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Porting Graphical Stacks to RISC-V using QEMU and Yocto

Alistair Francis <Alistair.Francis@wdc.com>

Presented by: Atish Patra <Atish.Patra@wdc.com>

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GUIs are important

- For RISC-V to compete with other incumbent architectures it will need support to run a Graphical User Interface (GUI).
- Users are accustomed to GUIs everywhere. From cars to smart fridges everything has a GUI
- The ones presented by Android™ and iOS™ are the most ubiquitous

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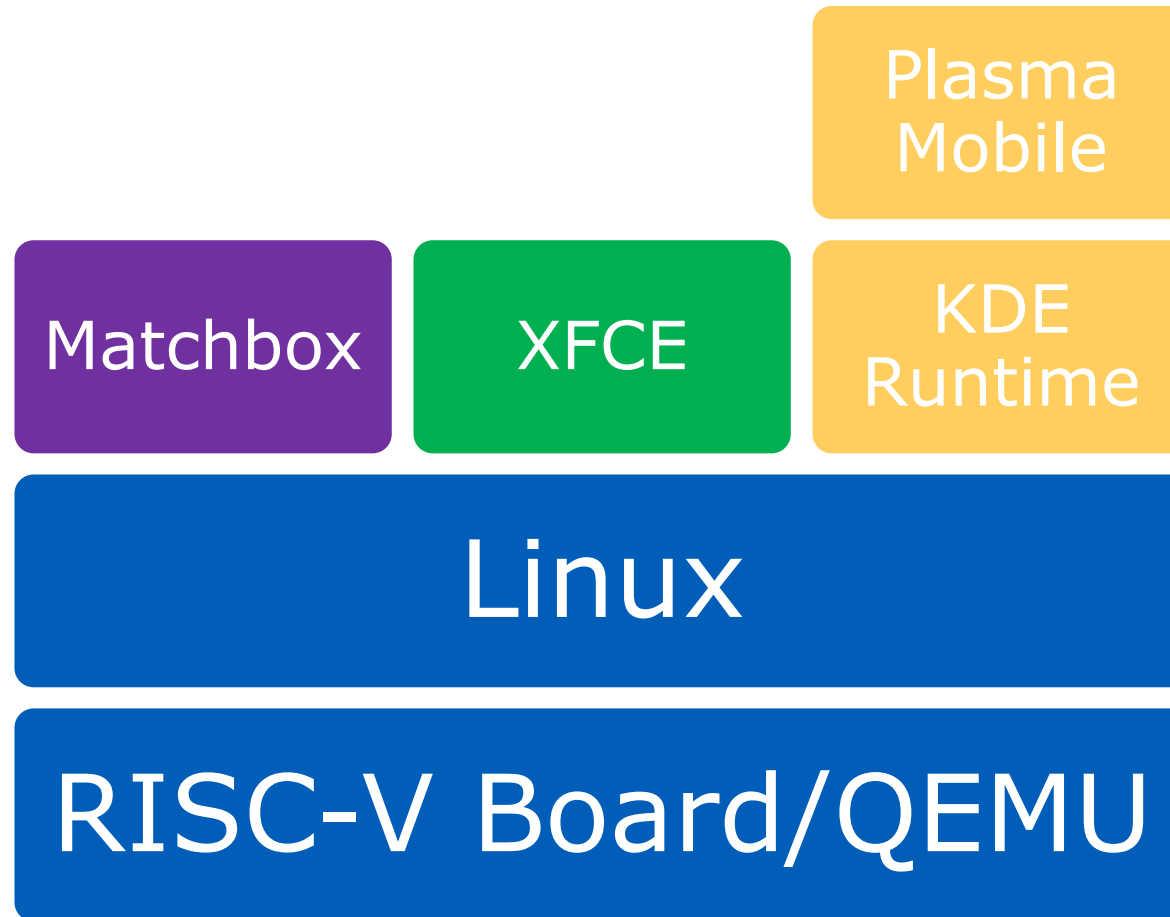
Privacy and Open Source are also important

- With the rise of open source software and people becoming increasingly privacy conscious there is a growing number of open source smartphone software stacks that compete against Android and iOS
- Users are interested in more open software stacks that take their privacy into consideration

Don't we already have GUIs?

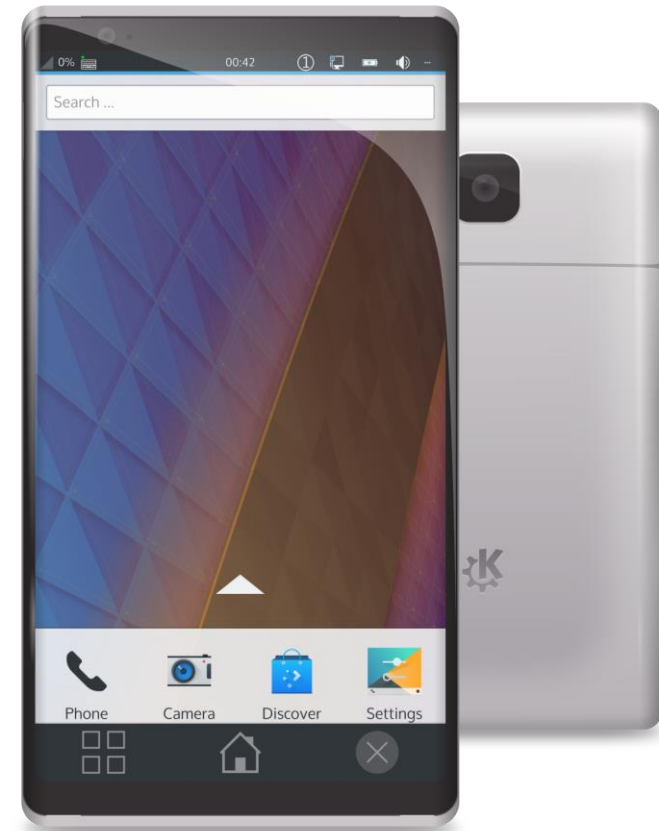
- What we have are some standard Desktop distribution (Debian, Fedora) environments
- This presentation is instead focused on
 - Trying to run a mobile distribution (Plasma Mobile)
 - Building the distribution ourselves (with Yocto)
 - Testing on QEMU with virtual GPUs and virtual displays

The software and hardware layers



Plasma Mobile and KDE

- Plasma Mobile is the mobile version of the KDE Plasma Environment
- It has an active development community behind it backed by the KDE desktop environment project developers
- It is running on real ARM hardware (Nexus 5) today
- Offers a complete software system for mobile devices with a strong focus on user's privacy protection
- Builds on top of Qt5



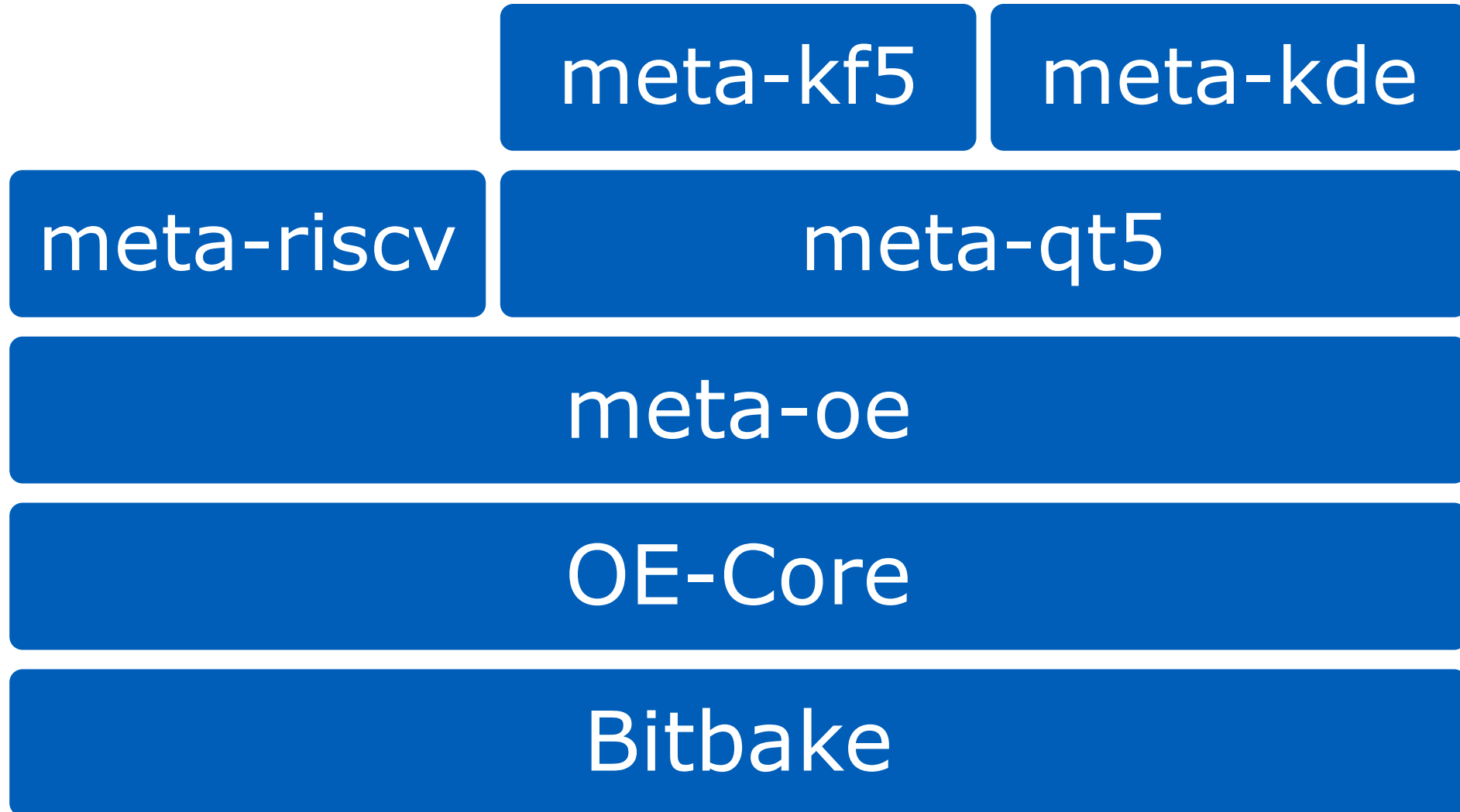
QEMU

- QEMU is a very quick open source (mostly GPLv2) emulator and hypervisor
- It is not cycle accurate, but it is functionally accurate
- It uses Tiny Code Generator (TCG) to translate different architecture instructions (guest) to the host PC (host)
- QEMU supports RISC-V machines!
- QEMU also supports PCIe, virtual GPUs, displays and input devices

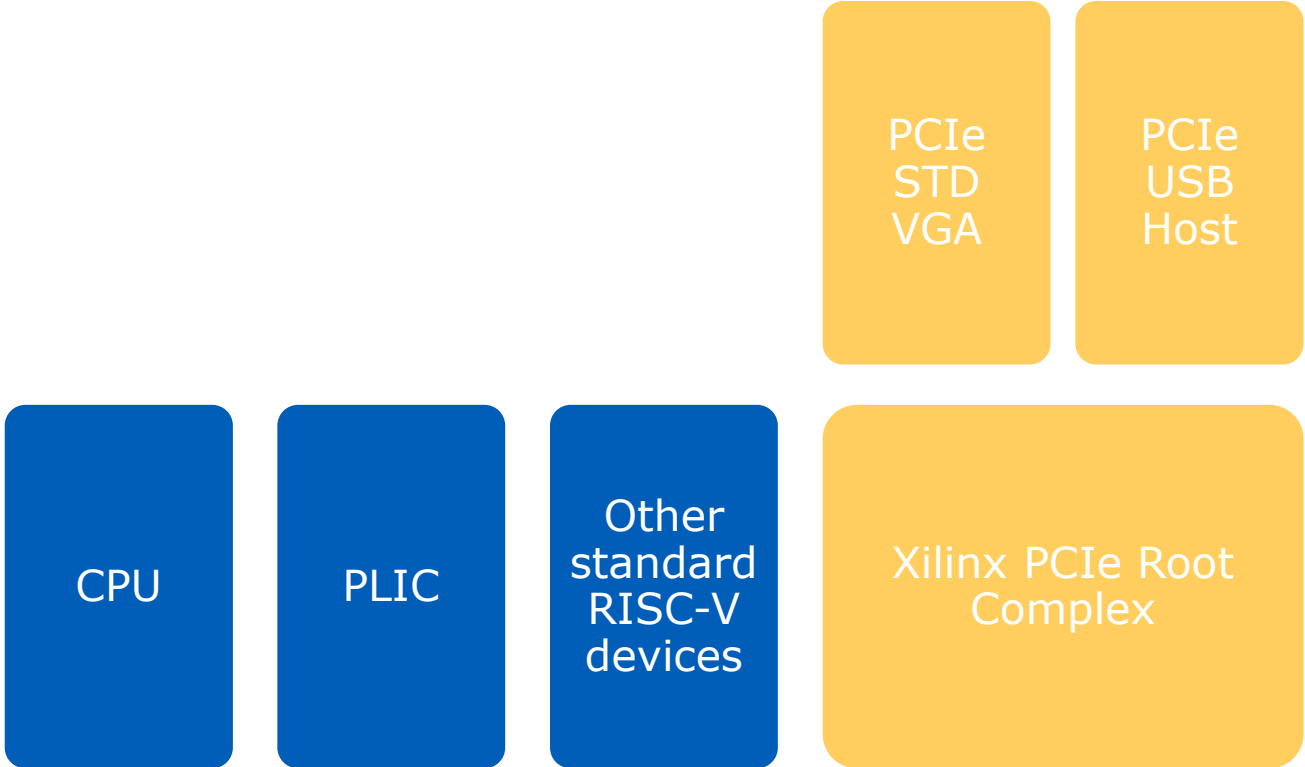
Yocto

- Yocto is a Linux Foundation backed project whose goal is to allow the creation of Linux distributions specifically for embedded devices
- Yocto allows developers to create their own distribution or their on SDK
- It builds all the software from the cross compiler to the Linux kernel itself
- Allows us to add/remove required packages as desired and make any source changes as required
- Functionality is added via meta layers

Yocto layers



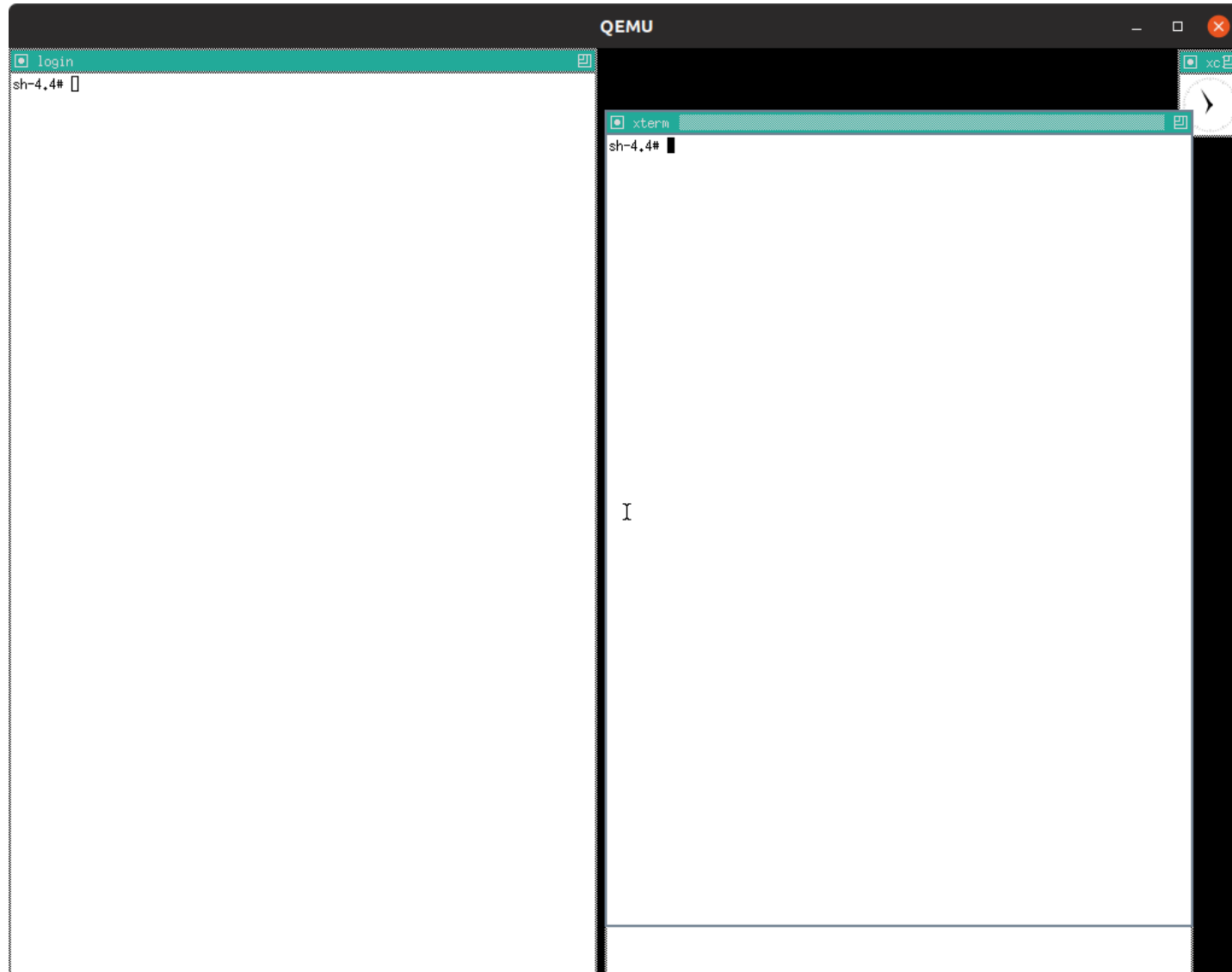
QEMU Model



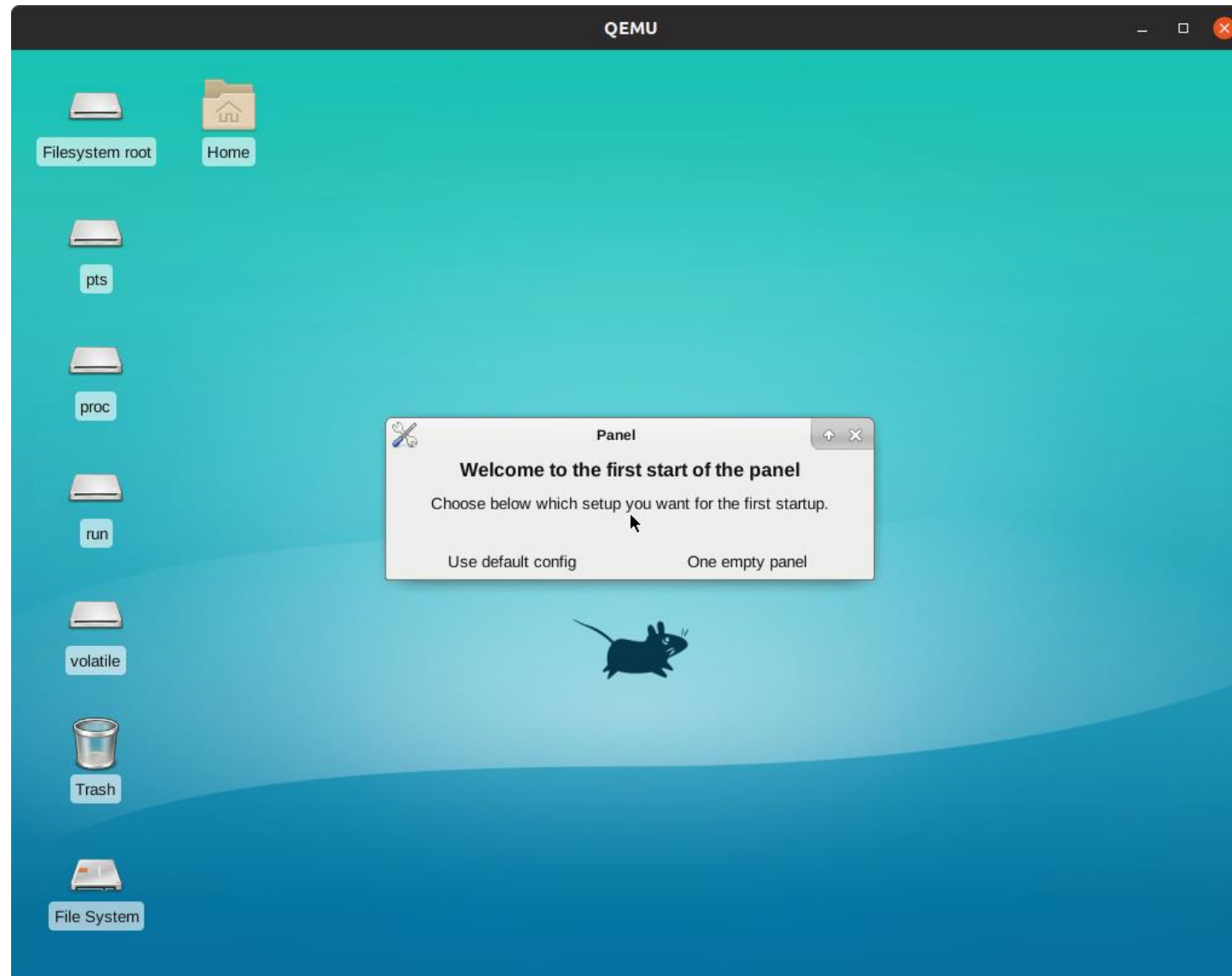
Building a full GUI stack in Yocto

- Working on top of other Yocto meta layers
 - meta-riscv: Allows cross compiling for RISC-V and includes specific RISC-V fixes
 - meta-qt5: Adds all the Qt5 packages, required for Plasma
 - meta-kf5: Base KDE framework packages required for KDE
 - meta-kde: KDE layer, includes plasma mobile
- Unluckily, this doesn't just work there are still cross compile errors
 - Changes have been made to meta, meta-qt5, meta-kf5 and meta-kde and corresponding packages to allow cross-compile
 - Mostly small changes to specify that RISC-V is a supported ISA
 - Also changes to some of the way everything is packaged
 - Upstreaming effort is ongoing

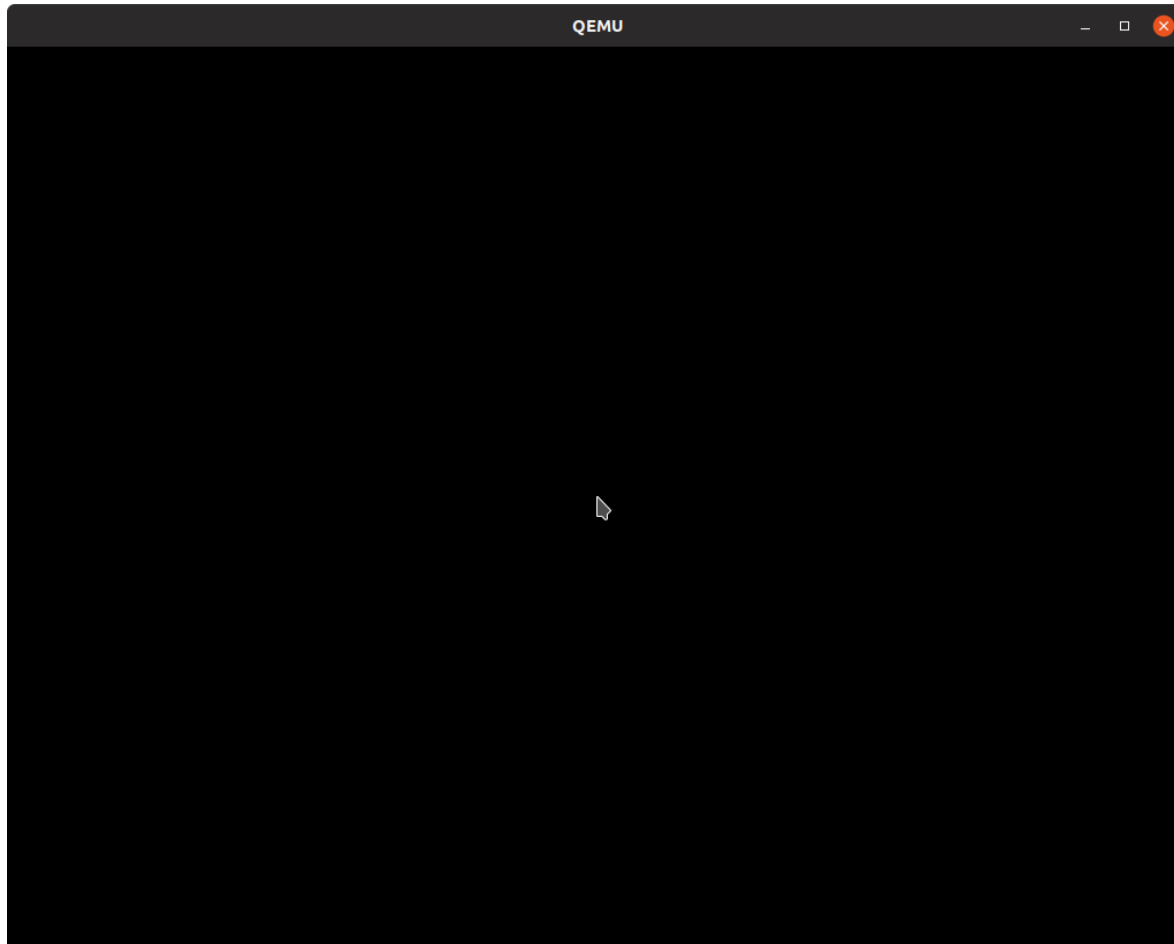
All this work, for the Matchbox Terminal



Next step, run XFCE



Moment of truth, Plasma Mobile



```
root@freedom-u540:~# DISPLAY="" startkde
/usr/bin/startkde: line 106: kapplymousetheme: command not found
QStandardPaths: XDG_RUNTIME_DIR not set, defaulting to '/tmp/runtime-root'
libEGL warning: DRI2: failed to authenticate
QStandardPaths: XDG_RUNTIME_DIR not set, defaulting to '/tmp/runtime-root'
[ 231.098066] ksplashqml[361]: unhandled signal 11 code 0x1 at 0x0000000000000000 in
libQt5Core.so.5.11.1[2000924000+50a000]
[ 231.098763] CPU: 0 PID: 361 Comm: ksplashqml Tainted: G      W      4.17.0 #1
[ 231.099198] sepc: 0000002000b5615c ra : 000000000001671e sp : 0000003ffffad6930
[ 231.099643] gp : 0000000000019d20 tp : 00000020025e8b60 t0 : 0000002000019150
[ 231.100048] t1 : 0000002000b5615c t2 : 0000000000019670 s0 : 0000003ffffad6930
[ 231.100450] s1 : 0000000000000000 a0 : 0000000000000000 a1 : 0000000000017310
[ 231.100845] a2 : 0000003ffffad6930 a3 : 0000000000000000 a4 : 0000000000000002
[ 231.101246] a5 : 0000000000000002 a6 : 000000000001a016 a7 : 0000002000be47a0
[ 231.101636] s2 : 0000003ffffad6a30 s3 : 0000003ffffad6a20 s4 : 0000002004005360
[ 231.102060] s5 : 0000003ffffad6990 s6 : 0000003ffffad6a08 s7 : 0000002000be47a0
[ 231.102455] s8 : 0000002000be67c8 s9 : 0000000000000001 s10: 0000000000000000
[ 231.102836] s11: 0000000000016f70 t3 : 000000000023215c t4 : 0000000000000002
[ 231.103225] t5 : 0000000000000050 t6 : 00000000000008b48
[ 231.103517] sstatus: 8000000000006020 sbadaddr: 0000000000000000 scause:
0000000000000000d
startkde: Starting up...
QStandardPaths: XDG_RUNTIME_DIR not set, defaulting to '/tmp/runtime-root'
kdeinit5: preparing to launch '/usr/libexec/kf5/klauncher'
kdeinit5: Launched KLauncher, pid = 381, result = 0
QStandardPaths: XDG_RUNTIME_DIR not set, defaulting to '/tmp/runtime-root'
libEGL warning: DRI2: failed to authenticate
QStandardPaths: XDG_RUNTIME_DIR not set, defaulting to '/tmp/runtime-root'
```

What doesn't work?

- Input. We don't have any input to the graphics stack via QEMU
 - This appears to be a configuration issue between QEMU and Linux
 - Linux can see the USB devices
- KDE. KDE starts up and we see the mouse theme change, but we never get the full graphics up

What next?

- Upstream! This work is being upstreamed so others can use it and build on it
- Keyboard and Mouse support. Need to setup input support in QEMU
- Full KDE stack. More debugging on why the display doesn't start is required
 - Trying to debug a seg fault in a graphics library is really hard
- Port and test on real hardware

Can I try it at home?

- Not really.
- At the moment focusing on upstreaming the changes to the meta layers and fixing hacks
- If anyone is interested in having a go reach out to me and I can send you information: alistair.francis@wdc.com

An abstract graphic on the left side of the slide, consisting of multiple overlapping, flowing lines in shades of red, orange, yellow, and cyan. The lines create a sense of movement and depth, resembling a stylized wave or a digital signal.

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