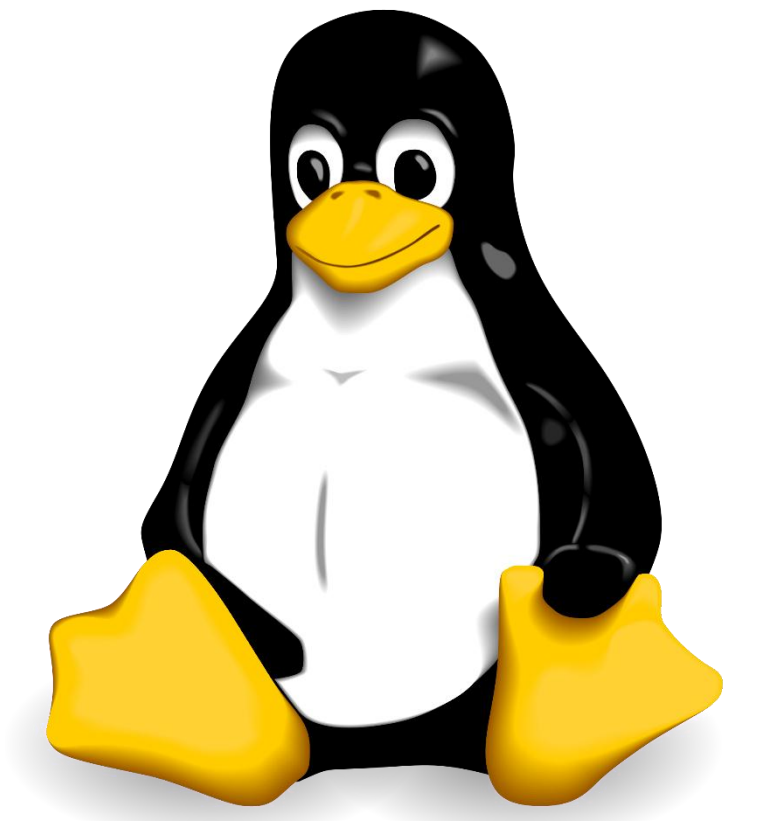


MANAGING A REAL-TIME EMBEDDED LINUX PLATFORM WITH BUILDROOT

John Diamond, Kevin Martin

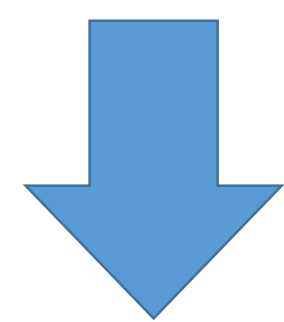
Fermi National Accelerator Laboratory, Batavia, IL 60510



Motivation

Desktop distributions are an awkward implementation of an Embedded RTOS

- Architecture-dependent binary packages
- Loaded with unnecessary software
- Huge footprints



First Try: Build Linux from Source

- Success! But..
- Is as difficult as it sounds
- Overwhelming number of packages and patches
- No version control
- Cross-compile even more headaches

Did not do what we needed:

- Small-footprint network bootable image
- Automated build system
- Support for multiple architectures
- Integrated system for building and deploying real-time application software

Solution

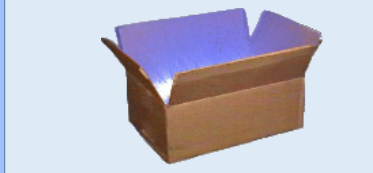
Buildroot + uClibc + Busybox + RTAI



Buildroot – downloads, unpacks, configures, compiles and installs system software automatically



uClibc – Small-footprint standard C library



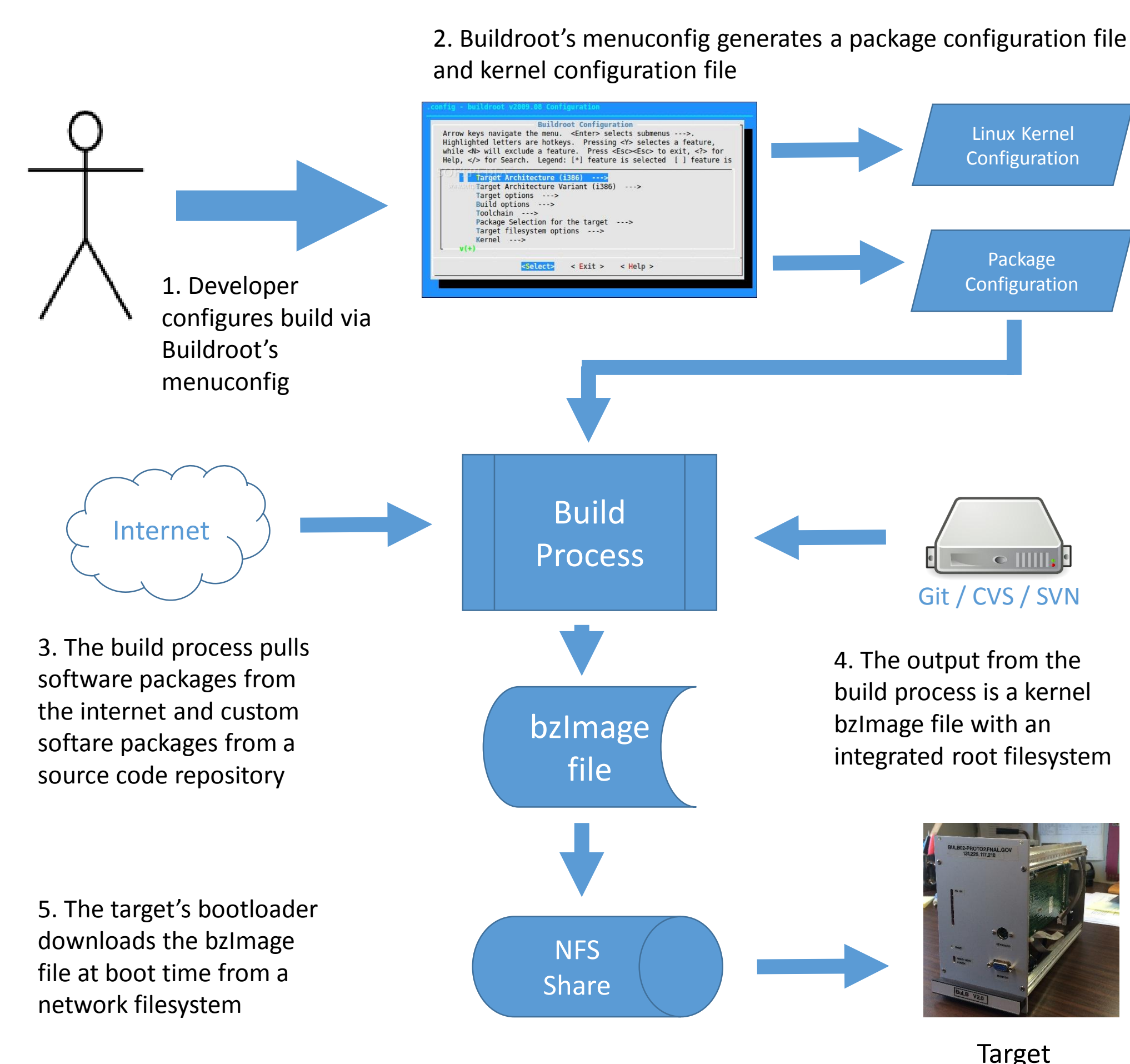
Busybox – all-in-one UNIX utilities and shell



RTAI – Real-Time Linux extensions



Simplified Build Process



Results

Quantitative Results

- Whole build process is automated resulting in much quicker build times (hours not days)
- Kernel and root filesystem size: 3.5 MB – 20 MB (reduction of 99%)
- Boot-time: ~9 seconds

Qualitative Results

- Allows integration with revision control into the platform development process, making it easier to manage an ecosystem of targets
- Community support for x86 & ARM targets gives us confidence that future targets can be supported without much effort

Deployments



ARM Cortex A-9

Power Supply Control and Regulation for the Fermilab Linac



PC/104 AMD Geode SBC

Quench Protection System for Tevatron Electron Lens (TEL II)



Intel Core 2 Duo VME/VXS

Beam Position Monitor prototype for Fermilab Booster



PC/104 Integrated in NIM module

Power Supply Control and Regulation for NuMI beam line