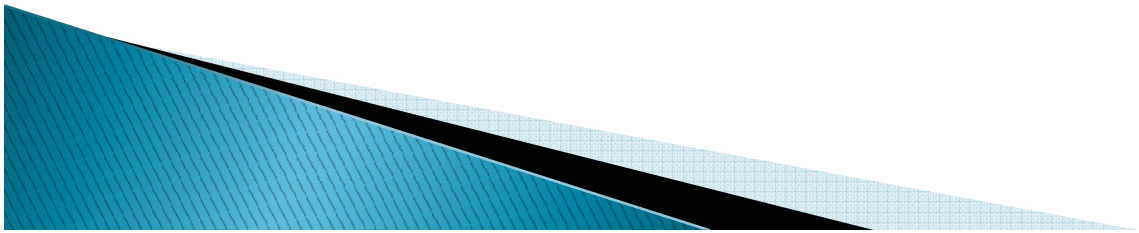
Framework Size

- Framework size (RAM or ROM)
  - ~1.5 MB
- Running RAM needs
  - 1 MB+ (depends on app)
- Typical application sizes
  - 5 – 100 KB
  - Apps often smaller due to use of platform features in the framework



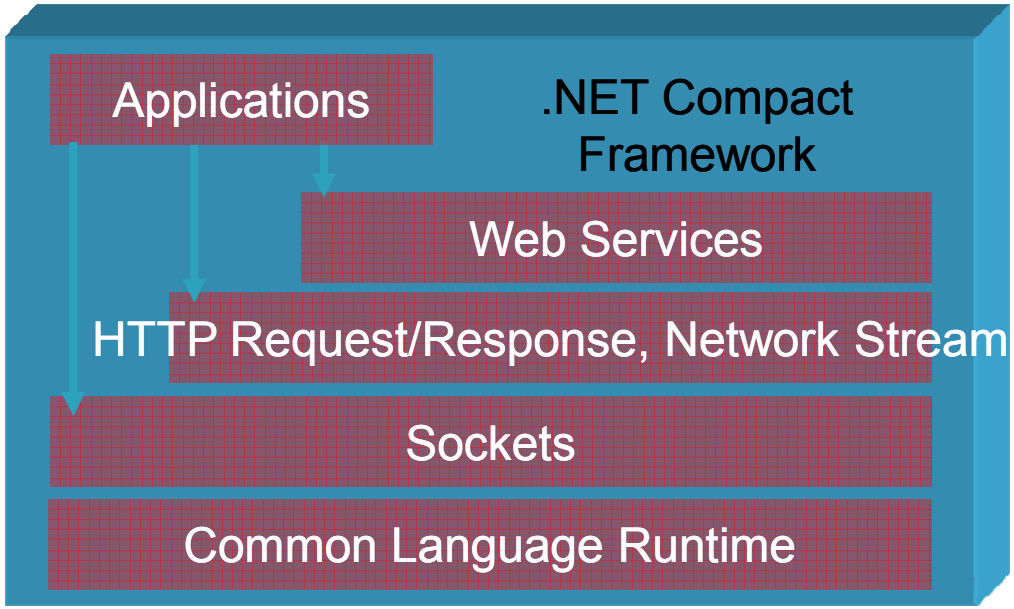
Basic Data Types

- Base data types are the same as the desktop
  - Formatting
  - StringBuilder
    - More efficient when string length changes
  - Arrays
  - Value types (Int16, Int32, Int64, UInt16, etc…)
  - Floats and doubles
- Collections
  - Classes for storing sets of objects
  - Arraylists and Hashtables



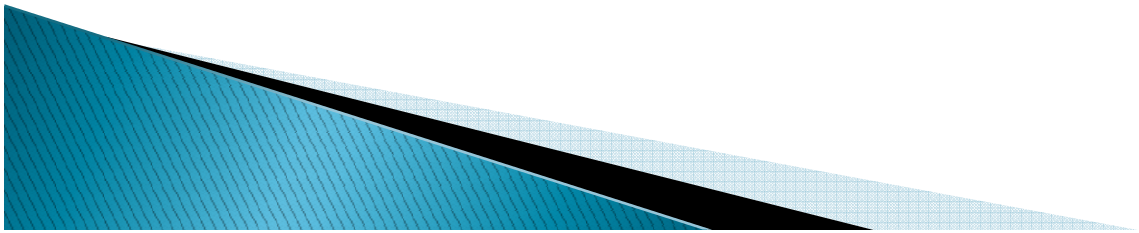
Networking

- Sockets
  - Synchronous and asynchronous
  - Multiple protocols
- Streams
  - Built on top of sockets
  - Synchronous and asynchronous
- HTTP request and response
  - Use stream model
  - Requires no user knowledge of HTTP



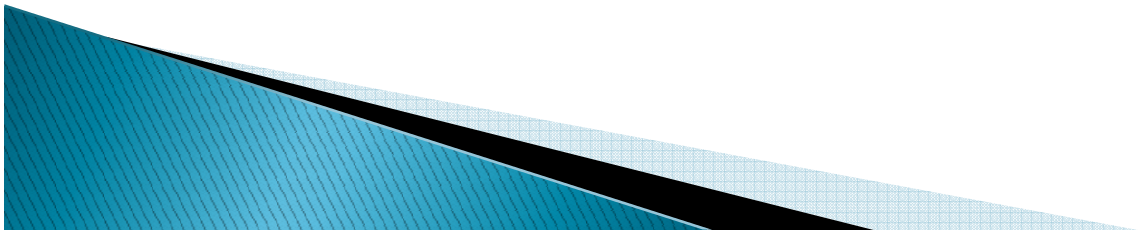
Threading

- Applications start with an initial thread
- Applications can start new threads
- Using threads
  - Responsive UI
  - Program function segregation
- Thread synchronization primitives
- App domains exist until all threads exit



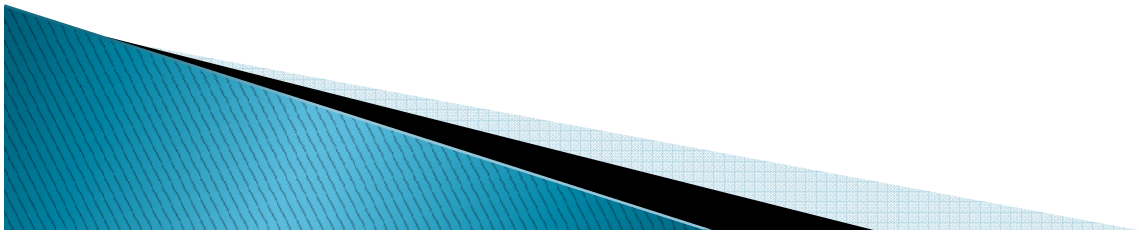
Native Code Interoperability

- Managed → native (P/Invoke)
  - Calls into existing native code
  - .NET Compact Framework does “flat” marshalling of arguments
  - Calling COM objects in process
- Native → managed
  - P/Invoke and block



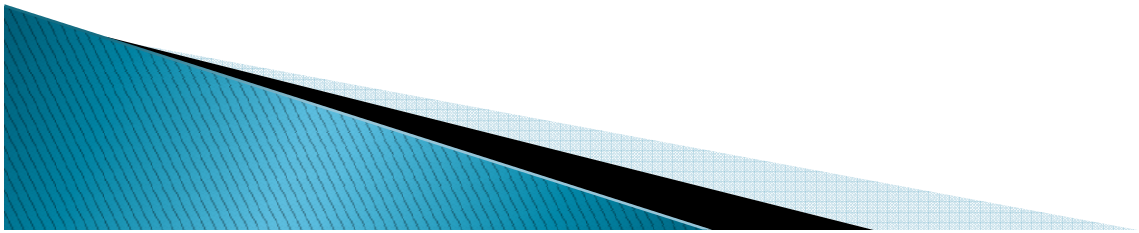
Globalization

- Culture-correct String comparison
- Calendar math
- DateTime and numeric formatting and parsing
- External data
  - Encodings
- .NET Compact Framework CLR is fully globalized
  - Can use Windows CE tables



Windows Forms Support

- Layout
  - Manual positioning
- Drawing
  - Polygons, lines, arcs, ellipses, rectangles
  - JPEG, BMP images
- Text and images
  - TrueType bitmap fonts on Mobile
- Most desktop controls
- Designer support



Supported Controls

- Supported controls

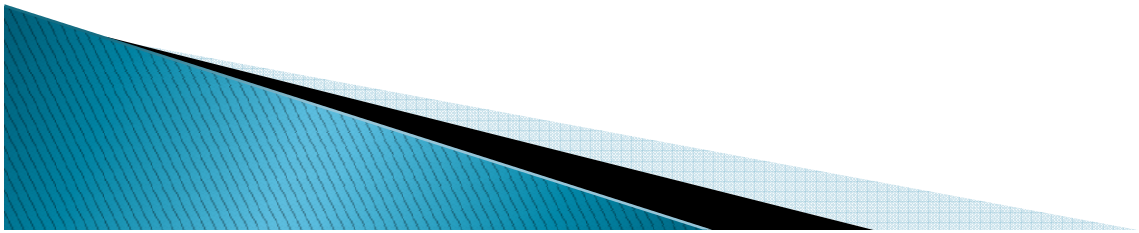
  Button
  CheckBox
  ComboBox
  ContextMenu
  DataGrid
  DomainUpDown
  FileOpenDialog
  HScrollBar
  ImageList
  Label
  ListBox
  ListView
  FileSaveDialog
  MainMenu
  NumericUpDown
  Panel
  PictureBox
  ProgressBar
  RadioButton
  StatusBar
  TabControl
  TextBox
  Timer
  ToolBar
  TreeView
  VScrollBar

- Unsupported controls

  GroupBox
  CheckedListBox
  ColorDialog
  ErrorProvider
  RichTextBox
  HelpProvider
  LinkLabel
  NotifyIcon
  Print Controls
  ToolTip
  Splitter
  FontDialog

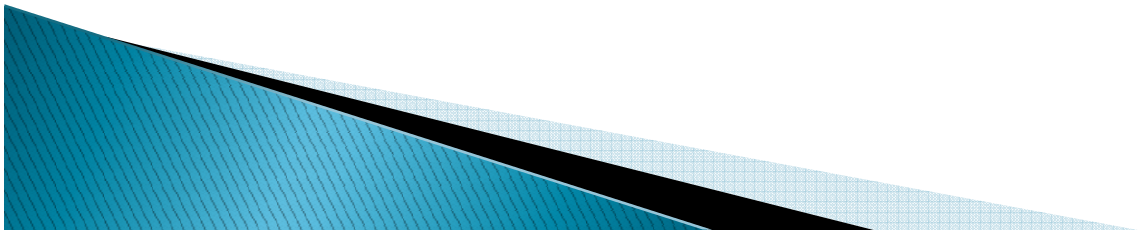
XML

- XmlTextReader and XmlTextWriter
  - Forward-only parsers of XML data
  - Better performance, no in-memory caching
  - Low memory requirements
- XmlDocument
  - Parse entire document
  - In memory traversal
  - Higher memory requirements; more functionality



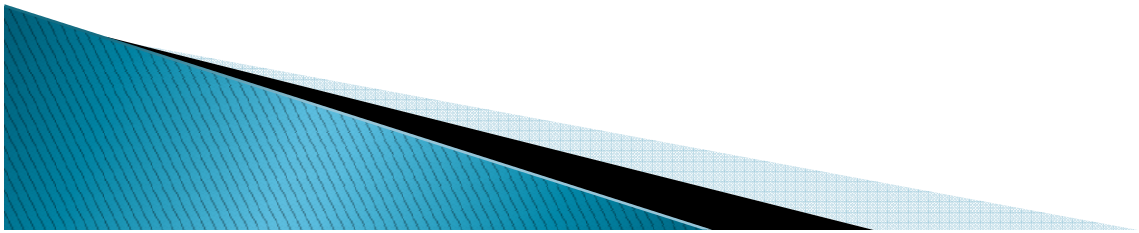
Unsupported XML Classes

- XmlDataDocument
  - Relational and hierarchical views of XML
- XPath
  - Query over unstructured XML data
- XSL/T
  - Transform XML data to other forms
- XML Validation
  - Verifies correctness of XML document



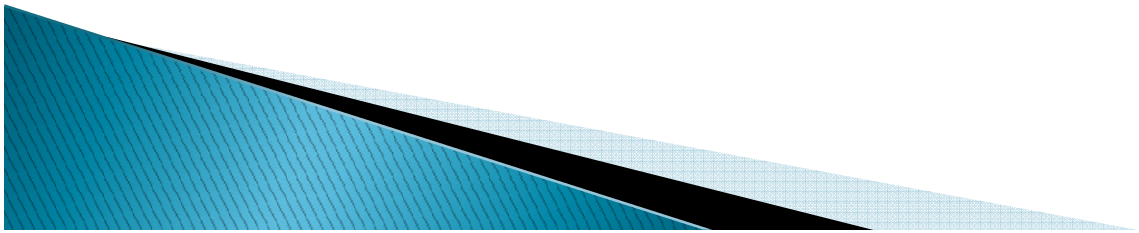
Classes Specific to CF v1.0

- Microsoft.WindowsCE.Forms
  - InputPanel, MessageWindow/Message
- System.Net.IrDA
  - IrDAXXX
    - EndPoint, Client, DeviceInfo, Listener
- System.Data.SqlServerCE
  - SqlCeXXXX
    - Command, CommandBuilder, Connection, DataAdapter, DataReader, Engine, Error, ErrorCollection, Exception, Parameter, RemoteDataAccess, Replication, Transaction



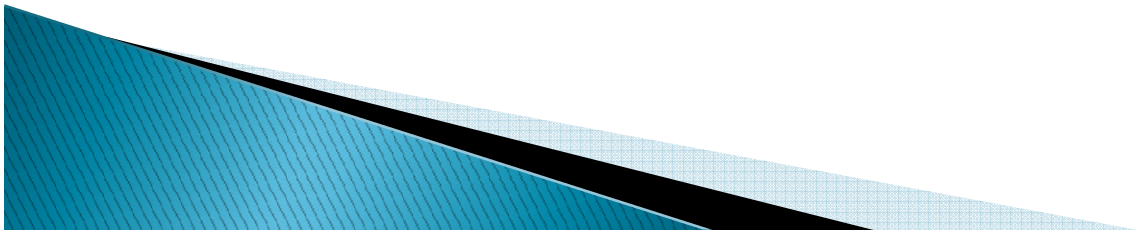
Classes Specific to CF v2.0

- Microsoft.WindowsCE.Forms
  - HardwareButton
  - MobileDevice.Hibernate
  - SystemSettings.ScreenOrientation
  - DocumentList
  - Notification
  - LogFont
- Microsoft.WindowsMobile.DirectX
  - .Direct3D
- SqlCeResultSet



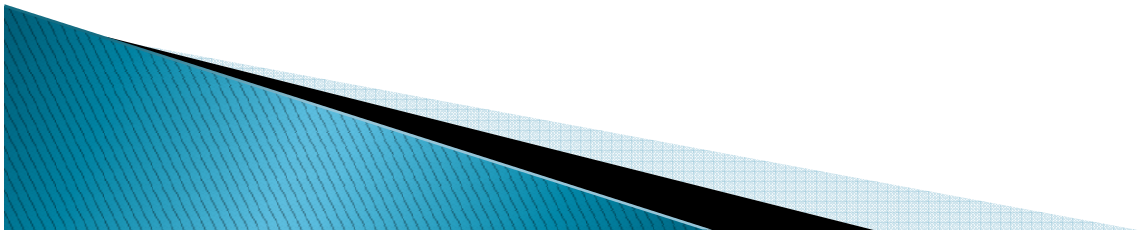
ADO.NET Support

- Handling data offline with DataSet
- Communicating DataSet with XML
- Common data model from server to PC to device
- Extensible ADO.NET provider model
- Included data providers
  - SQL Server (System.Data.SqlClient)
  - SQL Server CE (System.Data.SqlServerCe)



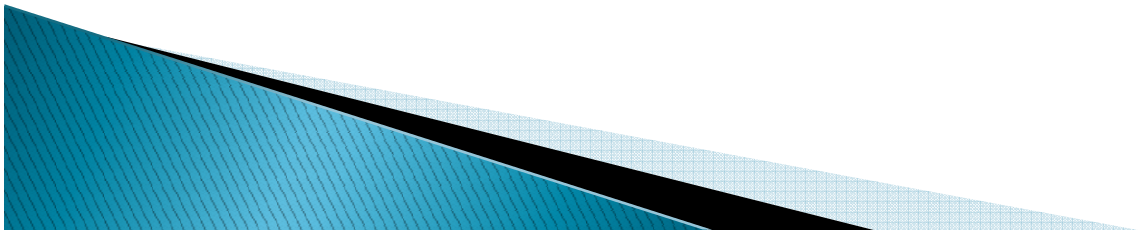
Web Services Support

- Calling XML Web Services
- All encoding types
- Synchronous and asynchronous invocation
- Basic and Digest authentication
- Secure Sockets Layer support for encryption (SSL)
- Custom SOAP headers
- SOAP Extension Framework



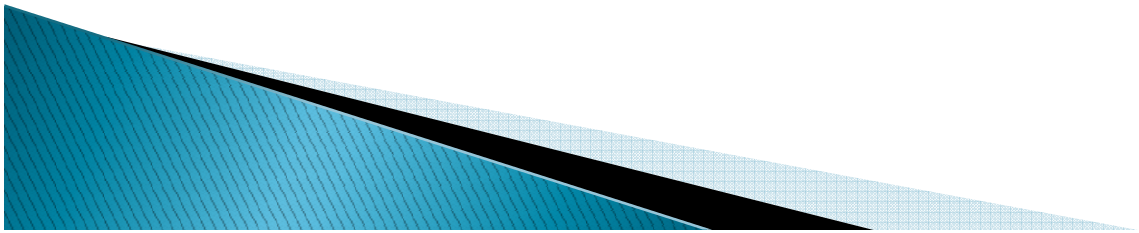
Mobile vs. Wireless

- Mobile Architectures
  - Application can function in a vacuum
  - “Synchronize When You Can”
- Wireless
  - Tethered to the data source, just like wired, only using wireless
    - WiFi, CDPD, GPRS,
  - Prone to problems
- Mobile Apps leverage Wireless
- Wireless is NOT Mobile



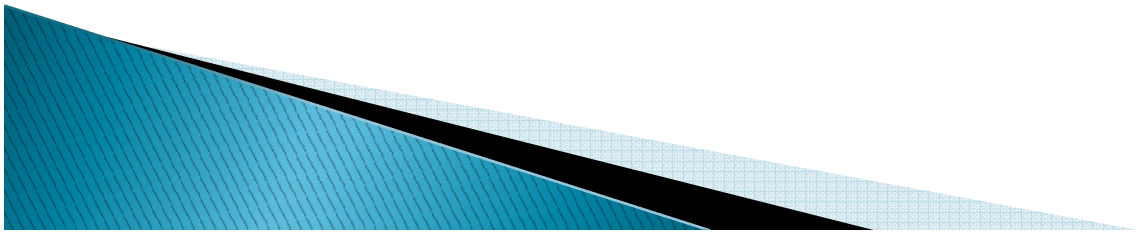
Goal for a Mobile App

- Can your user user your application at the bottom of the ocean?
- Is your application as reliable as their paper notebook?
- Take advantage of the internet/network, don't depend on it.



Compatibility Challenges

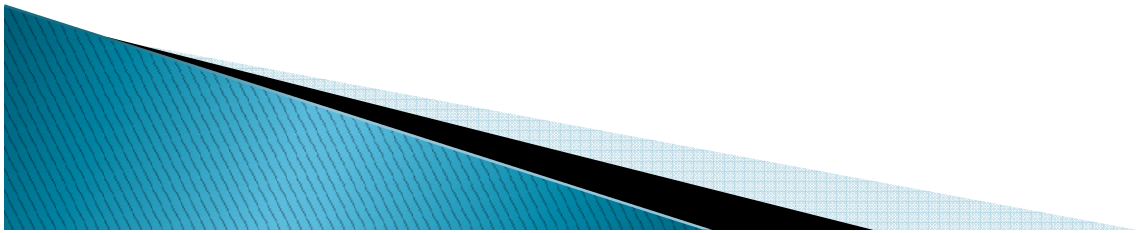
- Many different device types
  - Different form-factors
  - Human interface choices
  - Connectivity choices:
    - WiFi
    - Compact Flash
    - Wan
    - Desktop Cradle
    - Infra Red
    - Bluetooth
    - GSM/3G
- On-device resources vary widely
  - ROM/RAM capacity
  - File system
  - Battery life



Development Perspective

Think small, fast and light.

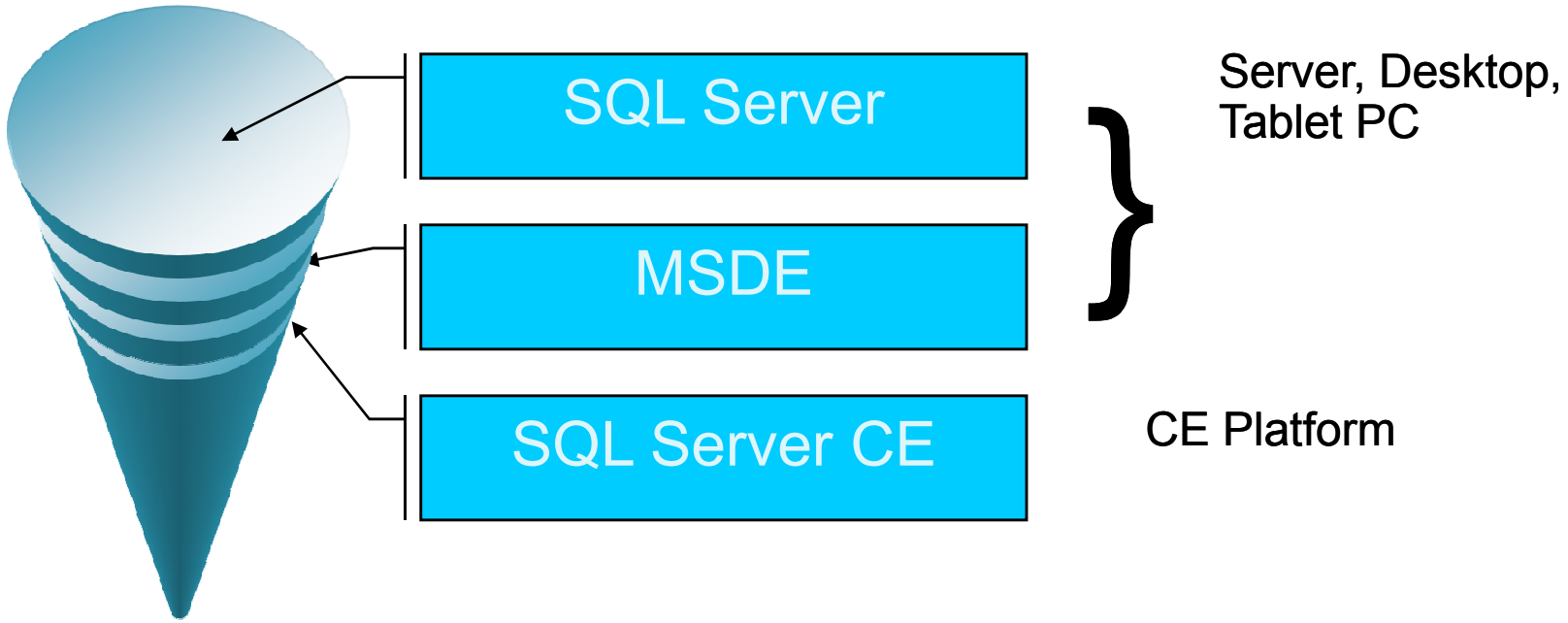
- Features
- Amount of Data
- Garbage Collection
- Data Entry/Selection
- Performance
- Memory Usage
  - Data, Objects
- Connectivity



Device Databases

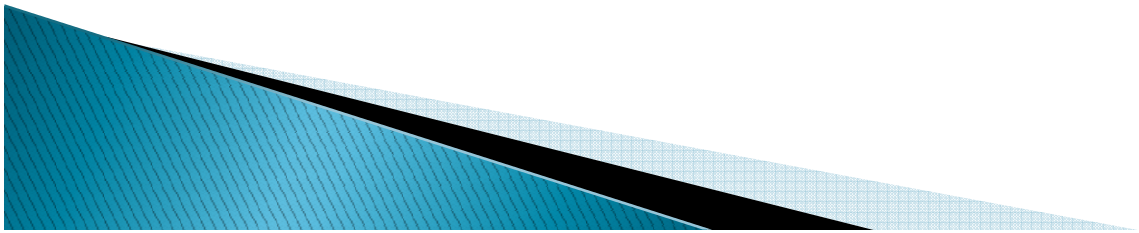
Microsoft Strategy
Scalable Solutions

- Scalable Solutions

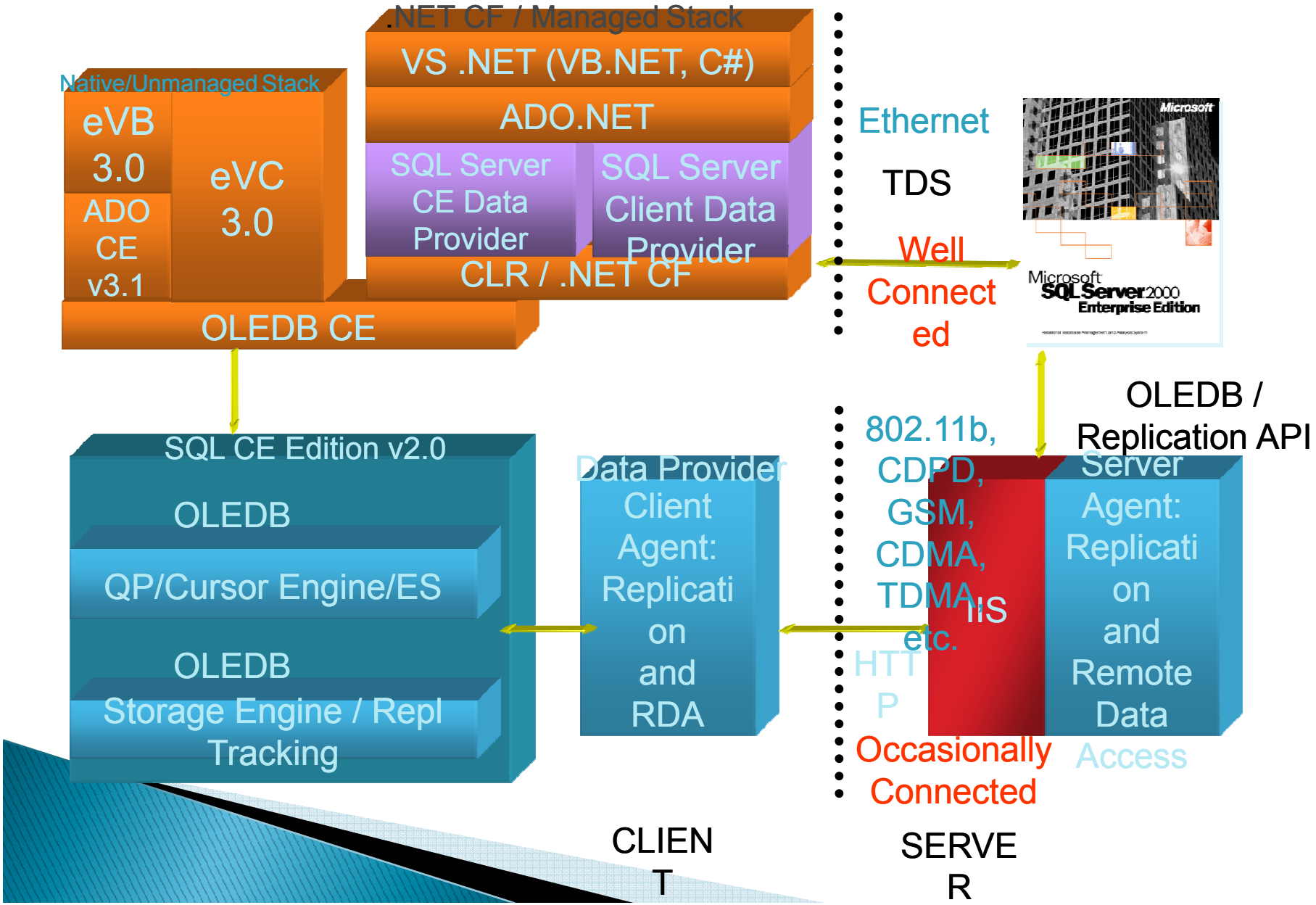


SQL Server CE *(SQL CE)*

- Database for the CE / Pocket PC Platform
- Similar programming style to SQL Server
- Limitations are more device then SQL/CE
- 1 Connection/ Database, *(usually not a problem)*
- Multiple Databases per device
- No Stored procs
  - Use cached DataCommands
- Referential Integrity with cascading updates/Deletes
- Stand alone, or replicate/sync with SQL Server
  - SQL Server not required, *but best match*
- SQL Server CE 2.0 designed for .NET Compact Framework (System.Data.SqlServerCe)
- Replacement of Pocket Access, just like DBF/Access



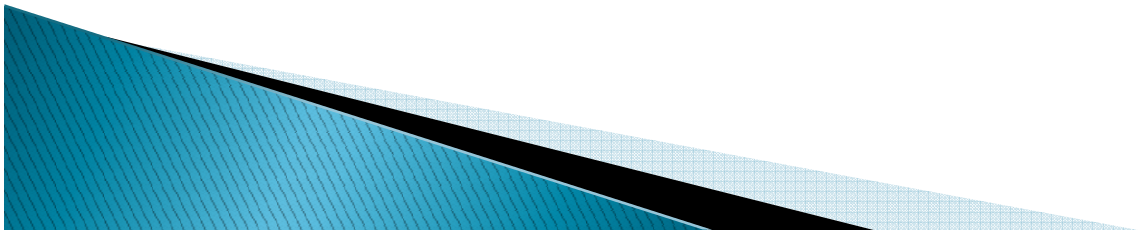
CE Data Access Storage Architecture



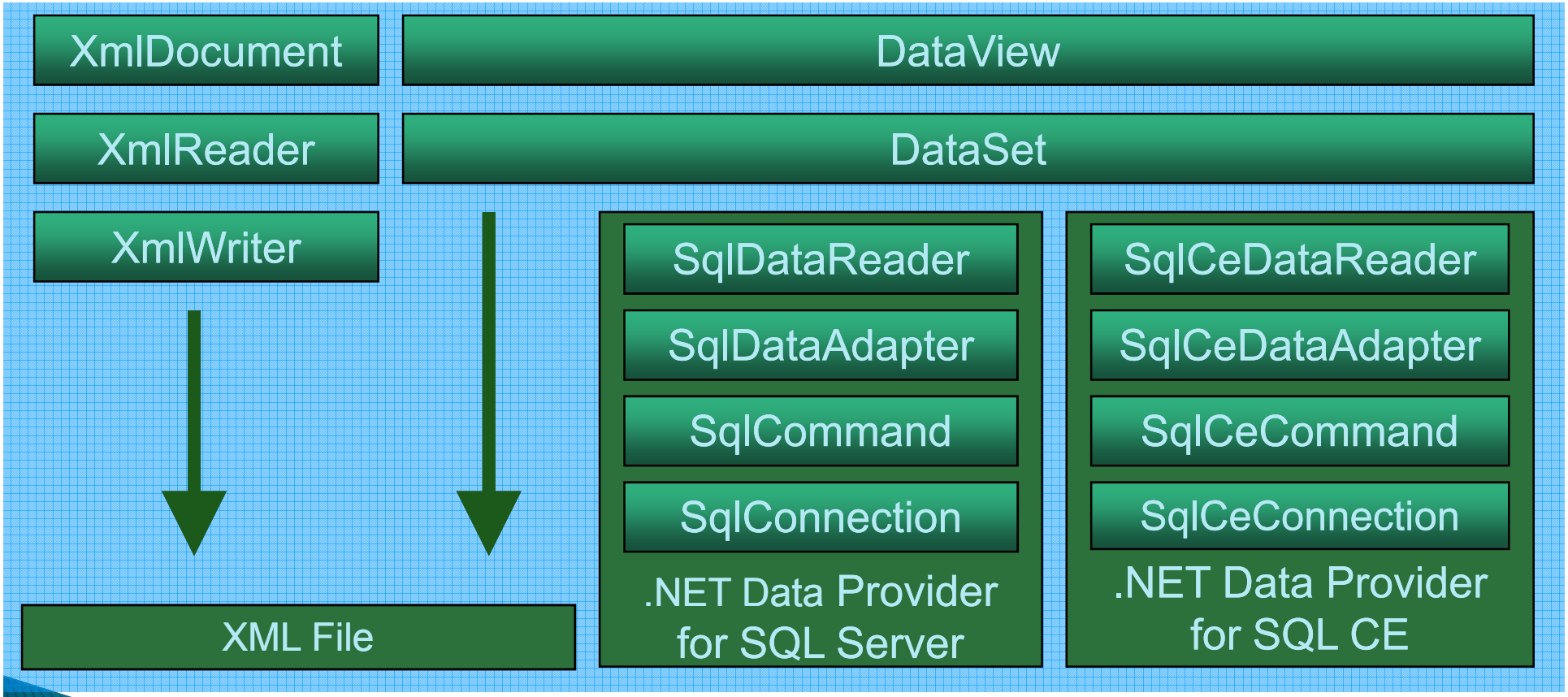
SQL / CE – Data Transfer

Multiple Techniques

- RDA
  `system.Data.SqlServerCe.SqlCeRemoteDataAccess`
  - Great for semi-connected environments, large data transfers
- Merge Replication Over IIS
- `System.Data.SqlServerCe.SqlCeReplication`
  - Great for managing concurrency
- ADO.net `System.Data.SqlClient.SqlCommand`
  - Can call SQL Server directly, but not a great idea…* *(*Not a Mobile Architecture)*
- Web Services
  - Great when concurrency isn't an issue, or server isn't SQL

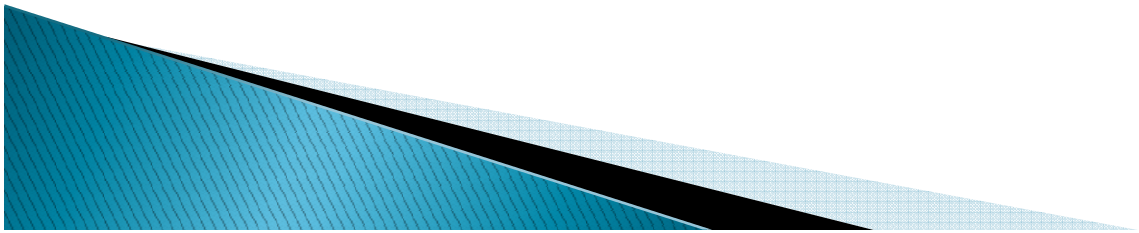


Supported ADO .NET And XML Classes On .NET CF



Development Tools

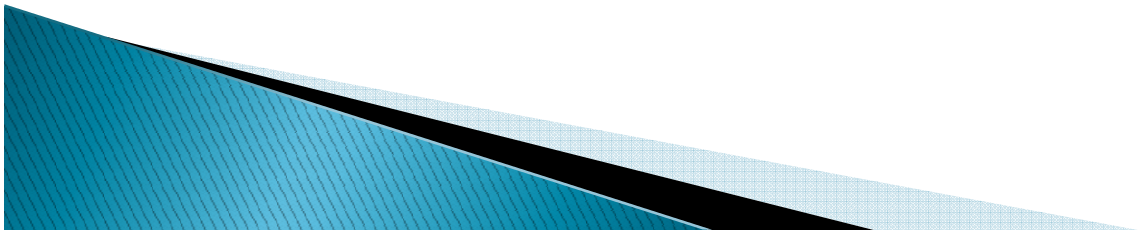
- Visual Studio .NET
- SQL Server Win. CE Edition 2.0 (SQL CE)
- Device Emulators
- Remote Display Viewer
- Remote Debugger
- eMbedded Visual Basic 3.0
- eMbedded C++ 4.0



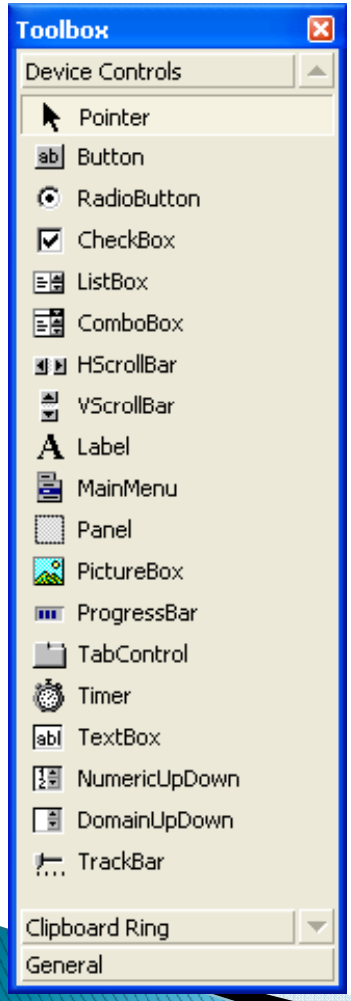
Development Tools

VS.NET Integration

- Templates for devices in New Project dialog
  - Template sets device and project type
- Template types
  - Pocket PC Application
  - Pocket PC Class Library
  - Pocket PC Control Library
  - Windows CE .NET Application
  - Mobile Phone Application
- Default set of references that are appropriate for your platform



Visual Studio
Overview of Controls



- Use Windows Forms Designer
- Drag-and-drop, property-based
- Rich subset of desktop controls
  - User Interface controls
    - Data Entry
    - Display
  - Formatting & RAD controls
    - Organizational controls
    - Helper controls

Visual Studio

Subset of Desktop Controls

Data Entry

- Check Box
- Combo Box
- Command Button
- Domain Up/Down
- List Box
- Numeric Up/Down
- Radio Button
- Text Box
- Track Bar

Display

- Label
- Picture Box
- Progress Bar
- Status Bar

Organizational

- List View
- Panel
- Tab Control
- Tree View

Helper

- Context Menu
- Scroll Bars
- Image List
- Main Menu
- Open & Save File Dialogs
- Timer
- Tool Bar

Controls Not Supported

- Checked List Box
- Data Grid
- DateTime Picker
- Group Box
- Month Calendar
- Splitter

Visual Studio

Customizing Emulator Settings

- Fully Functional PocketPC 2002 OS Emulator
- Options to change device configurations and connectivity
  - Resolution & Color Depth
  - Memory
  - COM & LPT ports!