RTEMS Status and Roadmap

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Overview

- Roadmap next few release series
- Information on 4.11 release series
  - for background information on RTEMS Ecosystem, see last year's FSW presentation
- Improvements already merged post 4.11
- Desirable changes
- Hosting and infrastructure status and plans
- An important project announcement

Roadmap Highlights – 4.11 and 4.12

- 4.11 release series
  - branch cut
  - many improvements detailed later in slides
  - pending ftp site clean up
- 4.12 release series
  - remove obsolete architectures and BSPs
  - other improvements as they happen, detailed later in slides
  - last major release on autoconf/automake

Roadmap Highlights - 5.0

- Focus is on switching to waf based build system from Amar Takhar and process improvments
  - Create devel branch. This branch is open to development. Movement of source should be avoided if possible
  - Update Amar's waf branch to master
  - Merge Amar's waf branch onto master
  - Update all BSPs to build with waf
- Buildbot (http://buildbot.net) building all BSPs on each commit on master
- Integrate Phabricator (http://phabricator.org) into project workflow
- When ready, merge the devel branch onto master and delete the devel branch
- This enables any desired source tree restructure to occur
- Add more use of Buildbot:
  - building 3rd party packages (e.g. NTP, netsnmp, graphics, etc.)
  - building development tools (e.g. gcc, binutils, etc.)
- Stability testing

Note the proposed version number scheme

Numbering Past 5.0

- 5.0, 5.1, 5.2… are minor releases
  - comparable 4.10.0, 4.10.1, …
- 6.0 will be a major release
  - 6.1, 6.2, … will be follow minor releases
- This scheme has been adopted by GCC and other major projects

RTEMS 4.11 Features

- SMP is no longer experimental
  - SPARC up to four cores with LEON3 and NGMP
  - PowerPC up to 24 cores on QorIQ
  - ARM on Zynq, Cyclone V, Realview
  - x86 needs algorithm update in context switch
- New architecture ports
  - ephipany, moxie, nios2, or1k, sparc64, v850
  - Collectively added 12 new BSPs
- Many other new features
  - JFFS2, dynamic loading, tracing, warning removal, etc.

New BSPs in 4.11

- 59 more BSPs that in 4.10 even after removing some
- This table is ONLY BSPs added to existing ports

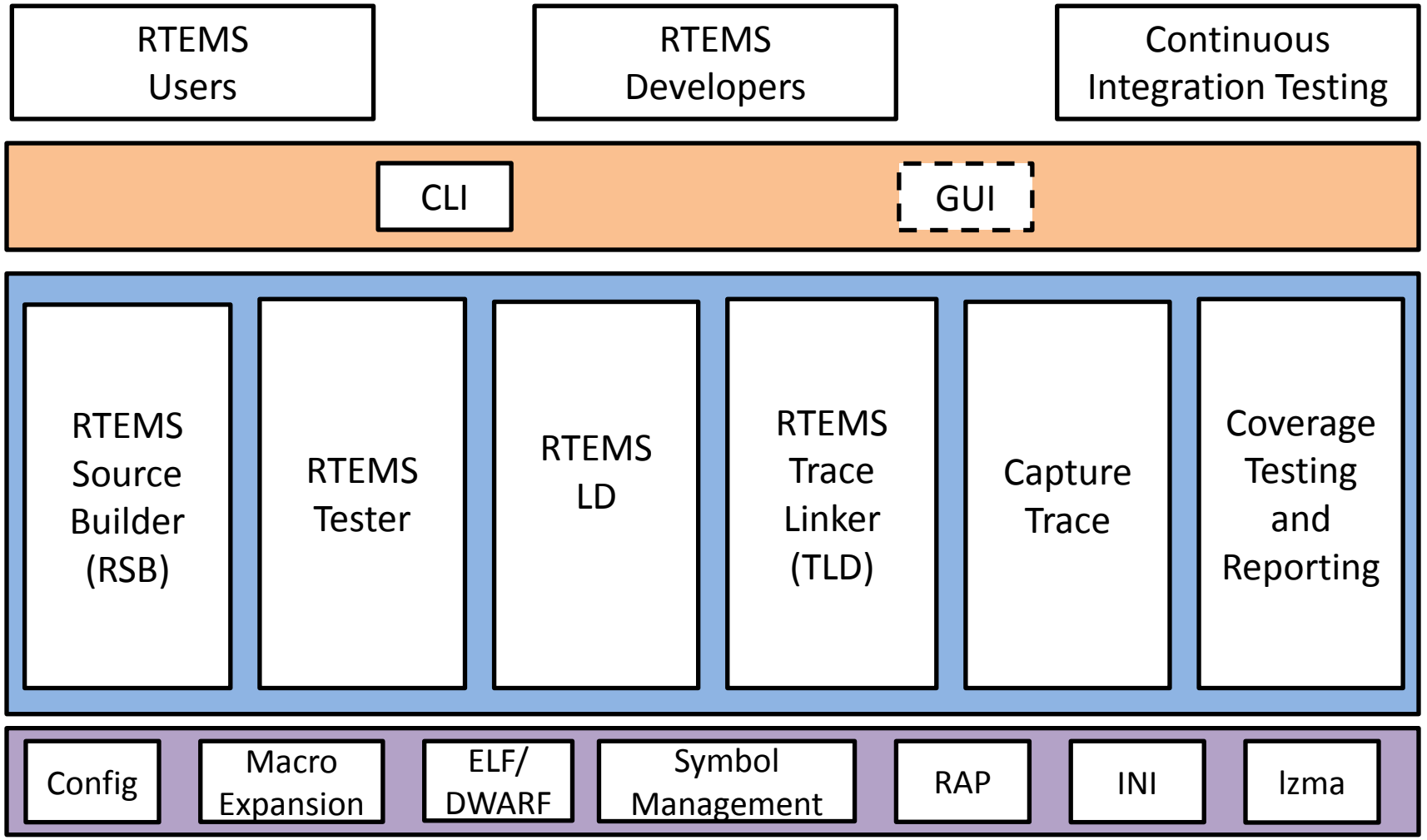
ARM	altcycv_devkit, altcycv_devkit_smp, beagleboardorig, beagleboardxm, beagleboneblack, beaglebonewhite, lm3s3749, lm3s6965, lm3s6965_qemu, lm4f120, lpc1768_mbed_ahb_ram, lpc1768_mbed_ahb_ram_eth, lpc1768_mbed, lpc17xx_ea_ram, lpc17xx_ea_rom_int, lpc17xx_plx800_ram, lpc17xx_plx800_rom_int, lpc23xx_tli800, lpc24xx_plx800_ram, lpc24xx_plx800_rom_int, lpc40xx_ea_ram, lpc40xx_ea_rom_int, lpc32xx_mzx, lpc32xx_mzx_stage_1, lpc32xx_mzx_stage_2, raspberrypi2, raspberrypi, realview_pbx_a9_qemu, realview_pbx_a9_qemu_smp, stm32f105rc, stm32f4, tms570ls3137_hdk, tms570ls3137_hdk_intram, tms570ls3137_hdk_sdram, xilinx_zynq_a9_qemu, xilinx_zynq_zc702, xilinx_zynq_zc706, xilinx_zynq_zedboard
I386	edison, pcp4
MIPS	malta
PowerPC	brs6l, dp2, br_uid, mpc8309som, qemuprep-altivec, qemuprep, mpc5566evb_spe, mpc5643l_dpu, mpc5643l_evb, mpc5668g, mpc5674f_ecu508_app, mpc5674f_ecu508_boot, mpc5674fevb, mpc5674fevb_spe, mpc5674f_rsm6, phycore_mpc5554, qoriq_core_0, qoriq_core_1, qoriq_p1020rdb, qoriq_t2080rdb, qoriq_t4240rdb, t32mppc, virtex4, virtex5
SPARC	NGMP

4.11 Tools Versions

- Cross development tools
  - GCC – 4.9.2
  - GNU Binary Utilities – 2.24
  - GDB – 7.9
  - Newlib – 2.20 snapshot from 20150423
  - Autoconf – 2.69
  - Automake – 1.12.6
- Qemu – 2.3.50

- NOTE: Some may have patches applied by RSB and some targets may not use these versions

RTEMS Tools Overview



RTEMS 4.11 Tools Status

- RTEMS Source Builder to build cross development tools, supporting tools, and target libraries
  - provides source and reproducible results appropriate for configuration control
- RTEMS Tester to enable users to test on the own hardware or simulators
- 4.11 includes initial release or significant update of
  - RTEMS Trace Linker
  - RTEMS Dynamic Loader and RTEMS LD
  - RTEMS Capture Engine
- Possible: More granular coverage test reporting

4.12 Improvements in Place

- Addition of lightweight API to be used by infrastructure packages
  - GCC run-times, newlib, etc.
- C++11 and C11 support
  - focus is on concurrency support for RTEMS
- Newlib locking
- OpenMP supported and optimized
  - Two cores and 24 core configuration on T4240
  - See RTEMS Trac ticket #2274 for optimizations

OpenMP Optimization #1

- GCC Improvement from 4.9.3 to 6.0
  - optimized use of malloc()/free()

GCC 4.9.3 on Two Core T4240

- barrier bench 20.6147 seconds
- parallel bench 16.8791 seconds
- static bench 0.852061 seconds
- dynamic bench 0.292199 seconds

GCC 6.0 on Two Core T4240

- barrier bench 23.3409 seconds
- parallel bench 9.60804 seconds
- static bench 0.472419 seconds
- dynamic bench 0.223881 seconds
- guided bench 0.00999273 seconds
- runtime bench 0.229282 seconds
- single bench 2.18316 seconds

OpenMP Optimization #2

- RTEMS Improvement post 4.11
  - use new lightweight API
  - results are GCC 6.0 on **24 core T4240**

Using pthread API

- barrier bench 783.888 seconds
- parallel bench 115.901 seconds
- static bench 5.7876 seconds
- dynamic bench 0.262251 seconds
- guided bench 0.0133215 seconds
- runtime bench 0.261378 seconds
- single bench 57.3227 seconds

Using new lightweight API

- barrier bench 5.74687 seconds
- parallel bench 2.38893 seconds
- static bench 0.118236 seconds
- dynamic bench 0.2516 seconds
- guided bench 0.00146854 seconds
- runtime bench 0.250789 seconds
- single bench 0.543456 seconds

- Most tests showed 10-100x improvement
- Two core configuration showed similar improvements

Goals for 4.12

- Removal of obsolete ports
- Removal of obsolete BSPs

- Improvements like OpenMP, C11, C++11 work will be included
- Other work included as it appears
- Last major release on autoconf/automake

Help us ensure no BSPs in use are removed

5.0 Changes

- Minimum goal conversion to waf build system
- Requires reorganization of include files to avoid preinstall phase of build
  - improves dependency tracking of builds
- Desirable to reorganize c/ subdirectory
  - make source easier to navigate and understand
  - shed legacy of not moving directories due to CVS
- Desirable to convert documentation to something more modern than texinfo

Waf Background

- Build system from Samba written in Python
  - https://github.com/waf-project/waf
- Computes full dependency tree, maximally parallelizes build using all available cores
- Already used on other RTEMS repositories
- Much faster than current build system
  - takes 12 seconds to 2 minutes from end of *git clone* to all tests built for sparc/sis depending on host OS and hardware
  - https://devel.rtems.org/wiki/waf/Timing

Desirable Changes

- RSB support for all ported third party packages
  - most known are in place now or patches posted
  - allows removal of two RTEMS git repositories
- TCP/IP stack desirable changes
  - More BSPs support new FreeBSD TCP/IP stack
  - More BSPs support port of LWIP
  - Current FreeBSD TCP/IP stack builds separate from RTEMS
- BSP Specific SMP Issues
  - Raspberry Pi 2: GSoC student worked on support, didn't finish
  - Update x86 to account for SMP context switch locking algorithm and update IRQ to APIC

Hosting and Infrastructure Status

- Hosting now at Oregon State University Open Source Laboratory (https://osuosl.org/) using multiple single purpose VMs versus multi-purpose single host
  - this did cause some URLs to break
- Since 4.10, project has switched to git from CVS, Trac from Mediawiki and Bugzilla, and updated to latest Texinfo allowing us to eliminate our own tool
- Future Hardware Infrastructure Plans
  - need another build machine dedicated to building tools
  - need more RAM and storage for machines (purchased with space to grow)
  - Mac for testing as host

All volunteer effort! Please pitch in!

Future Process Infrastructure Plans

- New infrastructure enables new capabilities
- Future plans
  - incorporate web based patch review and submission system (Phabricator)
    - eventually a patch will be tested before a human sees it
  - establish continuous integration and testing so every commit results in an appropriate test sweep (Buildbot)
  - provide database of test results
  - refresh user documentation in modern tools

Anything else we can use computers to help with

Micromonitor

- Micromonitor or uMon (https://git.rtems.org/umon) is an Apache licensed alternative to U-Boot developed over 15 years by Ed Sutter.
- was only recently relicensed to Apache
  - has history of use with RTEMS
  - now absorbed into the RTEMS Project
- GSoC student Jarielle Catbagan worked with Ed Sutter to move the target independent code into a new git repository and ensure it could be built by anyone
  - older, pre Apache licensed code at http://www.umonfw.com
- Jarielle ported uMon to the BeagleBone Black
- Low level ARM CPU initialization specific to the BBB. This include DDR3 memory, UART console I/O, and eMMC/SD card.
- uMon capable of booting from eMMC/SD card and via UART
  - network support not exercised in new repository
- Current developments include Ethernet functionality, RSB Integration, and application booting

Announcement #1

Relicensing to Two Paragraph BSD

- Original rationale for *GPL v2 + exception*
  - felt needed to establish a community
  - "stick" to encourage submissions
  - license was used by GCC language run-times
- Rationale to switch
  - RTEMS has a strong community
  - users understand business value of submitting
    - we have explained the "carrot"
  - GPL v3 has soured some on GPL in general

Mechanics of Switching

- Permission from each submitter must be obtained
  - permission obtained from top contributors
- All contributors to a file must give permission before that file can be relicensed
- Web form with confirmation email to grant permission to relicense
- Effort will be made to locate the “missing”

When Permission is Not Obtained

- Some files may never be relicensed
- If user funds, replacement may be written
- Older BSPs and ports may be obsoleted and removed on technical grounds
  - These are the most likely to contain files to have contributors that are hard to find

Generation of License Report

- We are considering marking files with Linux Foundation sponsored SPDX.org annotation
- Standard annotation for open source licenses
  - Examples: NASA-1.3, GPL-2.0
- Can annotate exceptions like current RTEMS license
  - Example: GPL-2.0-with-linking-exception
- Tools exist to generate overall license reports
  - RTEMS would have to integrate one with build system

Conclusion

- Work is ongoing and evolving
- Evolution is driven by feedback
- Community involvement and sponsorship is needed to keep technical work from dragging
- License change is important to community

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Backup Slides

RTEMS Source Builder (RSB)

- RSB contains “recipes” for building host tools and target packages from source
  - enables configuration management of source and patches
- Host independent way to obtain environment
- Full source and patches
- Use RSB to fetch source and build
  - RTEMS tools
  - cross development environment
  - RTEMS (or by hand)
  - simulators if desired
  - third Party Packages for target system

RSB Example

- Obtain RTEMS RSB from git or release
  - `git clone git://git.rtems.org/rtems-source-builder.git`
- Check basic host environment
  - `cd rtems-source-builder`
  - `source-builder/sb-check`
- Build SPARC toolset
  - `cd rtems`
  - `../source-builder/sb-set-builder --log=l-sparc.txt \`
    `--prefix=$HOME/development/rtems/4.11 4.11/rtems-sparc`
- Takes approximately 17 minutes on a (modest) quad-core machine

RTEMS Tester

- Automates testing on simulators and hardware using GDB Machine Interface (MI)
  - direct execution using various simulators
  - takes advantage of multiple cores to parallelize simulator testing
- Execute RTEMS Test Suite

```
~/development/rtems/test/rtems-tools.git/tester/rtems-test \
    --log=log_sis_run  --rtems-bsp=sis-run \
    --rtems-tools=$HOME/development/rtems/4.11 \
    sparc-rtems4.11/c/sis/testsuites
```

- Takes ~24 minutes single threaded but 11.3 minutes with tester on modest 2.4Ghz quad code
  - Note: end up waiting for longest to complete or timeout

- Future plans
  - reduce run-time of longest running tests
  - automatically calibrate performance of simulators and scale the timeouts
  - execute GCC Test Suite
  - execute tests on other components
  - compare results with RTEMS Project
    - requires RTEMS Project to provide a populated test results database