
# Open Source Compiler Tool Chains and Operating Systems for RISC-V

Jeremy Bennett
Mark Corbin

# Agenda

- Open source compilers: Jeremy Bennett
  - what is available?
  - how good are they?

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- Open source compilers: Jeremy Bennett
  - what is available?
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  - what is available?
  - how good are they?
- **Questions: Everyone**



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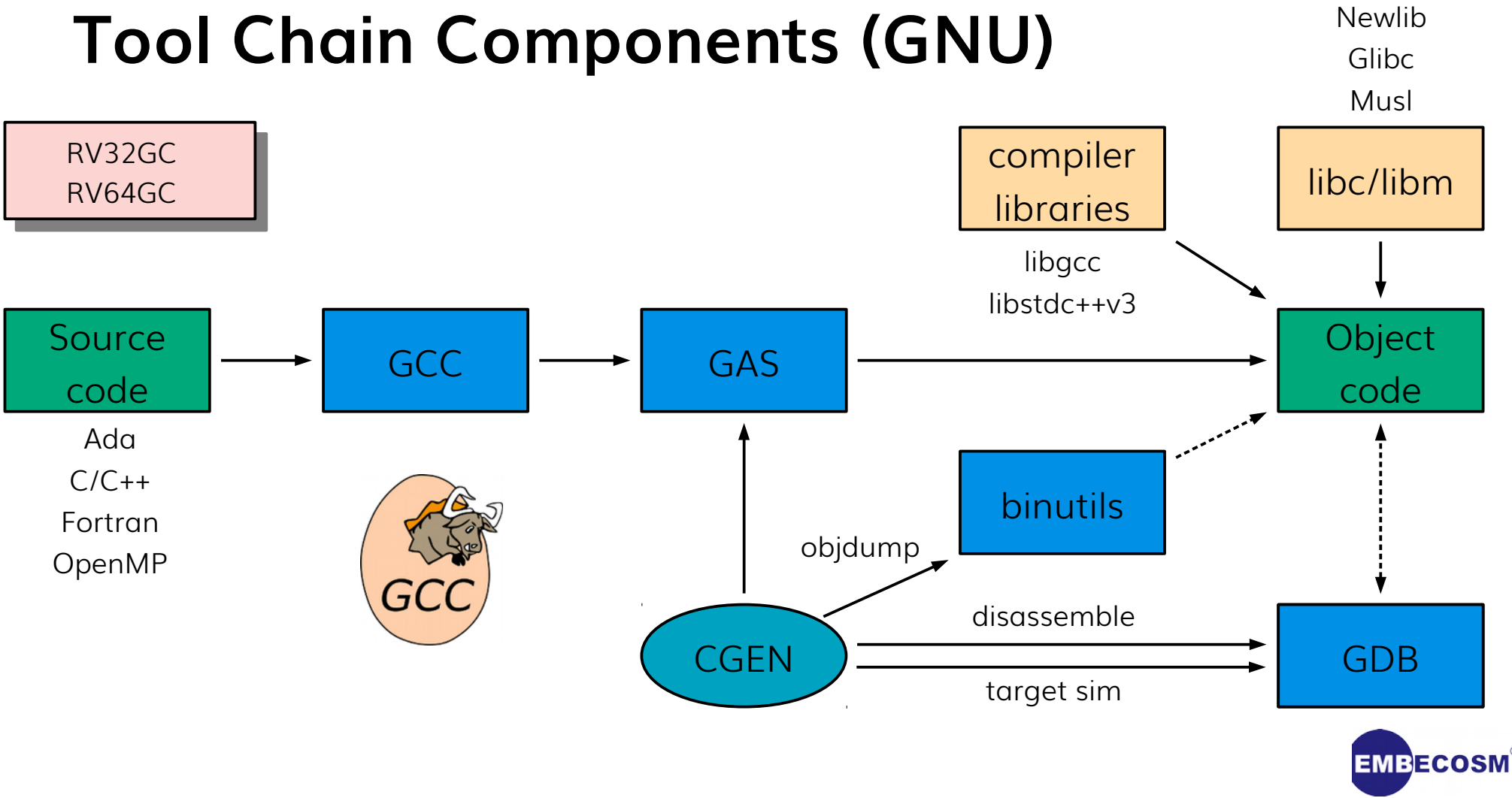
# Compilers

Jeremy Bennett

# Tool Chain Components (GNU)



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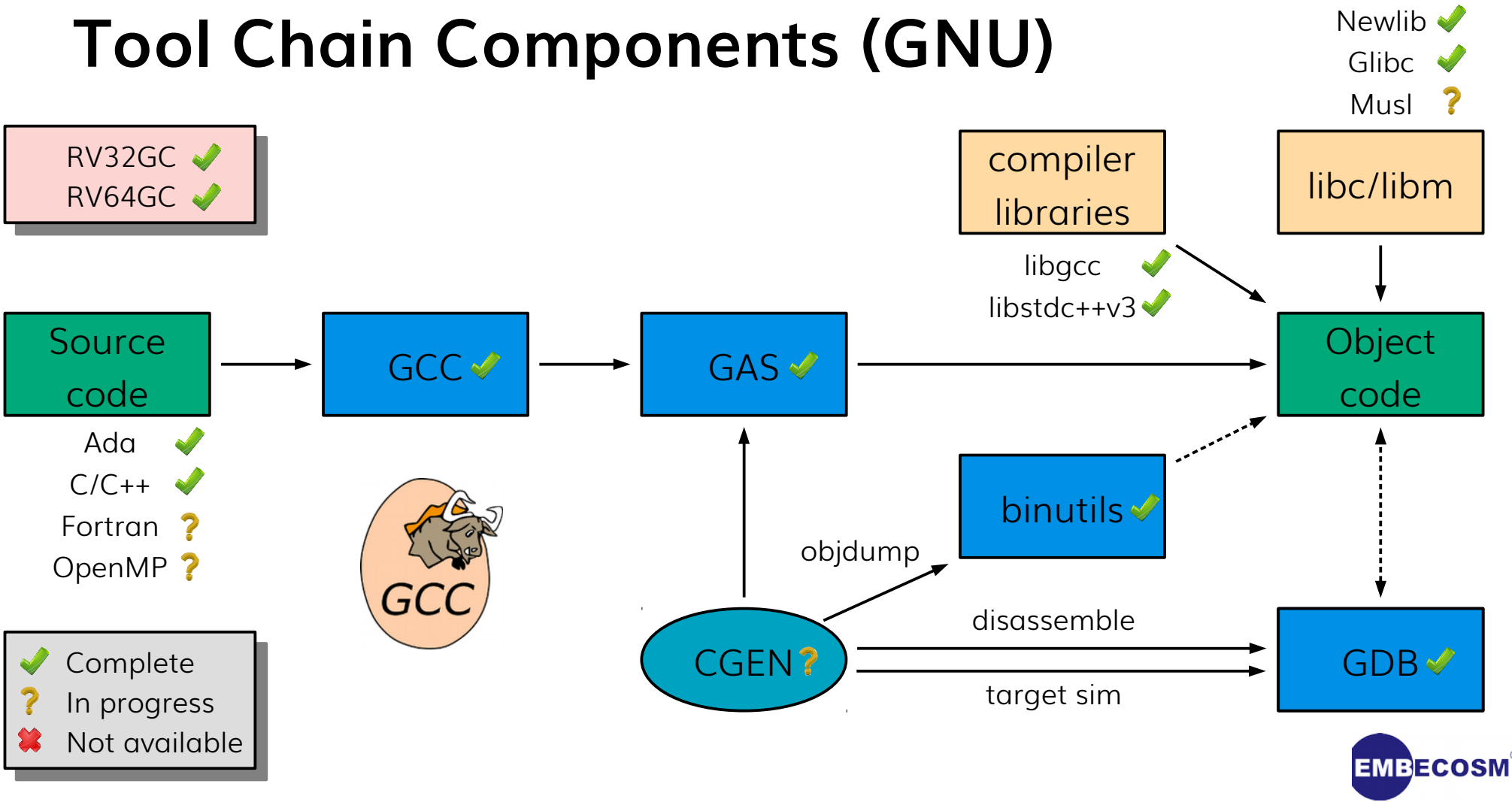
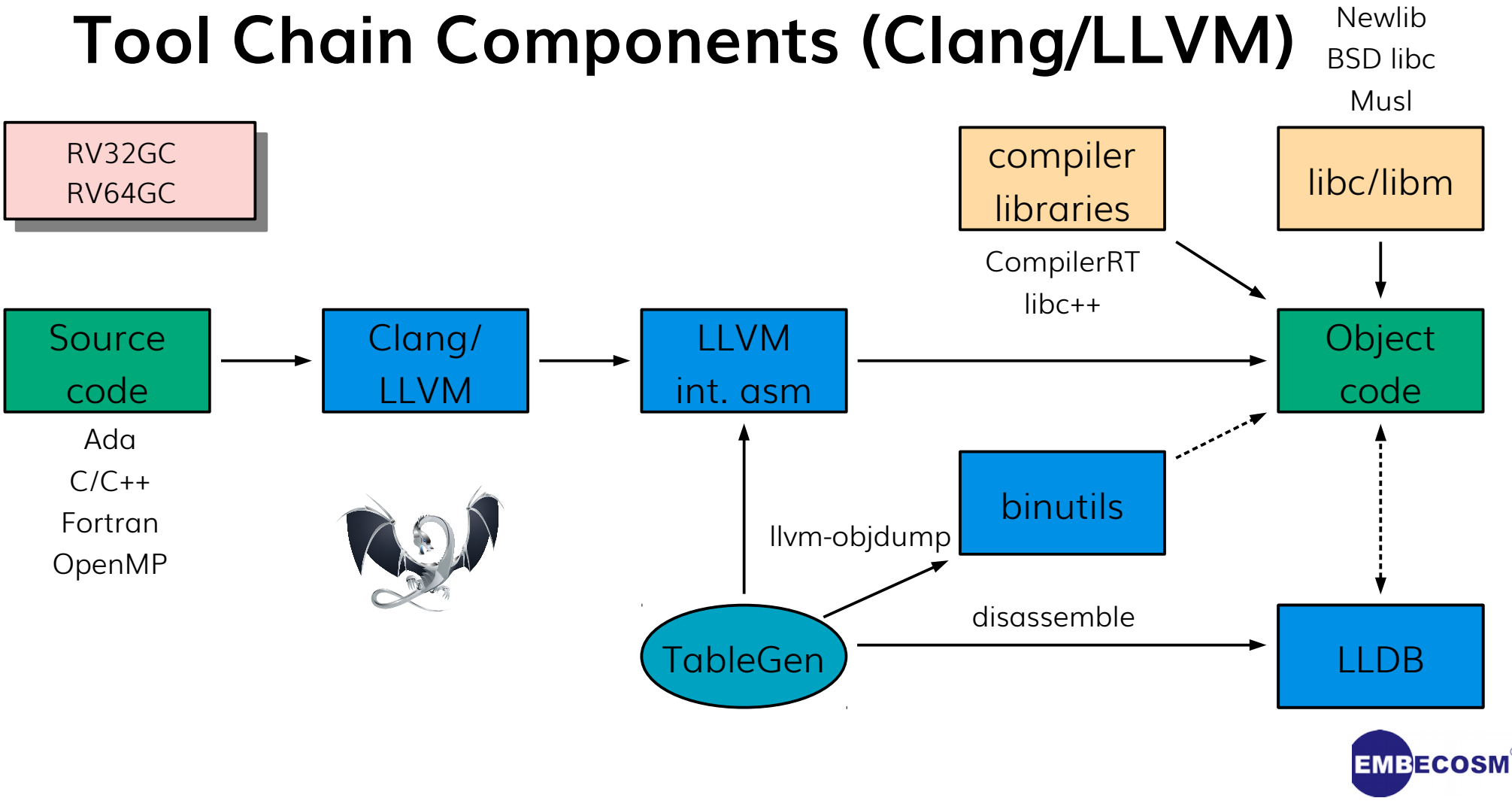


# Tool Chain Components (Clang/LLVM)



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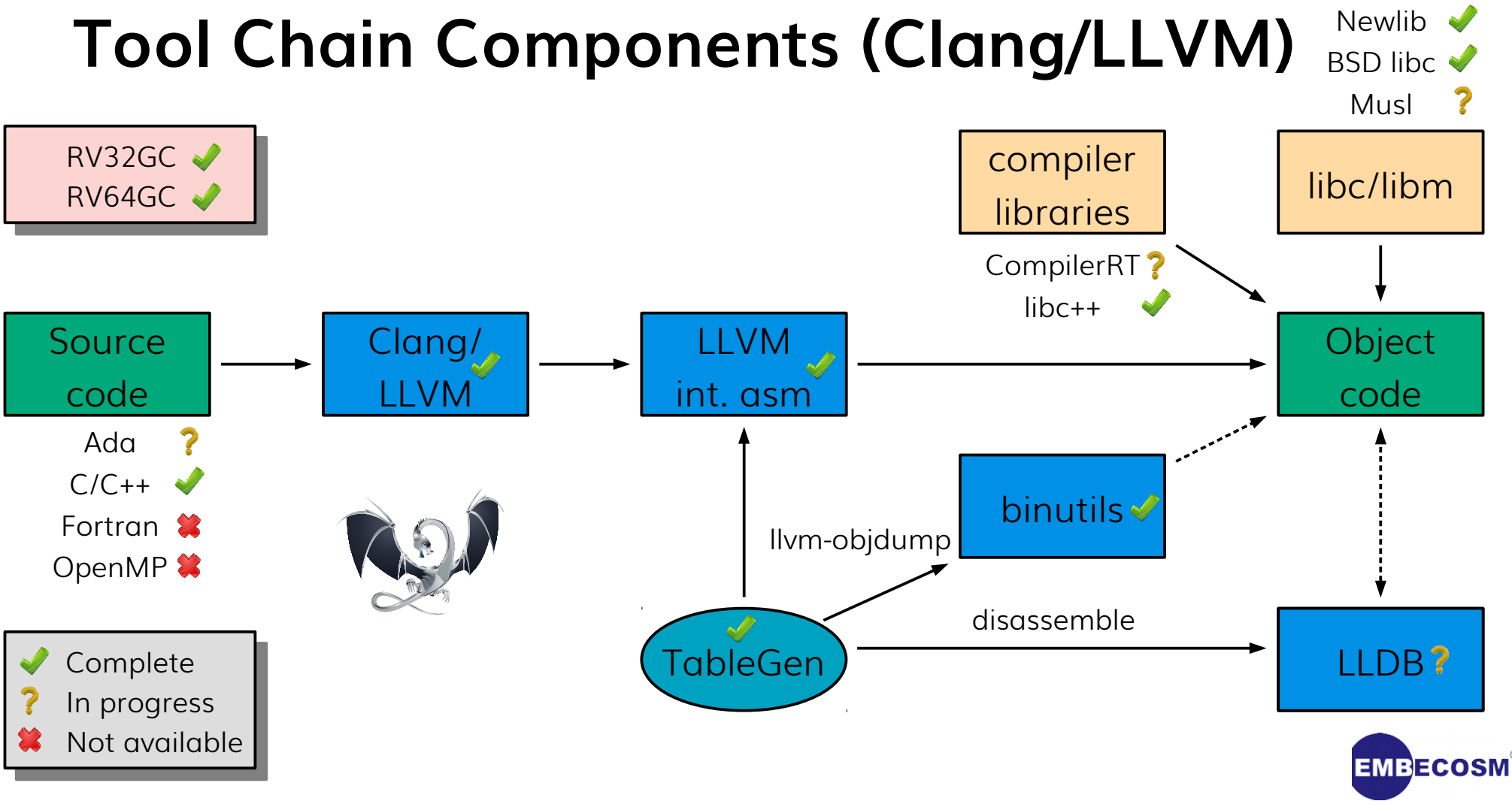
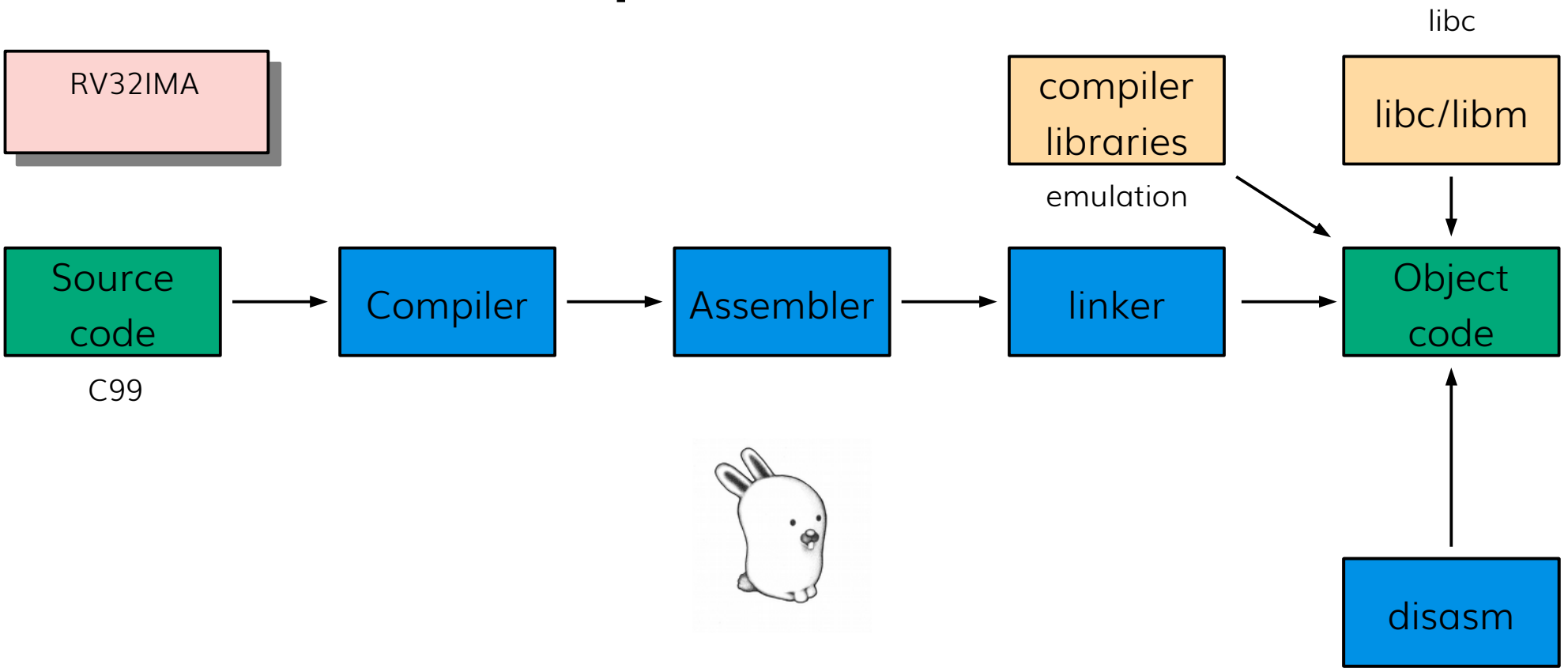


# Tool Chain Components (Plan 9)



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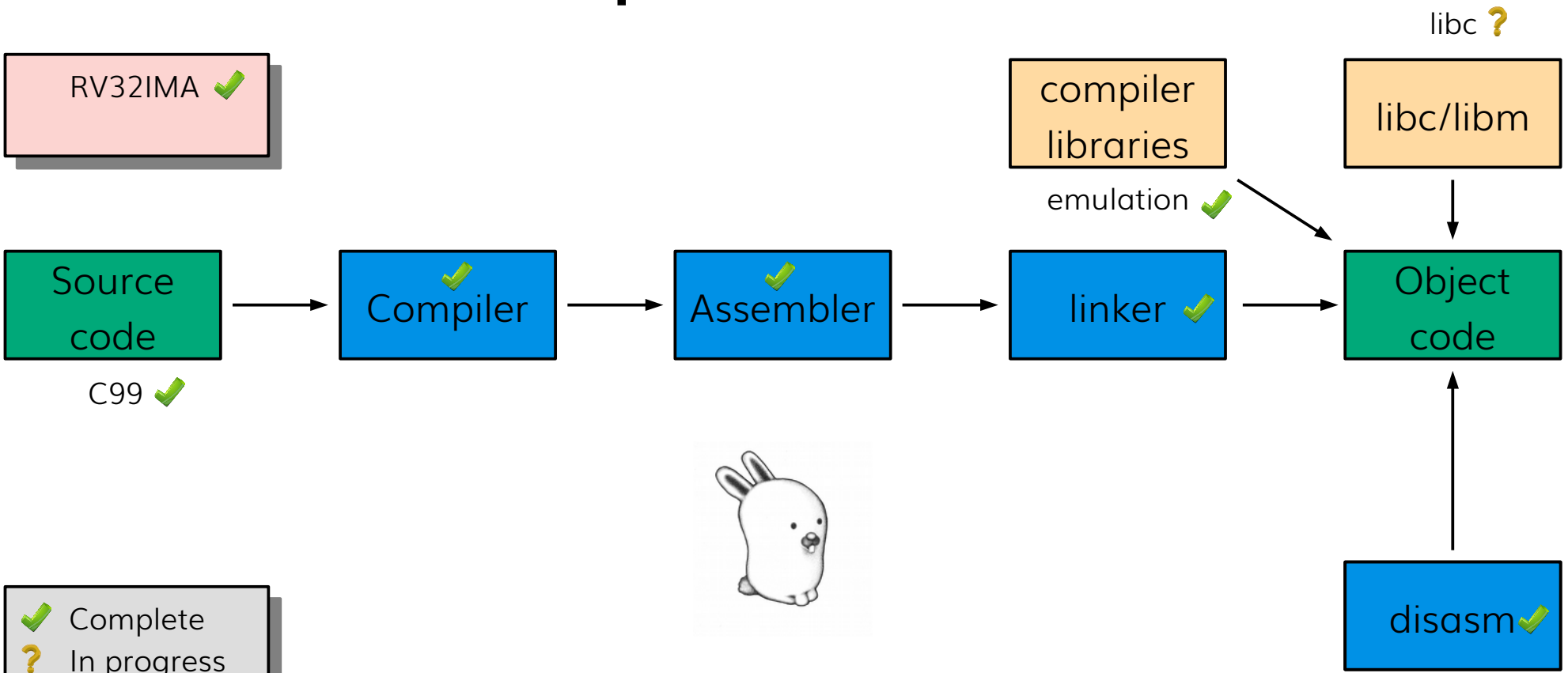


https://www.geeklan.co.uk/files/oshug69-Miller-criscv.pdf

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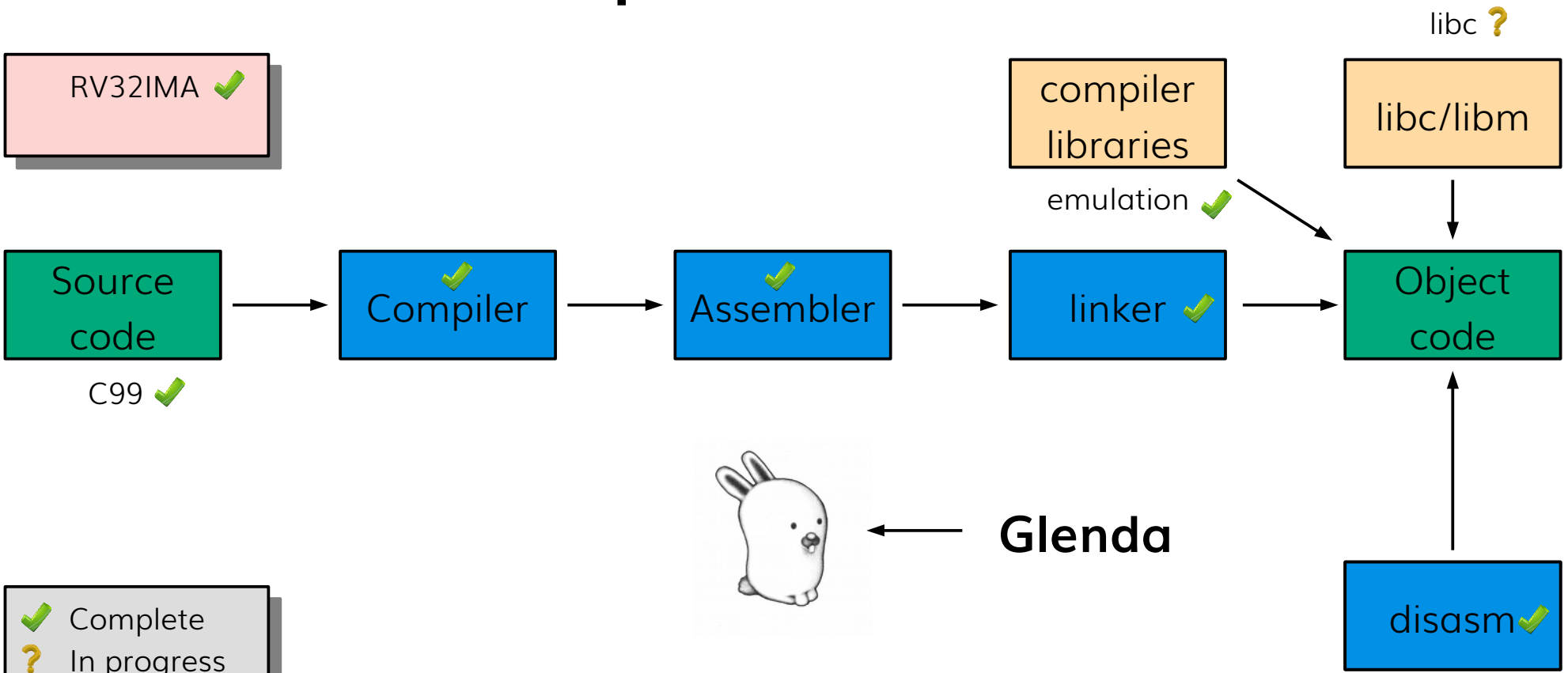
# Tool Chain Components (Plan 9)

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# GCC Quality (C/C++)

| | | 32-bit RISC-V | 64-bit RISC-V |
|---|---|---|---|
| **LIT** | Expected passes | - | - |
| | Expected failures | - | - |
| | Unsupported tests | - | - |
| | Unexpected failures | - | - |
| **GNU** | Expected passes | 92,378 | 93,458 |
| | Unexpected failures | 32 | 33 |
| | Unexpected successes | 2 | 3 |
| | Expected failures | 209 | 210 |
| | Unresolved tests | - | - |
| | Unsupported tests | 2,468 | 2,222 |

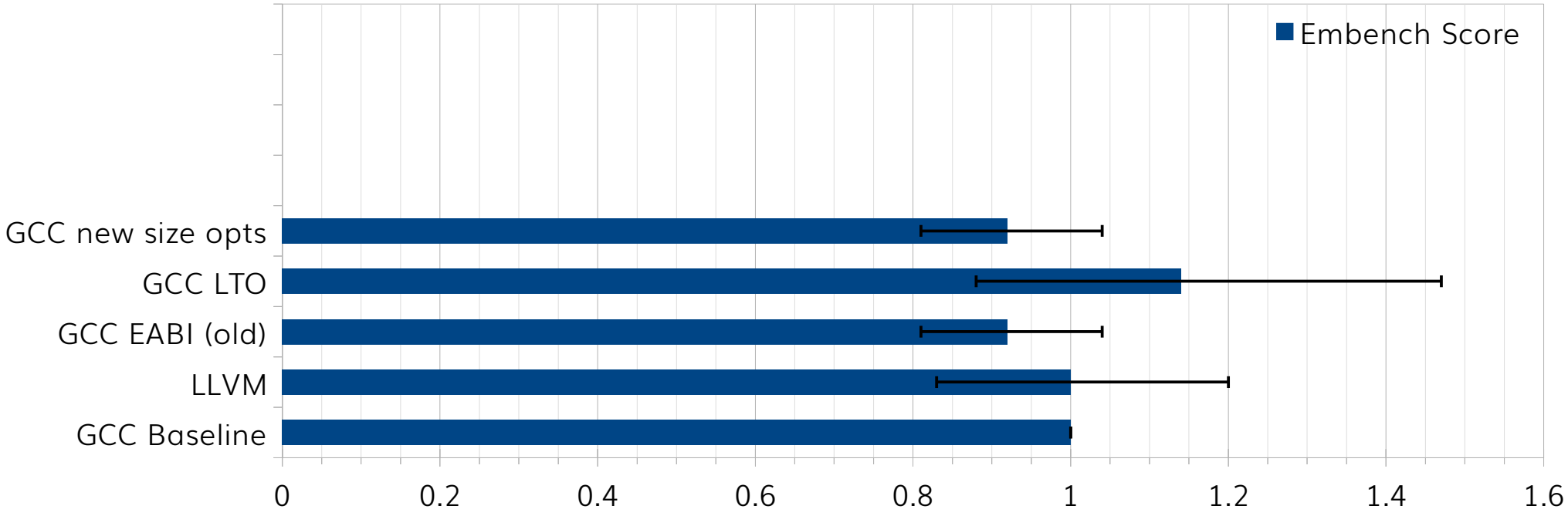
# Clang/LLVM Quality (C/C++)

| | | 32-bit RISC-V | 64-bit RISC-V |
|---|---|---|---|
| **LIT** | Expected passes | 46,135 | 46,136 |
| | Expected failures | 171 | 171 |
| | Unsupported tests | 427 | 427 |
| | Unexpected failures | 8 | 8 |
| **GNU** | Expected passes | | |
| | Unexpected failures | | |
| | Unexpected successes | | |
| | Expected failures | | |
| | Unresolved tests | | |
| | Unsupported tests | | |

# Clang/LLVM Quality (C/C++)

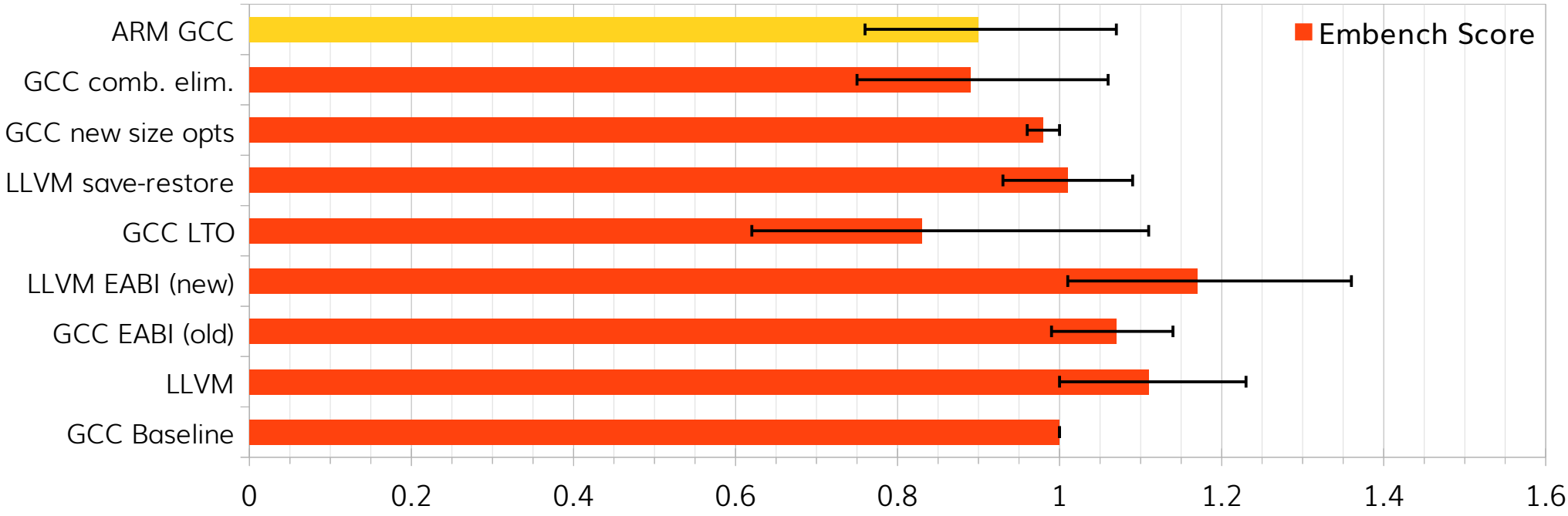
| | | 32-bit RISC-V | 64-bit RISC-V |
|---|---|---|---|
| **LIT** | Expected passes | 46,135 | 46,136 |
| | Expected failures | 171 | 171 |
| | Unsupported tests | 427 | 427 |
| | Unexpected failures | 8 | 8 |
| **GNU** | Expected passes | 28,579 | 28,568 |
| | Unexpected failures | 4,863 | 4,949 |
| | Unexpected successes | 4 | 4 |
| | Expected failures | 51 | 57 |
| | Unresolved tests | 1,851 | 1,861 |
| | Unsupported tests | 3,737 | 3,700 |

# Compiled Code Speed (RV32)




***Large*** **is good**

# Compiled Code Size (RV32)




***Small*** **is good**


# Operating Systems

Mark Corbin

# Debian

- Upstream 64-bit support as a 'ports architecture'
- Platforms - QEMU. HiFive Unleashed and LowRISC (with custom kernels).
- 88% of the Debian package archive builds for RISC-V
  - https://buildd.debian.org/stats/
- On-going work – change boot flow from BBL → U-Boot/OpenSBI
- Future plans – proper Debian Installer support, work towards 100% archive coverage (requires LLVM and Rust support), look at RV32 support
- Further details - https://wiki.debian.org/RISC-V

Information kindly provided by
Karsten Merker and Manuel A. Fernandez Montecelo

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# Fedora

- Upstream 64-bit support as a 'alternative architecture' (no 32-bit support planned)
- Platforms - QEMU and HiFive Unleashed
- Bootloader flow still in development – BBL → U-Boot/OpenSBI
- Boots to graphical desktop - https://abopen.com/news/building-a-risc-v-pc/
- Further details - https://fedoraproject.org/wiki/Architectures/RISC-V

Information kindly provided by
Richard W.M. Jones

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# Gentoo

- Upstream experimental 64-bit support
- Platforms - QEMU userspace only – no bootable systems yet
- Default ‘system set’ is complete
- Outstanding tasks – test more packages, automate build and update of installation stages/media
- Further details - https://wiki.gentoo.org/wiki/Project:RISC-V

Information kindly provided by
Andreas K. Huettel

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# openSUSE

- Upstream experimental 64-bit support
- Platforms - QEMU userspace only
- Build of openSUSE Factory, but missing some packages including LLVM and Rust.
- Outstanding tasks – add grub support to standardise the installation and boot process
- Further details - https://en.opensuse.org/openSUSE:RISC-V

Information kindly provided by
Andreas Schwab

# FreeBSD

- Upstream 64-bit support
- Platforms - QEMU and HiFive Unleashed
- HiFive Unleashed
  - Ethernet and SMP
  - No SD card support yet (ramdisk or NFS root)
  - See https://www.youtube.com/watch?v=nZsBp0Gbg_8
- Future plans - TODO list on Wiki page?
- Further details - https://wiki.freebsd.org/riscv

HiFive Unleashed details from mailing list post by Ruslan Bukin

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# NetBSD

- 64-bit support (not upstream)
- Platforms – Spike (not fully booting)
- Future plans – bootable system, userland, QEMU and HiFive Unleashed support
- Further details - http://wiki.netbsd.org/ports/riscv/

Information kindly provided by
Zachary McGrew and Maxime Villard

# Buildroot

- Upstream 32-bit and 64-bit support
- Platforms
  - QEMU
  - Coming soon … HiFive Unleashed (patches submitted)
- Most packages build - http://autobuild.buildroot.net/
- On-going work – maintain and remove forks
- Future plans – musl/uclibc support, additional board support, migrate to U-Boot/OpenSBI
- Further details - https://buildroot.org/

# OpenEmbedded/Yocto

- Upstream 32-bit and 64-bit support in OE-Core layer
- RISC-V Meta Layer - https://github.com/riscv/meta-riscv/
- Platforms - QEMU and HiFive Unleashed
- All standard packages work for 64-bit (and most work on 32-bit)
- Future plans – maintain and remove forks, add qemuriscv32/64 machines to OE-Core
- Further details - https://layers.openembedded.org/layerindex/branch/master/layer/meta-riscv/

Information kindly provided by
Alistair Francis

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# OpenWrt

- Upstream 64-bit support (in staging tree)
- Platforms - QEMU and HiFive Unleashed
- Supports musl (default C library for OpenWrt)
- Builds 99% of the OpenWrt package repo
- Further details - https://openwrt.org/docs/techref/hardware/soc/soc.sifive

Information kindly provided by
Alex Guo and Zoltan Herpai

# Apache MyNewt

- Platforms - HiFive1
- Further details - https://mynewt.apache.org/

# FreeRTOS

- Upstream 32-bit and 64-bit support
- Platforms – QEMU (sifive_e), Microsemi M2GL025 Mi-V and OpenISA Vega Board
- Future plans
  - will be adding support for IAR compilers
  - new features driven by user requests
    - Maybe ...floating point? ...memory protection? ...?
- Further details - https://www.freertos.org/Using-FreeRTOS-on-RISC-V.html

Information kindly provided by
Richard Barry

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# Zephyr

- Upstream 32-bit support
- Platforms
  - QEMU (sifive_e), HiFive1, Microsemi M2GL025 Mi-V and OpenISA Vega Board
  - Coming soon...HiFive1 Rev B and LiteX VexRiscv
- Future plans – SMP support, RV64 support, memory protection.
- Further details - https://www.zephyrproject.org/

Information kindly provided by
Nathaniel Graff

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# Plan 9

- Plan 9 C compiler has been re-targeted for RV32 (see https://www.geeklan.co.uk/files/oshug69-Miller-criscv.pdf)
- Compiler has been tested with a small subset of libc on a bare metal picoRV32 core
- Work not started on kernel

Information kindly provided by
Richard Miller

# Summary

- Common Issues
  - Waiting for mainline kernel to catch-up for HiFive Unleashed support
  - Need upstream 32-bit glibc for 32-bit Linux support
  - LLVM/Rust support needed for a number of package builds
  - Bootloader flow changing from BBL → U-Boot/OpenSBI
  - Broader range of (low cost) development platforms needed (especially Linux-capable 32-bit platform).
- Please let me have any changes or comments for updating:
  - https://github.com/riscv/riscv-wiki/wiki/RISC-V-Software-Status


# Thank You

mark.corbin@embecosm.com

www.embecosm.com