Using QEMU for industrial embedded applications

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15/10/2009

Topics

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Who am I?

- CTO of Open Wide (open-source software service company)
- Open Wide: created in 2001, 70 employees in Paris & Lyon
- OS4I : industrial software department of OW
- Author of « Linux embarqué » (Editions Eyrolles) the unique french book about « embedded Linux »

What is QEMU?

- Hardware emulator designed by Fabrice Bellard (author of FFMpeg)
- Licensed under the GPL
- Initially based on BOCHS (x86)
- Supported CPUs : x86, PPC, ARM, MIPS...
- Support for common peripherals => full board emulation
- User space application !
- Target OS agnostic => can run Linux, Win$, ...
- Some « hardware » acceleration with *kqemu* kernel module (x86, obsolete?)
- Competitors: GXemul, BOCHS, VirtualBox

Installing QEMU

- Available for Linux, Mac OS X, Windows
- Current stable version: 0.11.0
- Binary installation (Linux) :
  - $ sudo yum install qemu
  - $ sudo apt-get install qemu
- Compilation from sources :
  - $ ./configure --target-list=...
  - $ make
  - $ make install

Using QEMU in a standard way

- Typically, using OS inside another one
- Live CD :
  - $ qemu -cdrom F10-i686-Live.iso
- Home-made image
  - $ qemu linux-0.2.img
- OS installation
  - $ qemu-img create -f raw xp.img 1500M
  - $ qemu -hda xp.img -boot **d** -cdrom xp.iso
- Running installed OS from image
  - $ qemu -hda xp.img -boot **c**

QEMU Network support

- Some famous Ethernet controlers supported (x86): NE2000, RTL8139, PCNet
- Several ways to use network :
  - VLAN
  - TUN/TAP (bridge)
  - User mode (SLIRP) => no ICMP, no access from host to QEMU
- Lots of documentation available from the net...
- Option :
  - net nic,model=ne2k_pci -net user

QEMU for embedded development/training

- Embedded boards are « expensive », university and schools are poor...
- Most of training companies & schools have PC
- (Board + power supply + cable) x Nstudent x CPU => heavy load for teacher
- « Please could you send me your precious hardware prototype to start my dev ? »
- « I like to work in the TGV but policeman don't take my board, it's not a bomb :) »
- Binary compatibility in most cases

ARM9 emulation + embedded Linux

- Build a system with Buildroot, Open Embedded or home-made => 1 kernel image + 1 rootfs image
- Check-out emulated boards :
  - $ qemu-system-arm -M ?
  - Supported machines are:
  - integratorcp ARM Integrator/CP (ARM926EJ-S) (default)
  - versatilepb ARM Versatile/PB (ARM926EJ-S)
  - versatileab ARM Versatile/AB (ARM926EJ-S)
  - ...

ARM9 emulation + embedded Linux, testing...

- Test with :

  -
    ```
    $ qemu-system-arm -M versatilepb -m 16
      -kernel kernel.img -initrd rootfs.gz
    ```
  - -M : emulated board
  - -m : allocation RAM in Mb
  - -kernel : kernel image (zImage)
  - -initrd : initrd image (CPIO + gz)
- Of course we can use INITRAMFS (rootfs in kernel image)
- Very FAST boot (< 1s with Core 2 Duo PC)

Hacking QEMU

- When do you need to hack QEMU
  - New CPU ?
  - New hardware controller ?
  - New/updated board support?
  - New network protocol ?
- Not so simple:
  - lack of internal documentation
  - Some « unstable » API
- But: large community including famous companies (Red Hat, IBM)

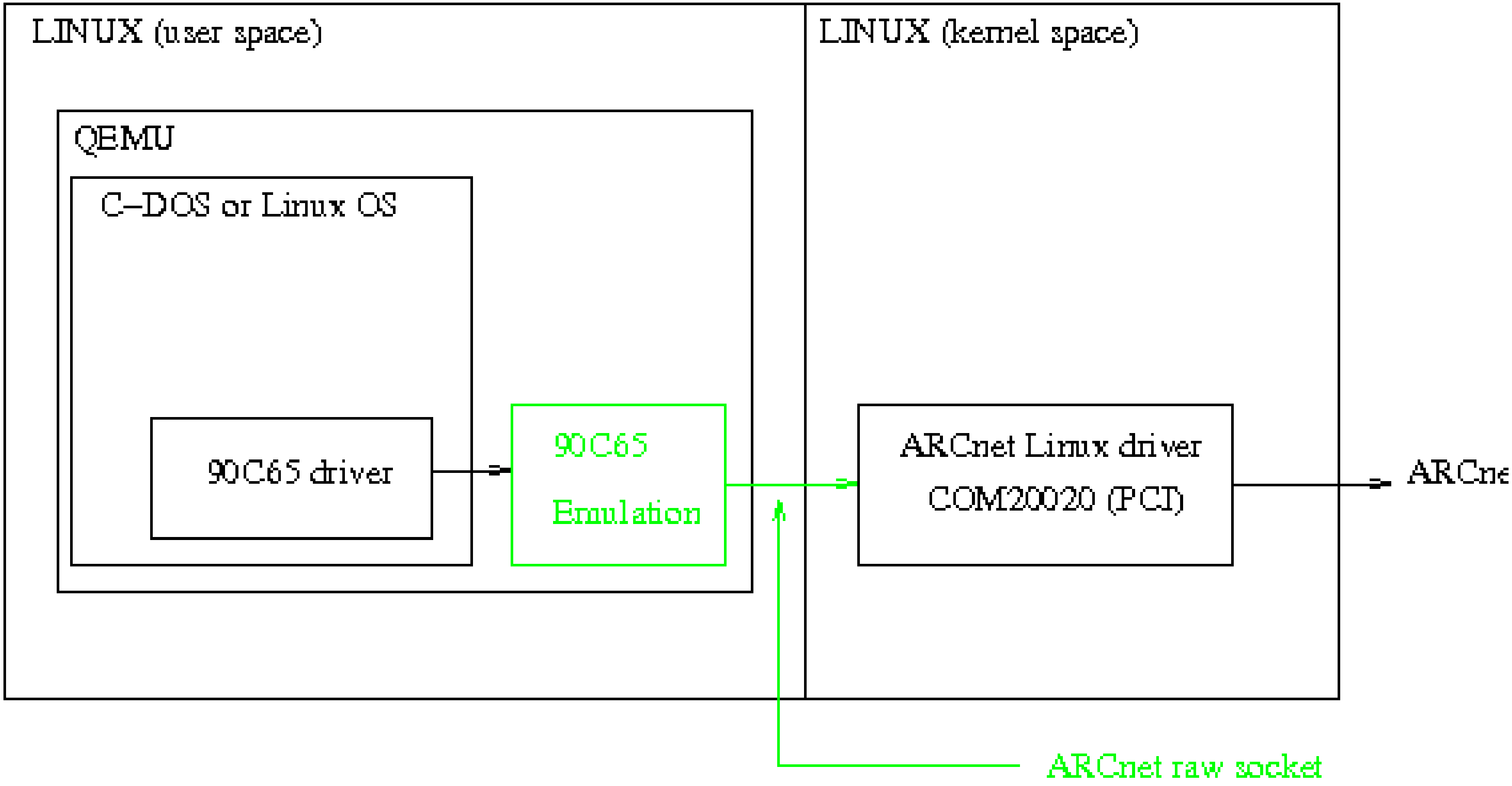
Use case (in real world)

- « Hey you, I have an old fashioned sofware running on obsolete hardware. Of course no sources available, could you help ? »
  - Text based software, binary only
  - Runs on very old PC (ISA, 4 Mb RAM) under C-DOS (Concurrent DOS, Digital Research)
  - ARCnet based (what's that ??)
    - **A**ttached **R**esource **C**omputer **NET**work
    - Designed by Datapoint Corp. In 1976
    - Linux kernel support for ISA and PCI adapter

The QEMU answer

- Running C-DOS in QEMU inside Linux host
- Linux host includes **PCI** ARCnet adapter (SH-ARC PCI, still available)
- Adding ARCnet **ISA** adapter support to QEMU (90C65 chipset, no more available)
- Adding ARCnet raw socket support to QEMU
- ARCnet data from application sent by emulated ISA adapter to Linux host...which sends data to the ARCnet network...
- First test « Linux to Linux », then QEMU/CDOS with real application

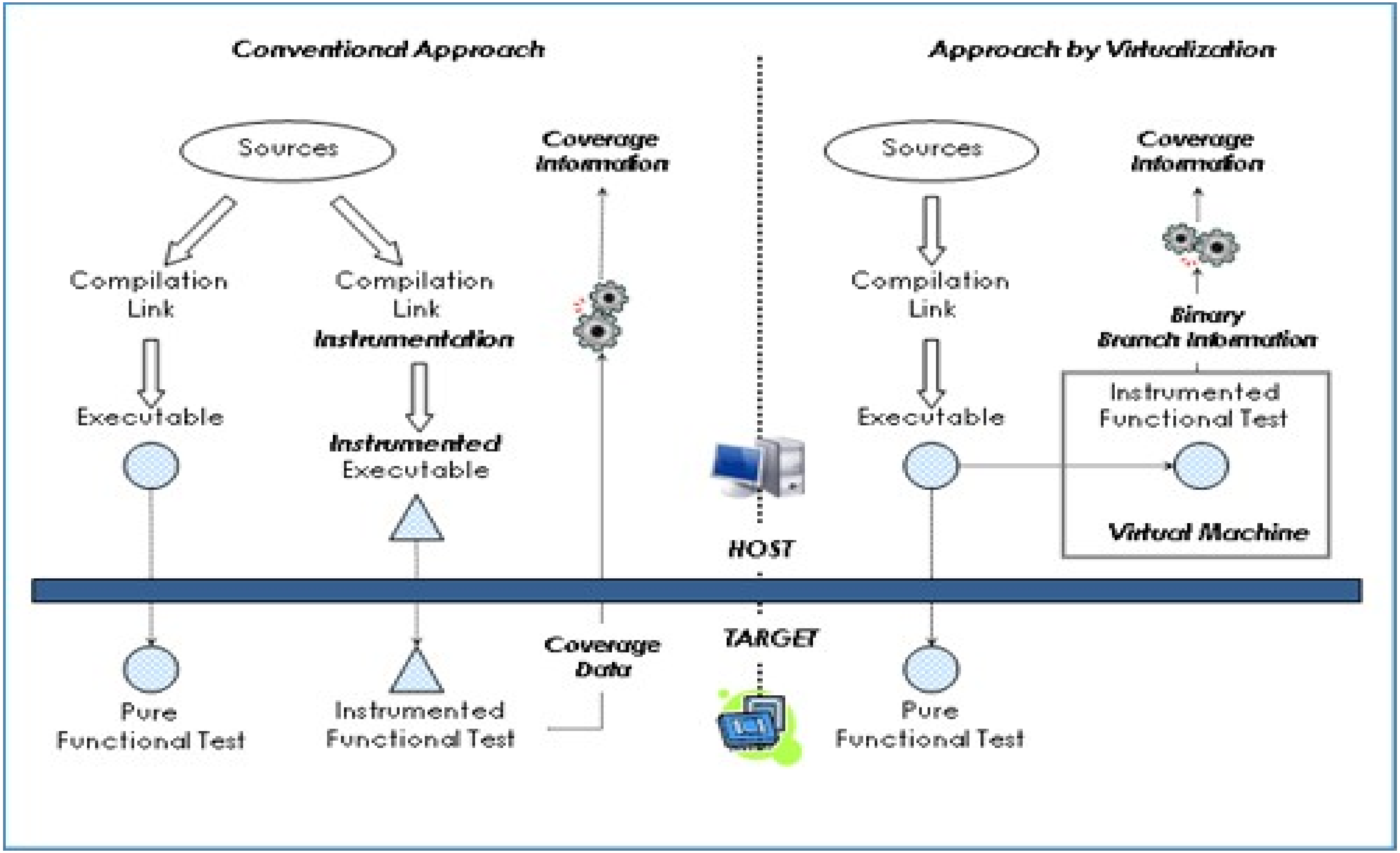
The QEMU answer, architecture



The « COUVERTURE » project

- Leaded by AdaCore, the GNAT Company
- New approach for software coverage in DO-178B environment
- Standard approach: embedded software *IS* instrumented, tested in « real » environment
- New approach: software is *NOT* instrumented, tested in instrumended virtual environment (QEMU)
- Open source solution
- Already used by industry as internal projects => fast testing (cf: QEMU ARM9 on standard PC)

Classical vs Virtualization



Testing program with COUVERTURE

- Build executable with the powerpc-elf GNAT toolchain, with special glue to let the program run into QEMU
- Run through instrumented QEMU to generate an execution trace,
- Use « xcov » coverage analyzer to generate user level relevant info, eg annotated sources, from one or more traces.
- Reference board is Wind River SBC8349E (support added to QEMU by OS4I)

Links

- http://www.os4i.com
- http://www.qemu.org
- http://savannah.nongnu.org/projects/qemu
- http://www.projet-couverture.com

Questions?