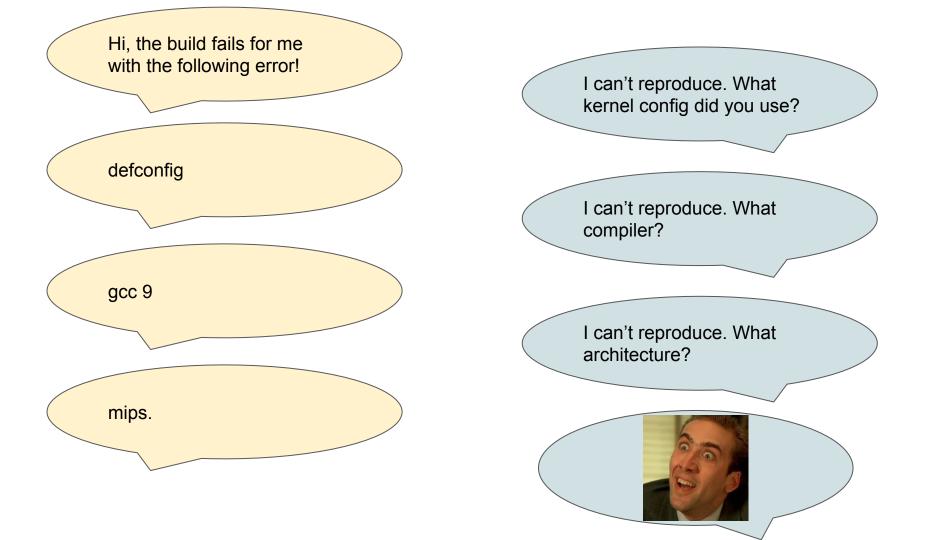
TuxMake and TuxBuild

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Linux Kernel Building Problem Statements

- Build environments are not reproducible
- Build environments are not portable
- Building the matrix of toolchains x architectures x configs x targets non-trivial
- Each toolchain, architecture, config, and target being built has user-space requirements
- Managing build artifacts can be messy
- Automating of the above is usually DIY and non-portable
- Making build artifacts available for testing is non-trivial
- Build coverage is generally constrained by hardware and integration effort

What if we could version and distribute build environments similarly to how we version Linux source code?

What if we weren't constrained by build capacity?

Introducing TuxMake

- Open source, MIT licensed
- Thin wrapper around Linux kernel builds
- Python based command-line tool and library
- Provides portable and hermetic docker-based build environments
 - Pristine build containers contain kernel building requirements and nothing more; debian-based
- Provides common interface to building across architectures, toolchains, configs, and targets
- Collects artifacts in common location per-build; kernel source is read-only
- 100% unit and integration test coverage, requires only python core libraries
- Written and maintained by Antonio Terceiro <<u>antonio.terceiro@linaro.org</u>>

Opinionated Defaults - build everything; native arch

\$ tuxmake

command line: tuxmake

make --silent --keep-going --jobs=72 0=/home/dan.rue/.cache/tuxmake/builds/1/tmp defconfig make --silent --keep-going --jobs=72 0=/home/dan.rue/.cache/tuxmake/builds/1/tmp grep -q CONFIG MODULES=y /home/dan.rue/.cache/tuxmake/builds/1/tmp/.config make --silent --keep-going --jobs=72 0=/home/dan.rue/.cache/tuxmake/builds/1/tmp modules make --silent --keep-going --jobs=72 0=/home/dan.rue/.cache/tuxmake/builds/1/tmp modules i tar caf /home/dan.rue/.cache/tuxmake/builds/1/tmp/modules.tar.gz -C /home/dan.rue/.cache/t test -d arch/x86 64/boot/dts # Skipping dtbs because precondition failed I: config: PASS in 0:00:01.308105 I: kernel: PASS in 0:00:52.821837 I: modules: PASS in 0:00:02.641460 I: dtbs: SKIP in 0:00:00 I: build output in /home/dan.rue/.cache/tuxmake/builds/1

Build in Docker using '--runtime docker'

\$ tuxmake --runtime docker # command line: tuxmake --runtime docker Using default tag: latest latest: Pulling from tuxmake/x86_64_gcc Digest: sha256:5a9fb76b7c5725725235e5d76b3e5cef0765a57a4db68fcddlc2deb45638aa61 Status: Image is up to date for tuxmake/x86_64_gcc:latest docker.io/tuxmake/x86_64_gcc:latest make --silent --keep-going --jobs=72 0=/home/dan.rue/.cache/tuxmake/builds/2/tmp defconfig make --silent --keep-going --jobs=72 0=/home/dan.rue/.cache/tuxmake/builds/2/tmp

- Requires docker to be available
- Each 'make' command happens transparently in an ephemeral docker container
- Source and output paths are mounted in; build runs as your uid
- x86_64 and arm64 native containers provided by default for each supported cross-build target architecture and toolchain

Build arm64 with clang-10 using Docker

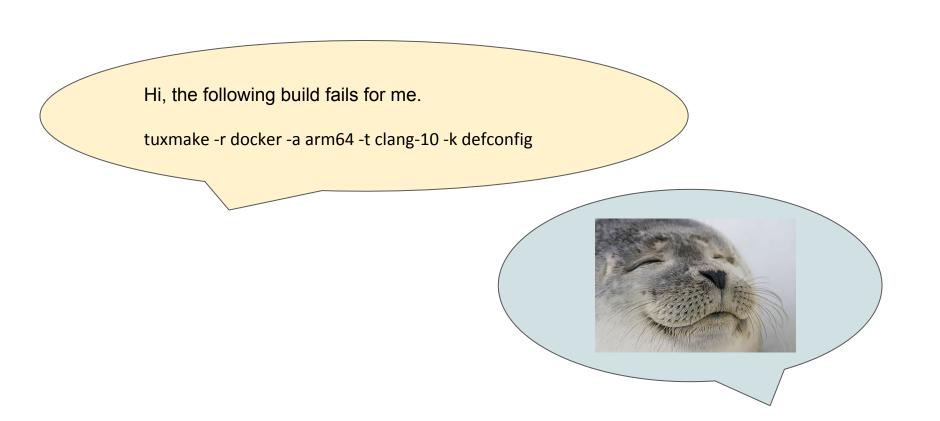
\$ tuxmake --runtime docker --toolchain clang-10 --target-arch arm64 # command line: tuxmake --runtime docker --toolchain clang-10 --target-arch arm64 Using default tag: latest latest: Pulling from tuxmake/arm64_clang-10 Digest: sha256:e8128416588564c2a3294d8be1690799bd46b9349bbb7160e61a8a0dfc9d2023 Status: Image is up to date for tuxmake/arm64_clang-10:latest docker.io/tuxmake/arm64_clang-10:latest make --silent --keep-going --jobs=72 0=/home/dan.rue/.cache/tuxmake/builds/3/tmp ARCH=arm64 CROSS_CO MPILE=aarch64-linux-gnu- HOSTCC=clang-10 CC=clang-10 defconfig make --silent --keep-going --jobs=72 0=/home/dan.rue/.cache/tuxmake/builds/3/tmp ARCH=arm64 CROSS_CO MPILE=aarch64-linux-gnu- HOSTCC=clang-10 CC=clang-10

Build artifacts are saved in ~/.cache/tuxmake/

```
ls /home/dan.rue/.cache/tuxmake/builds/1
build.log bzImage config metadata.json modules.tar.gz
 head -15 metadata.json
    "build": {
        "targets": [
            "config",
           "kernel",
            "modules",
            "dtbs"
        ],
        "target arch": "x86 64",
        "toolchain": "gcc",
        "wrapper": "none",
        "environment": {},
        "kconfig": "defconfig",
        "kconfig add": [],
        "jobs": 72,
```

Supported architecture/toolchain combinations

ar	c a	rm a	arm64	i386	mips	riscv	x86 64
clang yes	s y	es)	/es	yes	yes	yes	yes
gcc yes	s y	es)	/es	yes	yes	yes	yes
\$ tuxmake	epr	int-sup	oport-m	natrix	runti	me docke	er
	arc	arm	arme	i4 i38	6 mip	s ris	cv x86 64
clang	no	yes	yes	yes	yes	yes	yes
clang-10	no	yes	yes	yes		yes	yes
clang-8	no	yes	yes	yes	no	yes	yes
clang-9		yes	yes	yes		yes	yes
gcc	yes	yes	yes	yes	yes	yes	yes
gcc-10	no	yes	yes	yes	no	yes	yes
gcc-8		yes	yes	yes	yes	yes	yes
gcc-9	yes	yes	yes	yes	no	no	yes



Getting Started

- Current status: Alpha
- 'pip3 install tuxmake'
- Debian packages coming soon
- Project location: <u>https://gitlab.com/Linaro/tuxmake</u>
- Feature requests: <u>https://gitlab.com/Linaro/tuxmake/-/issues</u>

Introducing TuxBuild

- Fully managed service by Linaro
- Open source command-line client; closed-source back end
- Solves the build capacity problem
- Provides TuxMake "as-a-service"
- Cloud-native highly concurrent Linux kernel building service
- Easy to integrate with CI or developer workflows
- Used in production by LKFT since January 2020
- Supports individual builds as well as build sets
- Interface and features similar to TuxMake's
 - gcc 8/9/10, clang 8/9/10
 - Arm64, arm, x86_64, i386, mips, arc, riscv



TuxBuild Example

\$ tuxbuild build --git-repo 'https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git' -git-ref master --target-arch arm64 --kconfig defconfig --toolchain clang-10
Building Linux Kernel https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git at master
Z Queued: arm64 (defconfig) with clang-10 @ https://builds.tuxbuild.com/aU0afv8mBPYHcr_oJ7gryQ/
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vfio") arm64 (defconfig) with clang-10 @ https://builds.tuxbuild.com/aU0afv8mBPYHcr_oJ7gryQ/



TuxBuild Artifact Hosting

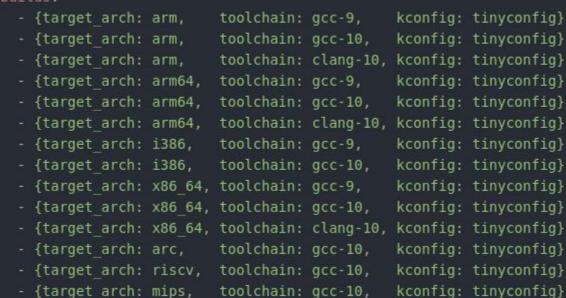
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\rightarrow C \triangle builds.tux	ouild.com/aU0afv8mBPYHcr_oJ7gryQ/	🖈 🥵 Z 🕼 🄌 🇯 酇	
Filename	Last Modified	Size	
Parent Directory			
🖕 dtbs			
Image	4 minutes ago	29M	
System.map	4 minutes ago	5M	
bmeta.json	4 minutes ago	1К	
build.log	4 minutes ago	2К	
build_definition.json	3 minutes ago	646B	
dtbs.json	4 minutes ago	15K	
kernel.config	4 minutes ago	221K	
modules.tar.xz	4 minutes ago	6M	
status.json	3 minutes ago	463B	
vmlinux.xz	4 minutes ago	56M	



Build Set Definition - can be local or a URL

- name: basic

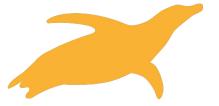
builds:



kconfig: tinyconfig} kconfig: tinyconfig}

Build Set Definition - can be local or a URL

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₩ buitding: /eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awitliam/linux-vfio") arm64 (tiny
Building: /eac66d0456f ("Merge tag 'vio-v.5-rc2' of git://github.com/awilliam/linux-vfio") afmod (lin)
A Pass (1 warnig): reac66d0456f ("Merge tag' vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") x86
Pass: 7eac66d0456f ("Merge tag 'vfo-v5.9-rc2' of git://github.com/awilliam/linux-vfio") i386 (tinyconfi
Pass: 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") arm64 (tinycont
🞉 Pass: 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") arm64 (tinycon1
Pass: 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") arc (tinyconfic
Pass: 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") i386 (tinyconfi
Pass: 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") arm (tinyconfic
Pass: 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") riscv (tinycon
🎉 Pass: 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") arm (tinyconfic
🎉 Pass: 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") mips (tinyconfi
🎉 Pass: 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") arm64 (tinycon1
🚔 Pass (1 warning): 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") x80
🎉 Pass: 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") arm (tinyconfig
Pass (1 warning): 7eac66d0456f ("Merge tag 'vfio-v5.9-rc2' of git://github.com/awilliam/linux-vfio") x80



Kernel Maintainer Build Pipeline in GitLab

3 jobs for lkft	-to-test-android-3.18-local in 14 minutes
P latest	
- o- 2a9967c3	ĥ
No related merg	je requests found.
Pipeline DAG Job	s 8 Tests 0
Build	
Juild-arm64-gcc	-0
🕑 build-arm64-gcc	-0
Juild-arm-gcc-8	0
Juild-arm-gcc-9	0
Juild-i386-gcc-8	0
build-i386-gcc-9	0
build-x86-gcc-8	0
Juild-x86-gcc-9	0

- Automatically builds after a git push
- 268 builds, including allmodconfig, allnoconfig for 4 architectures
- Completes in 14-16 minutes



https://gitlab.com/Linaro/lkft/users/lee.jones/lag-linaro-linux/-/pipelines

LKFT Pipeline

- LKFT builds kernels with TuxBuild and then tests them on hardware
- Performs ~70 builds in ~15 minutes

https://lkft.linaro.org/

Build	Sanity		Test	
🕑 build-arm64-gcc	sanity-i386		test-db410c	0
🕑 build-arm64-gcc 🖸	Sanity-juno	0	test-db410c-igt	0
🕑 build-arm64-gcc	sanity-x15	C	test-hikey	C
🕑 build-arm-gcc-9 🖸	sanity-x86_64	C	test-i386	C
🕑 build-i386-gcc-9 🖸			🕑 test-juno	0
🕑 build-x86-gcc-9 🖸			etest-juno-64k_pa	a C
🕑 build-x86-gcc-9 🖸			test-juno-compa	at C
S buildset-arc			🕑 test-juno-kasan	0
S buildset-arm			test-Is2088a	0
S buildset-arm64			test-qemu-arm	0
🕑 buildset-i386 🖸			test-qemu-arm6	40
🕑 buildset-mips 😨			test-qemu-i386	0
🕑 buildset-riscv 😧			test-qemu-x86_0	54
🕑 buildset-x86 🖸			test-x15	C
			test-x15-igt	0

Getting Started

- TuxBuild is a fully managed service by Linaro
- TuxBuild Status: Early Access
 - Reach out to us at <u>tuxbuild@linaro.org</u> to be added to our waiting list.
- More information and TuxBuild CLI can be found at https://gitlab.com/Linaro/tuxbuild

