

Creating a Tiny Linux Distribution Using Yocto: petalinux-tiny Case Study

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Agenda

- > What is Poky-Tiny?
- > DISTRO
- > Poky-Tiny 2018

Agenda

- > What Does petalinux-tiny Need?
- > Creating petalinux-tiny DISTRO on Yocto



What is Poky Tiny?



Poky-Tiny

- > **First Introduced in 2011 by Darren Hart at ELCE**
 - >> Kernel
 - >> EglIBC
 - >> Udev
 - >> Login
- > **Focused on explaining how to decrease size and boot time**
 - >> Remove or trim unnecessary components (userspace)
 - Switch to UClIBC
 - Switch to Busybox
 - Remove Udev
 - >> Remove Kernel drivers and modules
 - Drop networking support
 - “Cripple” busybox
 - “Cripple” kernel (acpi,smp,ipc,futex,printk)

Poky-Tiny

- > **Nothing in life is free**
 - » Tradeoff between functionality and size + boot time
- > **Times Change 2011 -> 2018**
- > **Decrease size and boot time (possible)**
- > **Focus on creating a Tiny Distro**

What is a DISTRO?



DISTRO

> DISTRO:

- » The DISTRO variable corresponds to a distribution configuration file whose root name is the same as the variable's argument and whose filename extension is .conf [Yocto Reference Manual].
 - meta-poky/conf/distro/poky.conf
 - meta-poky/conf/distro/poky-tiny.conf

> poky-tiny.conf (trimmed):

```
require conf/distro/poky.conf
DISTRO = "poky-tiny"
DISTROOVERRIDES = "poky:poky-tiny"
TCLIBC = "musl"
PREFERRED_PROVIDER_virtual/kernel = "linux-yocto-tiny"

VIRTUAL-RUNTIME_dev_manager = "busybox-mdev"
VIRTUAL-RUNTIME_login_manager = "busybox"

IMAGE_FSTYPES = "cpio.gz"
```

> DISTRO != Image

DISTRO

> Poky + core-image-minimal

- >> RootFS: 4 MB
- >> Kernel: 7 MB
- >> Boot time: 9.1 sec

> Main Components:

- >> Base-Utils: BusyBox
- >> C Library: GLIBC
- >> Dev manager: Udev/Eudev
- >> Other: Util-linux (sulogin,lsblk,umount,mkfs,fdisk,etc)

DISTRO

> Component size:

Package	Arch	Version	Repository	Size
<hr/>				
Installing:				
packagegroup-core-boot	qemux86	1.0-r17	oe-repo	5.8 k
packagegroup-core-ssh-dropbear	noarch	1.0-r1	oe-repo	5.6 k
run-postinsts	noarch	1.0-r10	oe-repo	8.7 k
Installing dependencies:				
base-files	qemux86	3.0.14-r89	oe-repo	13 k
base-passwd	i586	3.5.29-r0	oe-repo	7.1 k
busybox	i586	1.29.2-r0	oe-repo	352 k
dropbear	i586	2018.76-r0	oe-repo	131 k
eudev	i586	3.2.5-r0	oe-repo	249 k
initscripts	i586	1.0-r155	oe-repo	22 k
libblkid1	i586	2.32.1-r0	oe-repo	143 k
libc6	i586	2.28-r0	oe-repo	1.3 M
libfdisk1	i586	2.32.1-r0	oe-repo	185 k
libmount1	i586	2.32.1-r0	oe-repo	152 k
libncursesw5	i586	6.1+20180630-r0	oe-repo	91 k
libsmartcols1	i586	2.32.1-r0	oe-repo	93 k
util-linux	i586	2.32.1-r0	oe-repo	422 k
util-linux-losetup	i586	2.32.1-r0	oe-repo	43 k
util-linux-lsb1k	i586	2.32.1-r0	oe-repo	38 k
util-linux-sulogin	i586	2.32.1-r0	oe-repo	27 k
util-linux-swaponoff	i586	2.32.1-r0	oe-repo	31 k
util-linux-umount	i586	2.32.1-r0	oe-repo	18 k
v86d	qemux86	0.1.10-r2	oe-repo	46 k
util-linux-cfdisk	i586	2.32.1-r0	oe-repo	45 k
util-linux-fdisk	i586	2.32.1-r0	oe-repo	57 k
util-linux-ionice	i586	2.32.1-r0	oe-repo	17 k
util-linux-sfdisk	i586	2.32.1-r0	oe-repo	51 k

DISTRO

> **Poky-tiny + core-image-minimal**

- »> RootFS: 1 MB
- »> Kernel: 2.7 MB
- »> Boot time: 5.2 sec

> **Main Components:**

- »> Base-Utils: BusyBox
- »> C Library: Musl
- »> Dev manager: busybox-mdev
- »> Other: busybox (sulogin, lsblk, umount, mkfs, fdisk, etc)

> Component size:

Package	Arch	Version	Repository	Size
<hr/>				
Installing:				
packagegroup-core-boot	qemux86	1.0-r17	oe-repo	5.7 k
run-postinsts	noarch	1.0-r10	oe-repo	7.4 k
Installing dependencies:				
base-files	qemux86	3.0.14-r89	oe-repo	13 k
base-passwd	i586	3.5.29-r0	oe-repo	7.1 k
busybox	i586	1.29.2-r0	oe-repo	393 k
busybox-inittab	qemux86	1.29.2-r0	oe-repo	6.5 k
busybox-mdev	i586	1.29.2-r0	oe-repo	8.6 k
musl	i586	1.1.20+git0+0fa1e638e8-r0	oe-repo	350 k
netbase	i586	1:5.4-r0	oe-repo	15 k
update-alternatives-opkg	i586	0.3.6-r0	oe-repo	8.5 k
Installing weak dependencies:				
busybox-syslog	i586	1.29.2-r0	oe-repo	8.5 k
busybox-udhcpc	i586	1.29.2-r0	oe-repo	8.1 k

> DISTROOVERRIDES

- >> Enable us to use _poky-tiny
- >> Busybox defconfig:
 - meta-poky/recipes-core/busybox/busybox/poky-tiny/defconfig
- >> Kernel defconfig (not currently used)

> Busybox example configs diff:

```
+ CONFIG_FDISK=y
+ CONFIG_SWAPONOFF=y
> + CONFIG_UMOUNT=y
- CONFIG_ZCAT=y
- CONFIG_BZCAT=y
- CONFIG_DIFF=y
- CONFIG_AWK=y
- CONFIG_SED=y
```

Poky-Tiny 2018



Poky-Tiny 2018

> **core-image-tiny**

- >> Tiny RootFS but more functionality
- >> Improve boot time
- >> Boot to RAM

> **Boot Process:**

- >> Load Kernel
- >> Load Tiny RootFS to RAM : initrd=rootfs.cpio.gz
- >> Load Tiny Init
 - Mount virtual filesystems
 - Start udev
 - Start dropbear (or other services)
 - Drop to shell before switching root

Poky-Tiny 2018

> **core-image-tiny**

- >> core-image-tiny-initramfs: RootFS: 1.1MB (cpio.gz)
- >> Kernel: 2.7 MB
- >> Boot time: .93 sec (busybox-mdev)

> **Main Components:**

- >> Base-Utils: Busybox
- >> C Library: Musl
- >> Dev manager: busybox-mdev / eudev
- >> Other:
 - busybox (lsblk, umount, mkfs, fdisk, etc)
 - Dropbear (SSH)
 - No login

Poky-Tiny 2018

core-image-tiny

Boot Time

```
[ 0.408480] Trying to unpack rootfs image as initramfs...
[ 0.612795] Freeing initrd memory: 1032K
[ 0.615349] Scanning for low memory corruption every 60 seconds
[ 0.620084] workingset: timestamp_bits=30 max_order=16 bucket_order=0
[ 0.626754] io scheduler noop registered
[ 0.626954] io scheduler deadline registered
[ 0.627488] io scheduler cfq registered (default)
[ 0.629278] efifb: probing for efifb
...
[ 0.669212] Serial: 8250/16550 driver, 4 ports, IRQ sharing disabled
...
[ 0.717234] Linux agpgart interface v0.103
[ 0.731329] brd: module loaded
[ 0.738554] i8042: PNP: PS/2 Controller [PNP0303:KBD,PNP0f13:MOU] at 0x60,0x64 irq 1,12
[ 0.741451] serio: i8042 KBD port at 0x60,0x64 irq 1
[ 0.742358] serio: i8042 AUX port at 0x60,0x64 irq 12
[ 0.743569] mousedev: PS/2 mouse device common for all mice
[ 0.746918] input: AT Translated Set 2 keyboard as /devices/.../input0
...
[ 0.751511] rtc_cmos 00:00: alarms up to one day, y3k, 114 bytes nvram, hpet irqs
[ 0.756549] Using IPI Shortcut mode
[ 0.756882] sched_clock: Marking stable (756175949, 0)->(859115222, -102939273)
[ 0.758240] input: ImEXPS/2 Generic Explorer Mouse as /devices/.../input2
[ 0.935290] Freeing unused kernel image memory: 324K
[ 0.936327] Write protecting the kernel text: 2056k
[ 0.936644] Write protecting the kernel read-only data: 860k
/init: line 43: --daemon: not found
/init: line 44: udevadm: not found

Poky Tiny Reference Distribution:
/ #:
```

Poky-Tiny 2018

> Pros and Cons

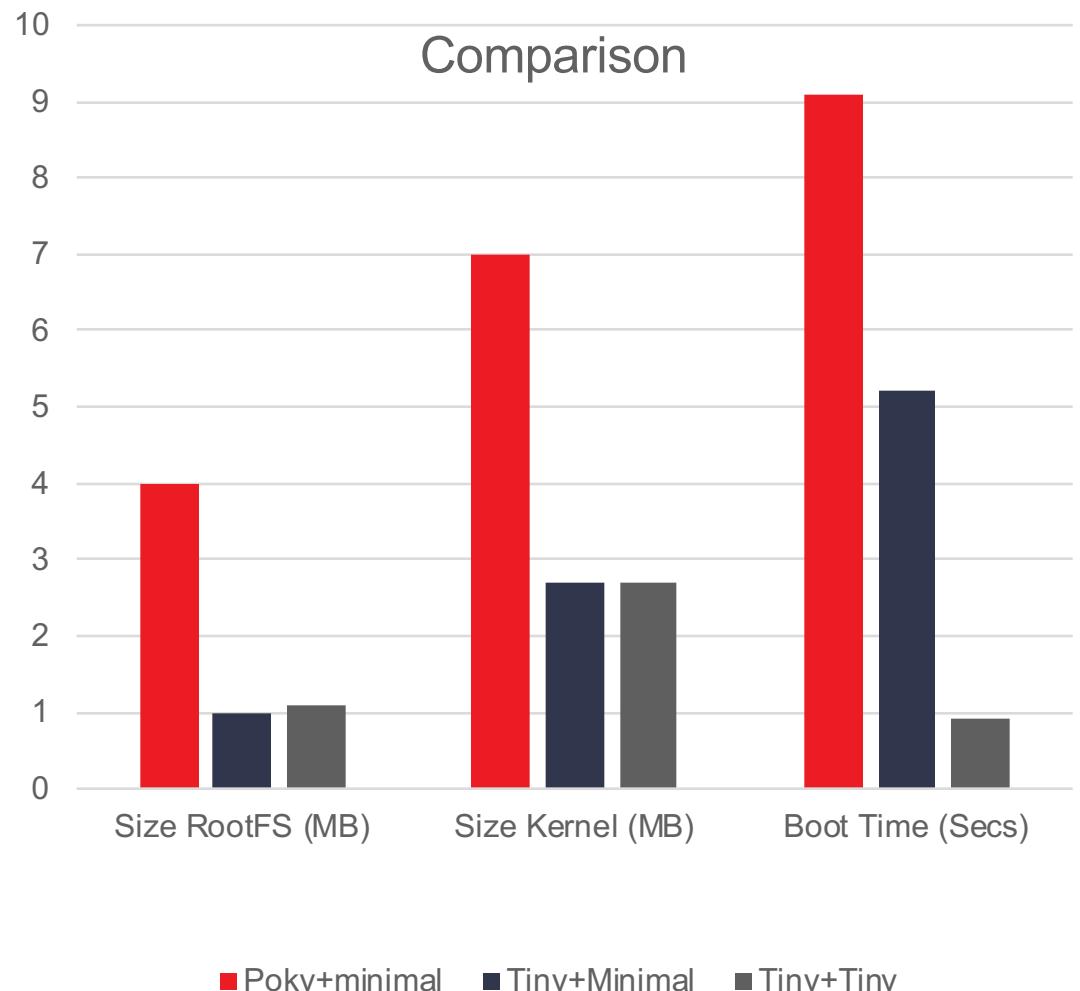
- >> Read Only RootFS
- >> Faster boot time

> Example Applications

- >> Network devices
- >> Upgrade system
- >> Anything with that needs Linux, but requires to boot fast

Comparison

- > Poky + core-image-minimal
- > Poky Tiny + core-image-minimal
- > Poky Tiny + core-image-tiny



petalinux -> petalinux-tiny



petalinux DISTRO on Yocto

> **petalinux-image-minimal** (From meta-petalinux, not to be confused with Petalinux Tools / BSP)

- >> ([Final PRODUCT])
- >> Dropbear
- >> Canutils
- >> Pci-utils
- >> Tcf-agent
- >> Kernel-modules

> **petalinux-image-full**

- >> QT
- >> OpenCV
- >> V4L
- >> Gstreamer
- >> MRAA
- >> Python

> **petalinux + petalinux-image-minimal**

- >> RootFS: 13MB (gz)
- >> Kernel: 15 MB
- >> Boot time: 42 sec

> **Main Components:**

- >> Base-Utils: BusyBox
- >> C Library: GLIBC
- >> Dev manager: Udev/Eudev
- >> Other: Util-linux (sulogin,lsblk,umount,mkfs,fdisk,etc)

> Bootchart2:

>> On Image:

```
IMAGE_INSTALL_append = "bootchart2"
```

>> On Kernel cmdline (Run as pid 1):

```
append = initcall_debug printk.time=y quiet init=/sbin/bootchartd  
--init /tiny-init
```

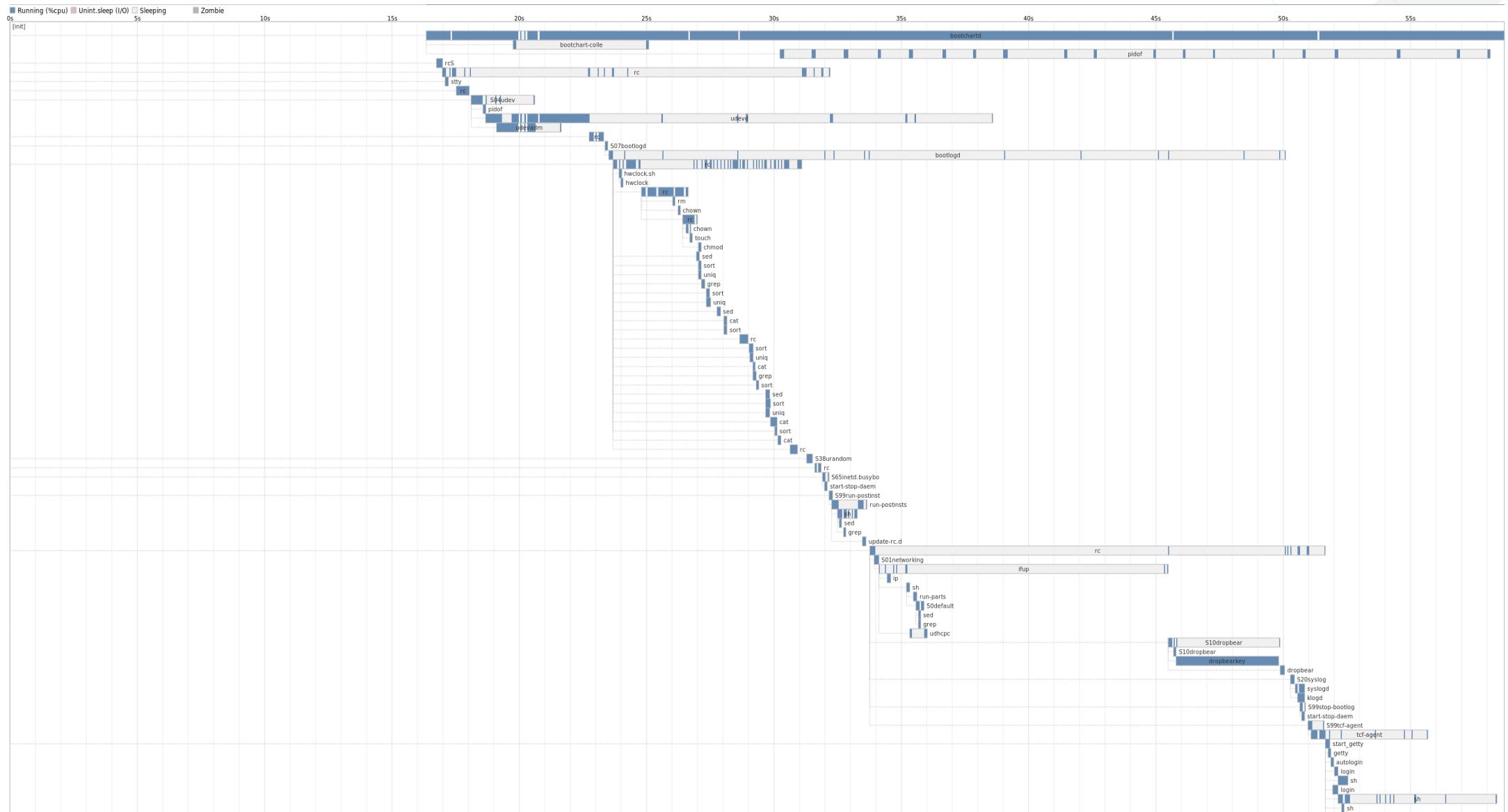
>> After booting:

```
$ bootchartd stop
```

>> Create image file:

```
pybootchartgui bootchart.tgz
```

Petalinux



Creating petalinux-tiny

> **petalinux-tiny Goals:**

- »> Reduce boot time - for testing and release
- »> Reduce Kernel Size
- »> Provide a more functional DISTRO than poky-tiny, still have features like FPGA manager
- »> Decrease filesystem size
- »> DON'T boot to RAM

petalinux-tiny

> Select userspace components

- >> musl
- >> BusyBox
- >> Udev
- >> Linux kernel

> Create a DISTRO.conf

```
require conf/distro/poky.conf
DISTRO = "petalinux-tiny"
TCLIBC = "musl"
PREFERRED_PROVIDER_virtual/kernel ?= "linux-xlnx"
VIRTUAL-RUNTIME_login_manager = "busybox"
VIRTUAL-RUNTIME_dev_manager = "udev"
```

petalinux-tiny

> **petalinux-tiny + petalinux-image-minimal**

- »> RootFS: 11MB (gz)
- »> Kernel: 15 MB
- »> Boot time: 24 sec

petalinux-tiny

> **petalinux-tiny + petalinux-image-tiny**

- >> RootFS: 1.5 MB (gz)

- >> Kernel: 15 MB

- >> Boot time: 18 sec

> **We should OVERRIDE linux-xlnx and BusyBox!**

> BusyBox's defconfig

```
+ CONFIG_FDISK=y
+ CONFIG_SWAPONOFF=y
+ CONFIG_UMOUNT=y
- CONFIG_ZCAT=y
- CONFIG_BZCAT=y
- CONFIG_DIFF=y
- CONFIG_AWK=y
- CONFIG_SED=y
```

> Override linux-xlnx defconfig

>> Nothing in life is free

```
# DROP IO SCHEDULERS
- CONFIG_IOSCHED_DEADLINE=y
- CONFIG_IOSCHED_CFQ=y

# DROP IPv6 AND BLUETOOTH
- CONFIG_IPV6=y
- CONFIG_BT=y
- CONFIG_BT_RFCOMM=y

# DROP FILESYSTEMS SUPPORT
- CONFIG_EXT2_FS=y
- CONFIG_EXT3_FS=y
- CONFIG_FAT_FS=y
- CONFIG_MSDOS_FS=y
- CONFIG_ECRYPT_FS=y
- CONFIG_NFS_FS=y
```

Petalinux-Tiny

```
[ 2.225855] fpga_manager fpga0: xilinx ZynqMP FPGA Manager registered
[ 2.259470] ff000000.serial: ttyPS0 at MMIO 0xff000000 (irq = 38, base_baud = 10416666)
is a xuartps
[ 2.353026] console [ttyPS0] enabled
[ 2.383205] ff010000.serial: ttyPS1 at MMIO 0xff010000 (irq = 39, base_baud = 2480158) is
a xuartps
[ 2.590514] mmc0: SDHCI controller on ff170000.mmc [ff170000.mmc] using ADMA 64-bit
[ 2.654683] input: gpio-keys as /devices/platform/gpio-keys/input/input0
[ 2.673809] hctosys: unable to open rtc device (rtc0)
[ 2.675150] of_cfs_init
[ 2.679289] of_cfs_init: OK
[ 2.680077] clk: Not disabling unused clocks
[ 2.758274] Waiting for root device /dev/mmcblk0p2...
[ 2.758322] mmc0: Problem switching card into high-speed mode!
[ 2.761183] mmc0: new SD card at address 4567
[ 2.774018] mmcblk0: mmc0:4567 QEMU! 39.8 MiB
[ 2.790302] mmcblk0: p1 p2
[ 2.832336] EXT4-fs (mmcblk0p2): couldn't mount as ext3 due to feature incompatibilities
[ 2.897037] EXT4-fs (mmcblk0p2): mounted filesystem with ordered data mode. Opts: (null)
[ 2.898913] VFS: Mounted root (ext4 filesystem) on device 179:2.
[ 2.906550] devtmpfs: mounted
[ 2.967794] Freeing unused kernel memory: 320K
mount: mounting none on /dev failed: Resource busy
[ 3.767837] udevd[1081]: error getting socket: Function not implemented
[ 3.769037] udevd[1081]: error initializing udev control socket
Booting Petalinux Tiny

Petalinux Tiny Test Distribution:

/ #
```

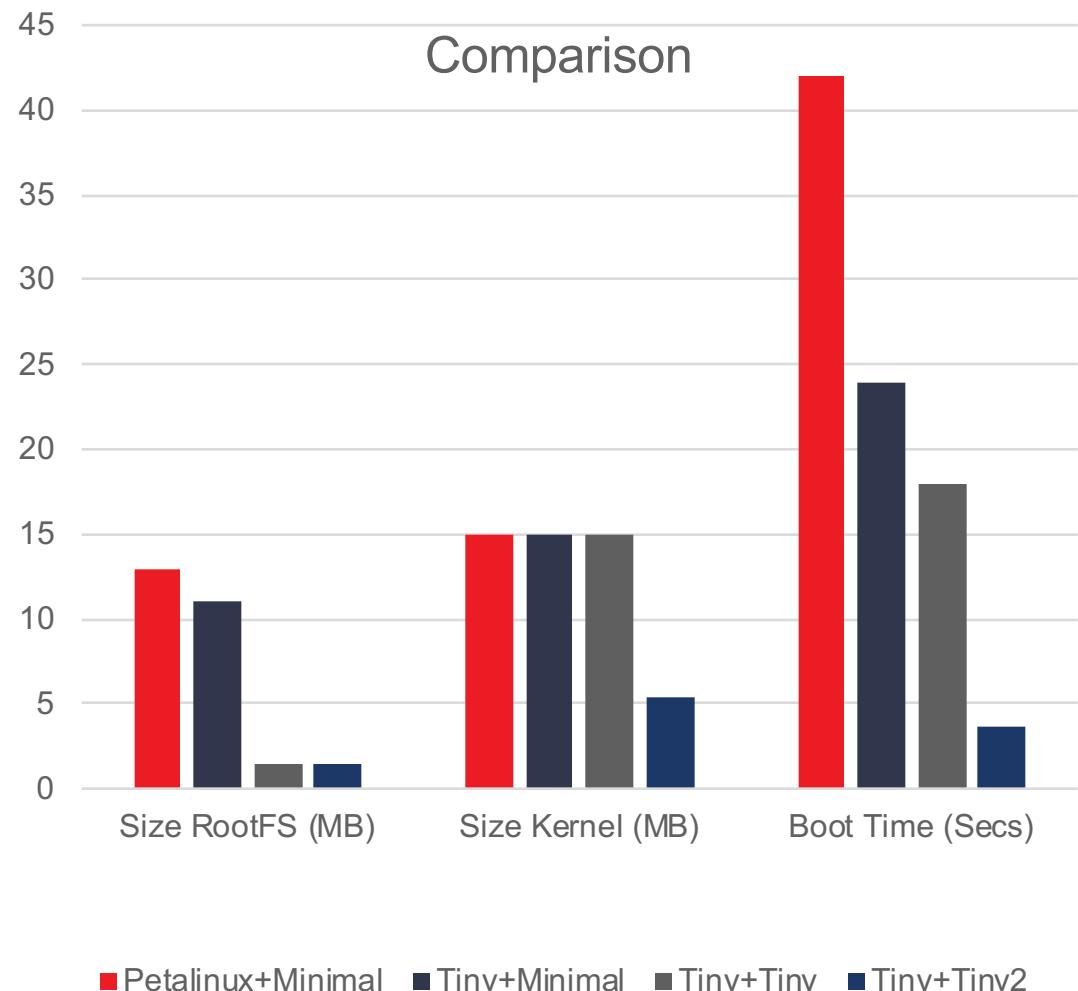
Petalinux-Tiny

> Petalinux-Tiny + Petalinux-Image-Tiny Final

- »> RootFS: 1.5 MB (gz)
- »> Kernel: 5.4 MB
- »> Boot time: ~3.76 sec

DISTRO + Image Comparison

- > petalinux + petalinux-image-minimal
- > petalinux-tiny + petalinux-image-minimal
- > petalinux-tiny + petalinux-image-tiny



Petalinux-Tiny

> What is next for petalinux-tiny?

>> Explore userspace component alternatives

- Sbase
- Toybox

>> Customize Kernel with Yocto Kernel Meta

- Easily customizable by customers
- Use MACHINE and DISTRO_FEATURES

Thanks!

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