



Embedded Linux Then and Now at iRobot

Patrick Doyle

pdoyle@irobot.com

Principal Software Engineer, iRobot

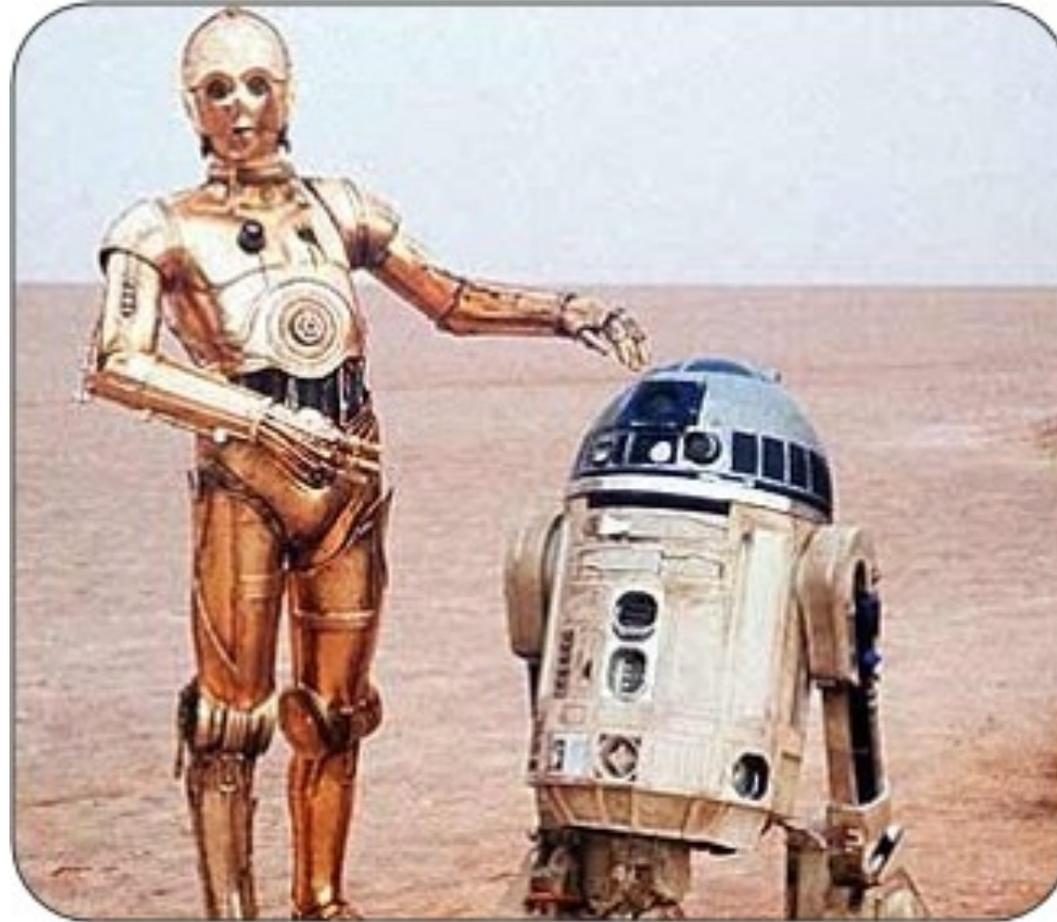
2017 Embedded Linux Conference, Portland OR

About Me

- Spent 20 years developing commercial and DoD embedded systems
- Spent 4 years working with a research group developing a retinal implant
- Spent the last 5 years playing with robots
- Rocket Scientist
- Brain Surgeon
- Roboticist
- Linux Enthusiast
 - Running Linux since 1995



Gratuitous Star Wars Reference



Agenda

Then

- DoD Robots
- x86 Processors (mostly)
- Open Embedded
 - With iRobot layer on top

And (almost) Now

- Consumer Robots
- ARM processors
- Yocto & buildroot
 - With iRobot customizations



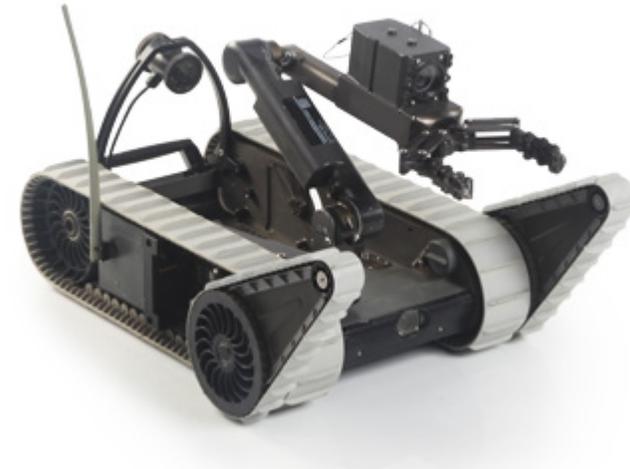
Packbot

- 1999 - 2005
- x86 Pentium III
- Bluecat Linux
- Came up pretty easily
- Core problems:
 - RT characteristics
 - Terrible WiFi support
 - Hard to get AdHoc networking to work



One Linux to Rule them

- 2007 – 2010
- Multiple Hardware Platforms:
 - x86, ARM, PowerPC
 - Kernel was on a separate branch, not as well supported
 - Needed latest kernel
 - But older Wifi drivers needed older kernels
- Needed an embedded Linux Distribution
- "Common OS" project
 - IRobot Layer on top of Open Embedded
 - BSPs for various products
 - Common build system
 - Started with "OE Classic" migrated to Yocto/OE



Issues & Problems

- Compiler support was terrible
 - No scripts, no buildroot, had to buy cross compilers
- Backporting drivers is hard
- Various custom Linuxes for radios
- Boot time was minutes
 - Not good for military applications
- No good power management sleep/wake support



Ava

- 2011 - 2015
- Remote Presence Robot
- Off-the-shelf x86 COM Express module
 - running Ubuntu 12.04 (and then 14.04)
- ROS-like Robotics layer
- LIDAR used for mapping
 - Connected to CPU via Ethernet
- UART connection to mobility module



Then What?

- Defense and Remote Presence Groups were 100% Linux
- Home/Consumer Group was 100% NOT Linux
 - Minimal FLASH, RAM, processing power and cost!

Fast Forward to 2015

- Roomba 980 released
 - First product with vision based mapping
 - LPC3250 (ARM9 SoC) Processor from NXP
 - 2 MByte FLASH
 - 16 Mbyte SDRAM
 - WiFi Connected via separate module
- New product developments considering SoCs such as the SAMA5 product line from Atmel
 - Cortex A5 CPU
 - 16 MByte FLASH (more on that in a bit)
 - 128 MByte SDRAM
 - WiFi Connected directly



New board to /bin/sh in 8 days

- Received a board from the electrical engineer on a Thursday afternoon in March
- Celebrated a "I got the prompt" party the following Friday
- Customized Atmel's at91bootstrap bootloader to support our FLASH and SDRAM memory configuration
- Minor tweaks to U-Boot
- No modifications to Linux source tree
 - Except, of course for our custom device tree
 - And a few bugfixes/enhancements submitted upstream
- Second board came up in 2 days
 - But that one only had a FLASH change
 - WiFi took longer



Application Development Model

- Develop, debug and test the application on the Desktop
 - Using standard driver models (v4l2, USB, audio, network stack, etc...)
 - Doesn't work so well for I2C, SPI, or GPIO devices
- Optional: Recompile natively on the target
 - Works if you have a native distribution such as Ubuntu running on the target
- Cross compile for the target
 - Linaro, Buildroot, and Yocto help a lot here!
 - Debug with gdbserver
 - Can use USB networking, or even PPP/SLIP!
- Fight to keep your boot console!
 - Don't let the hardware design take that from you
 - Perhaps adb can help here



Praise for (and a plea) to Chip Manufacturers

- SoC manufactures now maintain Linux kernels for their devices
 - And Yocto distributions as well
- Please work to get your kernel mainlined
- Please work to isolate your Yocto changes to a single meta package that can be dropped into the standard Yocto distribution

Going Forward

- More Cores
- More FLASH
- More SDRAM
- More Off-the-Shelf Software
 - Amazon Echo
 - Android Things
 - Stacks are provided, assume more resources
- GPL vs NDA
- Security, Security, Security
- STEM



Gratuitous iRobot Video



<https://www.youtube.com/watch?v=oj3Vawn-kRE&t=7s>

Questions?

Thank you

We're hiring! (Software, Cloud, Mobile, IoT...)
<http://www.irobot.com/careers>

iRobot

iRobot Ventures: early stage investing program