Mono's progress and roadmap

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What is Mono?

An Open Source implementation of .NET

- Cross platform:
  - Unix family: Linux, MacOS X, Solaris, HP-UX.
  - Windows family: 2000, XP.
  - Embedded systems (tiny profile).
- Open Source compilers and tools:
  - Today: C# language, IL, Java, Nemerle.
  - Preview: VB.NET, Jscript, Python.
- Most of the non-windows specific stuff implemented
- Additional features

Motivations

Increase Developer Productivity.

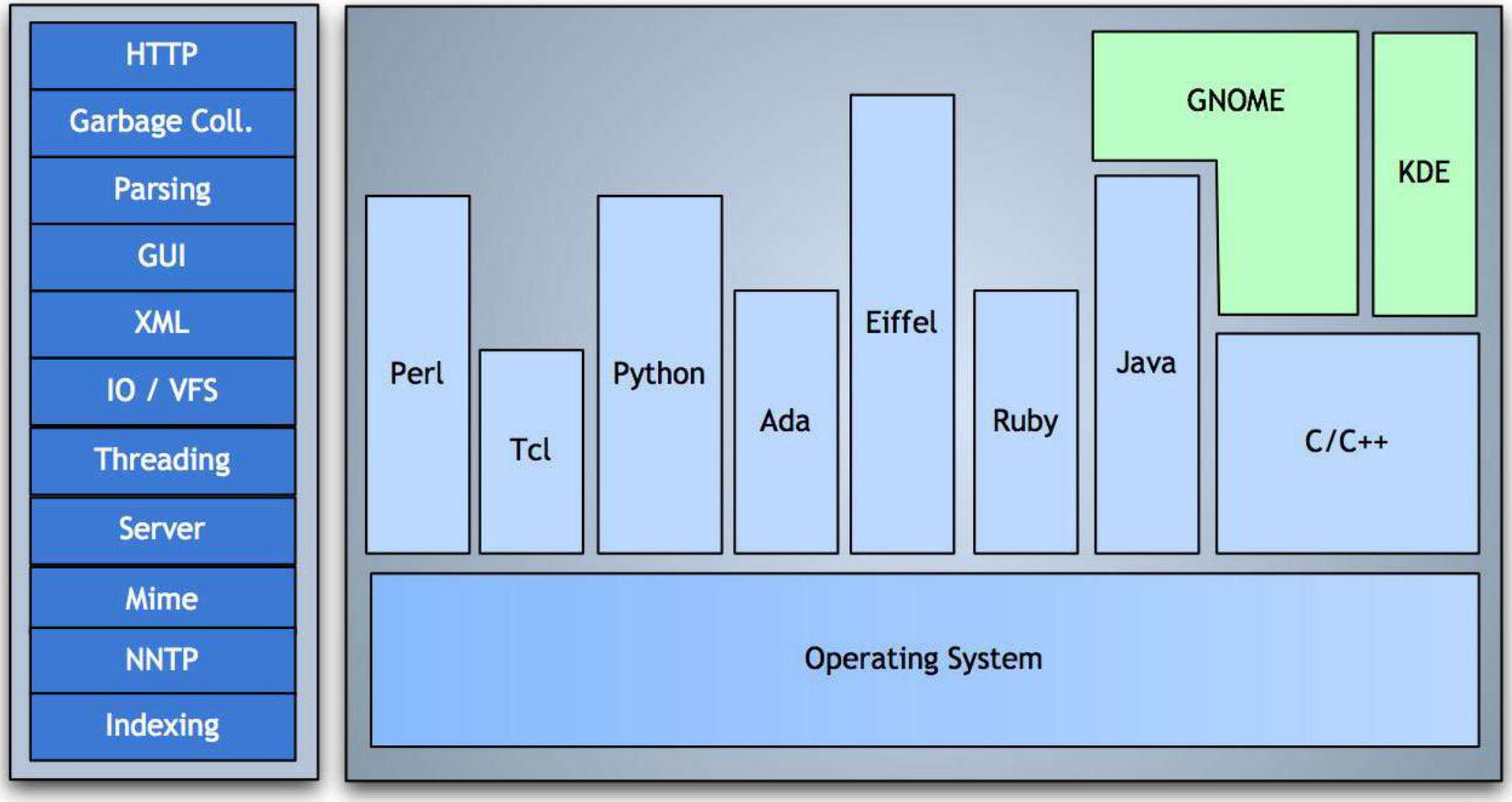
- Modern platform to Unix.
- Managed environment.
- Mainstream langueage with the features most free software langauges had for ages.
- Evolving platform.

Unify API reuse.

- Reduce API-based language fragmentation
- Multiple language support

Side effect: Windows to Linux migration.

Unix:
Everyone Building its Own Platform



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Mono Today.

Mono 1.0 release a few months ago.

- .NET framework 1.1-based.
  - Minus Windows.Forms, EnterpriseServices
- Gtk# and other Un*x integration assemblies
- Extensive third-party database support
- Relax NG extensions.
- Mono.* namespaces.

GUI Tools:

- Monodoc and Monodevelop.

Mono Users Today.

Novell's desktop development platform

- For new software.
- For extending existing software.
- Beagle, Dashboard, F-Spot, Evolution 2.next
- Gtk# community.

ASP.NET applications on Unix

- Voelcker: 400 servers, 150,000 users

Apple/Cocoa#: recent community.

Gnome Project.

Bring Linux to the desktop.

- Started in 1997
- Fill the gaps on the desktop offering.
- Raising the programming level:
  - Component-based software.
  - Raise programming level: language bindings.

Technically:

- C-based APIs, contracts to bind it.
- CORBA used for exposing components APIs.
- Far from perfect solutions.
- Bindings came out of schedule.

The Ximian Background.

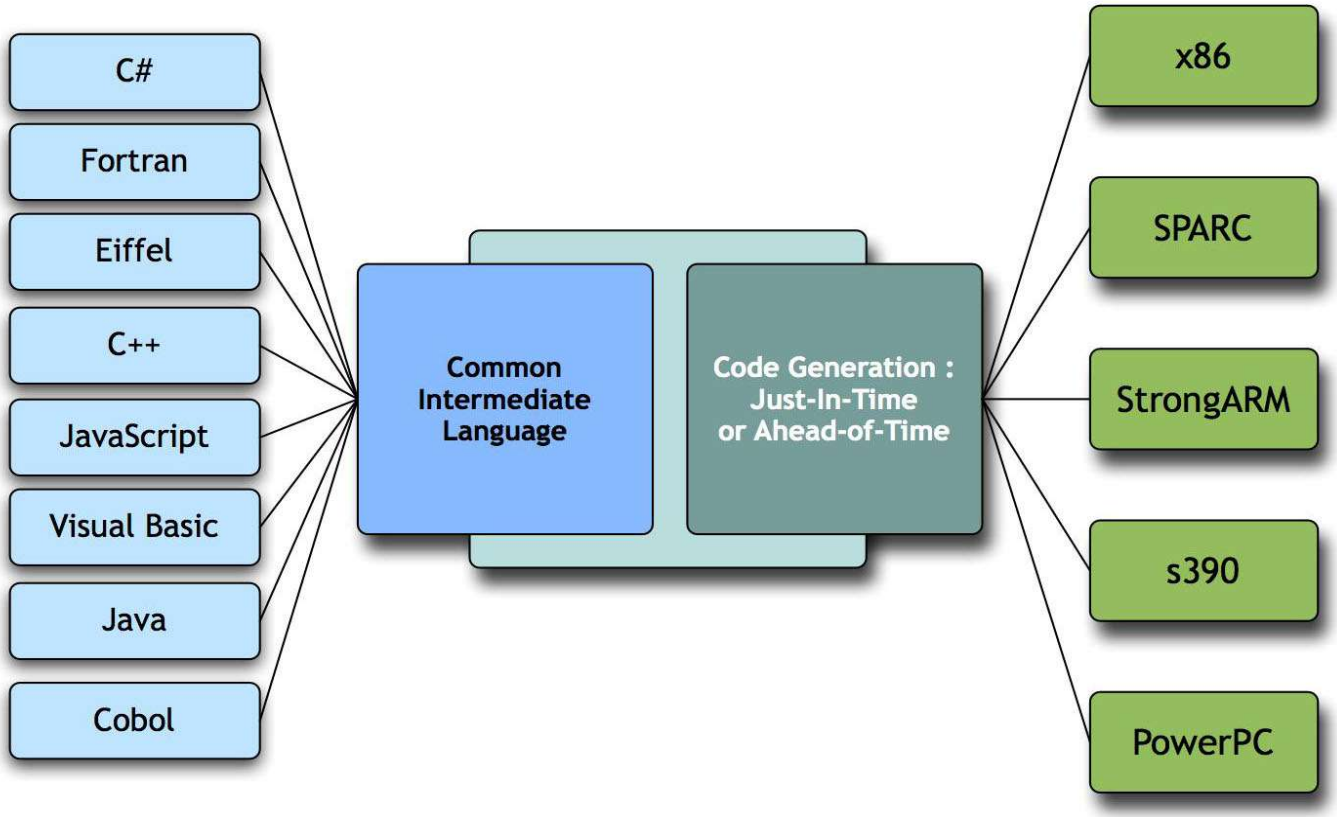
Ximian: focused on making Linux succeed on Desktop.

Evolution: our large application

- Standards compliant, best email/calendar/address.
- Complex: multi-threaded, multi-process
- Too many standards.
- Innovation was hard
- At peak for 1.0: 17 developers, 2.5 years Too Expensive.

We needed better tools.

Multi-language and multi-platform.



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Reuse.

Existing .NET:

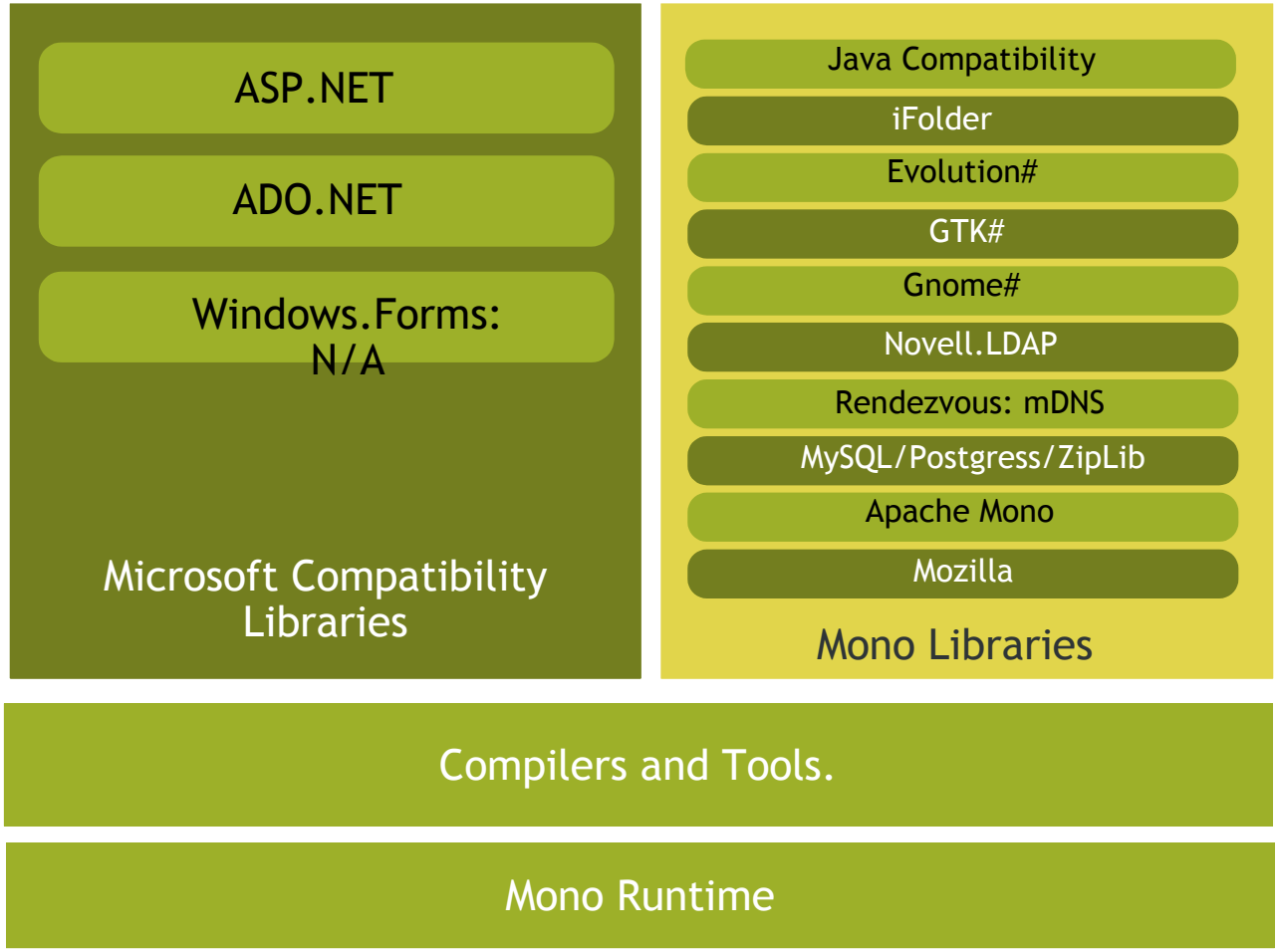
- Third party components written in C#, VB.
- Third party compilers:
  - Eiffel, Ada, Fortran, C/C++, Python.

Java:

- Seemless integration of Java libraries and applications.
- Execute C# and Java code side-by-side
- Share components, expose components.
- The IKVM Virtual Machine.

The Ultimate Open Source Reuse.

The Two Stacks.



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Mono Development.

Mono is an effort lead by Novell.

- 20 Engineers from Novell (5 at the time of Ximian)
- 300 developers from the Open Source community.

Like other open source efforts, other companies help:

- Embedded system vendors.
- Mainsoft
- SourceGear.

Reuse pieces of open source code:

- Intel's ORP research.
- SGI/HP's Boehm GC.

Virtual Execution System.

Two execution systems today:

- Native Code Generator. (ppc, x86, sparc)
- Interpreter (bootstrap helper).

Native Code Generator:

- Just-in-Time compilation mode.
- Ahead-of-Time batch compilation.
  - Avoids startup time
  - Increases shared code across applications.
- Fairly advanced compiler optimization platform.

GC: Boehm conservative GC.

Mini JIT

Two intermediate representations

- IL -> Tree based
  - Most optimizaions done on the trees
  - BURS rules transforms trees into list of quadruples
- quadruples of opcode, dreg, sreg1, sreg2
  - Close to the CPU, but still allow for easy porting and code sharing between multiple targets

Optimizations

- Can be individually enabled
- The quick ones are enabled by default
- SSA framework enabled manually (or during recompilation with profiling info): SCCP, ABC removal

Embeddable VM

The complete VM is on a library.

- Extend existing applications.
- Add scripting.
- Gradual transition to managed code.
- Do not lose investment in current code base.
- Create snippets of code that get jitted.
- Export new facilities to the CLR.
- Plugin interface for multiple languages.
- Easy to use and low overhead.

Where we are going?

Continue improving Unix, Gnome, Cocoa

- iFolder
- Beagle/Novell Dashboard.

Continue .NET/Java compatibility work:

- To allow reuse of third party .NET libraries.
- To allow reuse of Java third party libraries.

Support scripting and new languages:

- IronPython, Boo, Nemerle

Improve our development tools:

- MonoDevelop
- Mono Debugger
- Mono Documentation.

Mono Development.

Three tracks of development.

Mono 1.0: Stable

Mono 1.1: Incremental development

Mono 2.0: .NET 2.0 APIs and bigger runtime changes

Future of Mono: Short Term.

Mono 1.2: incremental update.

- Add Windows.Forms.
- Add Visual Basic compiler.
- ASP.NET, ADO.NET scalability.
- C# 2.0 compiler.

Mono features:

- Debugger.
- Gtk# 1.2, Cocoa# 1.0
- Generics.
- More ports (sparc64, amd64, s390)
- Faster (20-50% faster than 1.0 already in many tasks)
- Stability.

Mono: Medium Term

Mono 2.0:

- Support the .NET 2.0 profile
  - ASP.NET 2.0
  - ADO.NET 2.0
  - System.Xml 2.0
  - Windows.Forms 2.0
- Code Access Security.
- Generational precise garbage collector
- More ports (S/390x, PPC64, ARM, MIPS, Itanium, ...)
- More optimizations in the JIT
  - New register allocator

Ongoing work.

Optimizations

- SSA-Partial Redundancy Elimination.
- New register allocator + scheduler (PPC, SPARC)
- Moving more VM code into managed land
  - Avoid managed<->unmanaged transitions
- Per-architecture rule tuning
- AOT
  - ELF-like relocations (increase page sharing).

Precise Garbage Collector

- Today we use Boehm (using as precise as possible).
- Currently incrementally fixing to introduce a moving GC

Future of Mono as a VM.

More 'scripting' language runtimes and compilers

- Perl, ruby, Tcl ported to run on Mono and other VMs.
- Will have more than one implementation, driving stabilization of interfaces and standardization
- It will push for enhancements of Mono (not just speed, but new features at the runtime and IL level)
  - Dynamic optimizations (self-modifying IL code)
- Creation of a common interface for use when the concepts of types and methods in a language aren't (can't be) mapped to types and methods in the VM

Future of Mono as a VM.

Smaller footprint for embedded systems.

- Tradeoff memory for speed
- Remove some features (Decimal, Re.Emit, locales, verification, Remoting support,...)
- Realtime extensions

Desktop systems

- Reduce GC pause times
- Reduce startup time (fast JIT, AOT)
- Reduce memory footprint

Scalability enhancements for SMP, server loads.

- Threaded GC
- Better performance with shared code

Future of Mono as a VM.

Security and sandboxing

- Statistic-based low-overhead resource accounting

Support from cpu designers and operating systems

- Thread local access (ABI issue): pthread, __thread
  - Needs to be fast for appdomains, code sharing
- VM dirty bits for use in GC
- Virtualized performance counters
- IP-relative addressing (on 64 bit platforms tradeoffs between icache footprint, memory reads)
- Don't pessimize writes to code (callsite patching)
- Standards for controlling a thread (suspend/resume, move to safe points...)

The importance of mistakes.

In the design of a VM

- To get researchers to solve the issues created
- Job security!^W^W

Examples:

- Synchronized methods in Java
  - Thin lock implementations
- Heap allocations
  - Escape analysis
- Imperative langauges
  - SSA form in compilers to convert into functional

Make sure we don't get back to lisp machines in 20 years

More Information.

Mono:

- http://www.mono-project.com

Email:

- lupus@ximian.com

Mailing list:

- http://lists.ximian.com/mailman/listinfo/mono-devel-list

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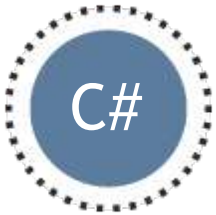
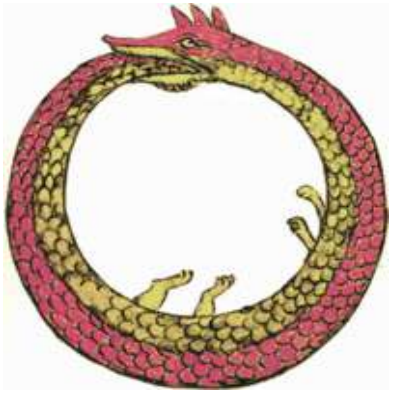
Mono C# Compiler.





- C# written in C#
  - Fast: 2.5 seconds to rebuild itself.
  - 54,000 lines of code.
  - Includes JIT time.
- Implements C# 1.0
  - 2.0: generics and iterators.
- Self-hosting since Jan 2002.
  - Six months since start.
  - Two developers.
  - AOT:
  - 30% performance increase.

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