Building Chromium on an embedded platform using Ozone-Wayland

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@JacoboAragunde
• Open Source experts and consultants
• 14 years of experience
• Important contributions to:
  • Client-side web technologies: WebKit, Blink/Chromium, Servo
  • Graphics: Wayland, Mesa
  • Compilers: V8, JavaScriptCore, Guile
  • Multimedia: GStreamer, Grilo
  • …
Introduction
Ingredients

- Renesas R-Car M2 Porter
- Recipes to build a Weston image
- Meta-browser recipes to build Chromium
- Computing power
- Patience!
Layers

- Poky
- meta-openembedded
- meta-linaro
- meta-renesas
- meta-browser

BBLAYERS ?= " \\
${TOPDIR}/../poky/meta \\
${TOPDIR}/../poky/meta-yocto \\
${TOPDIR}/../poky/meta-yocto-bsp \\
${TOPDIR}/../meta-renesas/meta-rcar-gen2 \\
${TOPDIR}/../meta-renesas \\
${TOPDIR}/../meta-openembedded/meta-oe \\
${TOPDIR}/../meta-openembedded/meta-multimedia \\
${TOPDIR}/../meta-linaro/meta-linaro-toolchain \\
${TOPDIR}/../meta-browser \\
"
local.conf

- Use local-wayland.conf file for porter board
- Add Chromium to the list of software in the image
  - IMAGE_INSTALL_append = "chromium"
Our tools
Devshell

- devshell opens a shell where all the OE variables and recipe defines are set.
- you need the xterm package around
- depending on your environment, you may need export DISPLAY=:0.0
Devshell: usage

- `bitbake -c devshell <package name>`
gdbserver

• Allows to debug a piece of software that is running on a remote machine

• Very useful for development on embedded
  • gdb difficult or impossible to run there
    – Memory, processing power, disk space constraints
    – 30 minutes to load chromium symbols in the porter!
gdbserver: requirements

- Gdbserver available in the image for the target board
  - Add to local.conf:
    - IMAGE_INSTALL_append = " ... gdbserver"
- On the build/host machine:
  - `apt-get install gdb-multiarch`
gdbserver: usage

- On the target:
  - $ gdbserver 0.0.0.0:15000 <program>
  - $ gdbserver --attach 0.0.0.0:15000 <pid>

- On the build/host machine:
  - $ cd ${YOCTOBUILDDIR}
  - $ gdb-multiarch tmp/work/cortexa15hf-vfp-neon-poky-linux-gnueabi/<module>/image/<path-to-exec>
  - (gdb) set sysroot tmp/sysroots/porter
  - (gdb) set arch armv5
  - (gdb) target remote ${ip.address.of.board}:15000
  - (gdb) run | continue
Chromium --gpu-startup-dialog

- Multi-process architecture
  - Great for user experience and security
  - Extra difficulty to debug
- Flag --gpu-startup-dialog to debug the GPU process
--gpu-startup-dialog: usage

- **On the target:**
  - $ google-chrome --gpu-startup-dialog
    Gpu (816) paused waiting for debugger to attach. Send SIGUSR1 to unpause.
  - $ gdbserver --attach 0.0.0.0:15000 816

- **On the build/host machine:**
  - $ cd ${YOCTOBUILDIR}
  - $ gdb-multiarch tmp/work/cortexa15hf-vfp-neon-poky-linux-gnueabi/chromium/46.0.2459.0-r0/src/out/Release/chrome
  - (gdb) set sysroot tmp/sysroots/porter
  - (gdb) set arch armv5
  - (gdb) target remote 192.168.10.135:15000
  - (gdb) signal SIGUSR1
Getting in trouble…
and out of it
Missing gnome-keyring

• Error:

| No package 'gnome-keyring-1' found |
| gyp: Call to 'pkg-config --cflags gnome-keyring-1' returned exit status 1. |
| WARNING: exit code 1 from a shell command. |
| ERROR: Function failed: do_configure (log file is located at .../log.do_configure.17258) |
ERROR: Task 5 (.../chromium_46.0.2459.0.bb, do_configure) failed with exit code '1' |
Missing gnome-keyring

- Workaround: add to local.conf:
  - `IMAGE_INSTALL_append = " chromium libgnome-keyring"

- Solution: check dependencies in Chromium recipe:
  - In chromium_40.0.2214.91.bb:
    
    DESCRIPTION = "Chromium browser"
    DEPENDS += "libgnome-keyring"
    include chromium.inc

  - In chromium.inc:
    
    DEPENDS = "xz-native pciutils pulseaudio cairo nss zlib-native libav cups ninja-native gconf libexif pango libdrm"

  - Wrong include, libgnome-keyring dependency gets overwritten!
Missing gnome-keyring

- **Patch:** Include chromium.inc before appending to DEPENDS

```diff
--- a/recipes-browser/chromium/chromium_40.0.2214.91.bb
+++ b/recipes-browser/chromium/chromium_40.0.2214.91.bb
@@ -16,9 +16,9 @@
    # * CHROMIUM_WAYLAND_DEPENDS
    # * CHROMIUM_WAYLAND_GYP_DEFINES

+include chromium.inc
DESCRIPTION = "Chromium browser"
DEPENDS += "libgnome-keyring"
-include chromium.inc
SRC_URI = "\n  ../chromium-browser-official/${P}.tar.xz \n  file://include.gypi \n```
Missing gnome-keyring

• New error:

ERROR: Nothing PROVIDES 'libgnome-keyring' (but
.../chromium_40.0.2214.91.bb DEPENDS on or otherwise requires it)
NOTE: Runtime target 'chromium' is unbuildable,
removing...
Missing or unbuildable dependency chain was:
['chromium', 'libgnome-keyring']
ERROR: Required build target 'core-image-weston' has no buildable providers.
Missing or unbuildable dependency chain was:
['core-image-weston', 'chromium', 'libgnome-keyring']
Missing gnome-keyring

• How to get libgnome-keyring?

   $ find -name libgnome-keyring*
   ./meta-openembedded/meta-gnome/recipes-gnome/gnome-keyring/libgnome-keyring_2.32.0.bb

• Solution: add meta-gnome layer:

   BBLAYERS ?= " \
   ${TOPDIR}/../poky/meta \n   ${TOPDIR}/../poky/meta-yocto \n   ${TOPDIR}/../poky/meta-yocto-bsp \n   ${TOPDIR}/../meta-renesas/meta-rcar-gen2 \n   ${TOPDIR}/../meta-rcar-gen2 \n   ${TOPDIR}/../meta-openembedded/meta-oe \n   ${TOPDIR}/../meta-openembedded/meta-multimedia \n   ${TOPDIR}/../meta-linaro/meta-linaro-toolchain \n   ${TOPDIR}/../meta-browser \n   ${TOPDIR}/../meta-openembedded/meta-gnome \n   "

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Problem building libglu

• Error:

```
| collect2: error: ld returned 1 exit status
| Makefile:1041: recipe for target 'libGLU.la' failed
| make: *** [libGLU.la] Error 1
| ERROR: oe_runmake failed
| WARNING: exit code 1 from a shell command.
| ERROR: Function failed: do_compile (log file is located at .../log.do_compile.27132)
```
Problem building libglu

- **Cause:** libglu, required by dependencies, depends on full GL, which is not available in the device.

- **Dependency chain when X11 is enabled:**
  - chromium → libav → libSDL → libglu → GL

  ```
  $ cat ./meta/recipes-multimedia/libav/libav.inc
  ...
  PACKAGECONFIG[x11] = "--enable-x11grab,--disable-x11grab, virtual/libx11 libxfixes libxext xproto virtual/libSDL"
  ```

- **Workaround:** add to local.conf:
  - `DISTRO_FEATURES_remove = " x11"`
Problem building libglu

- Solution: patch recipe, glu was not really necessary to build libsdl

```bash
--- a/meta/recipes-graphics/libsdl/libsdl_1.2.15.bb
+++ b/meta/recipes-graphics/libsdl/libsdl_1.2.15.bb
@@ -13,7 +13,7 @@ LIC_FILES_CHKSUM = "file://COPYING;md5=27818cd7fd83877a8e3ef82b82e3ef"
 PROVIDES = "virtual/libsdl"

 DEPENDS = "@{base_contains('DISTRO_FEATURES', 'directfb', 'directfb', '', d)} \ 
 - @{base_contains('DISTRO_FEATURES', 'opengl', 'virtual/libgl libglu', '', d)} \ 
 + @{base_contains('DISTRO_FEATURES', 'opengl', 'virtual/libgl', '', d)} \ 
  @{base_contains('DISTRO_FEATURES', 'x11', 'virtual/libx11 libxext libxrandr libxrender tslib"
```
Problem building libglu

- Proper patch is already upstream

commit 0e5a9114f58828058595d773e5b97771c88f7be8
Author: Robert Yang <liezhi.yang@windriver.com>
Date:   Tue Sep 15 19:28:46 2015 -0700

libSDL: depends on libglu when both x11 and opengl

The libglu requires both opengl (depends on virtual/libgl) and x11
(needs libGL.so which is provided by mesa when x11 in
DISTRO_FEATURES),
so let libSDL depends on libglu when both x11 and
opengl in
DISTRO_FEATURES.
Missing includes in v8

- Error:

```bash
| FAILED: g++ -MMD -MF obj.host/v8/src/base/v8_libbase.bits.o.d -D... -W... -f... -pipe -m32 -O3 -std=gnu++11 -I../../v8 -Igen --param=ssp-buffer-size=4 -pthread -c ../../v8/src/base/bits.cc -o obj.host/v8/src/base/v8_libbase.bits.o |
| In file included from /usr/include/bits/errno.h:24:0, |
| ... |
| from ../../v8/src/base/bits.cc:5: |
| /usr/include/linux/errno.h:1:23: fatal error: asm/errno.h: No such file or directory |
| #include <asm/errno.h> |
| ^ |
| compilation terminated. |
| ninja: build stopped: subcommand failed. |
| WARNING: exit code 1 from a shell command. |
| ERROR: Function failed: do_compile (log file is located at .../log.do_compile.25688) |
```
Missing includes in v8

- Check what is happening with devshell:
  - $ bitbake -c devshell chromium
  - # whereis g++
    
    g++: /usr/bin/g++
    
  - # env
    
    CPP=arm-poky-linux-gnueabi-gcc -E -sysroot=.../build/tmp/sysroots/porter -march=armv7-a
    
    PATH=.../build/tmp/sysroots/x86_64-linux/usr/bin/python-native:
    
    env:
    
    CPP=arm-poky-linux-gnueabi-gcc -E -sysroot=.../build/tmp/sysroots/porter
    
    CXX=arm-poky-linux-gnueabi-g++ -march=armv7-a
    
    CC=arm-poky-linux-gnueabi-gcc -march=armv7-a

  - # whereis arm-poky-linux-gnueabi-g++
    
    arm-poky-linux-gnueabi-g++: .../build/tmp/sysroots/x86_64-linux/usr/bin/cortexa15hf-vfp-neon-poky-linux-gnueabi/arm-poky-linux-gnueabi-g++
Missing includes in v8

• Problem: wrong compiler being used
  • Calling `g++` instead of `$CXX`
  • `$CXX` points to `arm-poky-linux-gnueabi-g++` inside the sysroot
  • `g++` is the system compiler

• Workaround:
  • `apt-get install gcc-multilib g++-multilib`

• Proper solution would be fixing the recipe!
Cannot open libGLESv2.so

• Error:
  
  [display.cc (117)] Failed to load GLES library: libGLESv2.so.2: cannot open shared object file: no such file or directory

• Check contents in /usr/lib
  
  • libGLESv2.so is there, symlinks with version numbers are not

• Workaround: manually add a symlink
  
  cd /usr/lib
  ln -s libGLESv2.so libGLESv2.so.2
Cannot open libGLESv2.so

• Solution: patch recipe

--- a/meta-rcar-gen2/recipes-graphics/gles-module/gles-user-module.bb
+++ b/meta-rcar-gen2/recipes-graphics/gles-module/gles-user-module.bb
@@ -65,7 +65,10 @@ do_install() {
     $(D)/${sysconfdir}/powervr.ini
   fi
   fi
-}
+
+  # Fix symlink
+  cd ${D}/usr/lib && ln -s libGLESv2.so libGLESv2.so.2
+

PACKAGES = "\n ${PN} \n"
Error in egl.c

• Error:

  egl.c:228: eglQueryString: Assertion `ret != ((void *)0)' failed.

• Check code flow with the debugger
  • Set breakpoint at egl.c:228

    224    ret = _eglQueryString(dpy, name);
    225
    226   #ifdef WANT_WAYLAND
    227    if (name == EGL_EXTENSIONS) {
    228       assert(ret != NULL);
    229      ...

• Check backtrace to know where we are: libegl
Error in egl.c

- Solution: replace the assert with a softer if sentence
- Check solution with original developers, share upstream

--- a/egl.c
+++ b/egl.c
@@ -224,8 +223,7 @@ const char *eglQueryString(EGLDisplay dpy, EGLint name)
     ret = _eglQueryString(dpy, name);

+#ifdef WANT_WAYLAND
-     if (name == EGL_EXTENSIONS) {
-         assert(ret != NULL);
+     if (ret && name == EGL_EXTENSIONS) {

         if (!_eglextstr) {
             _eglextstr = calloc(1, strlen(ret) + strlen(EGL_WL_EXT_STRING) + 1);
Error in egl.c

• Solution: replace the assert with a softer if sentence

• Modify libegl recipe:

```diff
--- a/meta-riscv-gen2/recipes-graphics/wayland/libegl.bb
+++ b/meta-riscv-gen2/recipes-graphics/wayland/libegl.bb
@@ -5,7 +5,7 @@ LIC_FILES_CHKSUM = "file://egl.c;beginline=5;endline=15;md5=3677623633a6e459b1f6
         COMPATIBLE_MACHINE = "(r8a7790|r8a7791|r8a7793|r8a7794)"

-PROVIDES = "${@base_contains("DISTRO_FEATURES", "wayland", "virtual/egl", ",", -SRCREV = "ee4bce93878d02a144ae6ebfba1eff28fe9b4442"
+SRCREV = "02b559098042a0aeb9ac63eece547868a140fa46"
```
Missing certificates
Missing certificates

- Solution: add ca-certificates package to the image
  - `IMAGE_INSTALL_append = "chromium ca-certificates"`
Finally, it's working!
Contributions upstream

- Contributions to meta-browser
  - 4b27058 chromium: Include chromium.inc before appending to DEPENDS
  - 6ae140b chromium: Rework the evaluation of the Wayland feature.
  - 65d7e9f chromium: Clean the definitions of some ozone-wayland variables.
  - 556b41a chromium: Allow to build in Debug mode.
Contributions upstream

• Contributions to libegl
  • ce7caca Don't assert when eglQueryString() returns null.

• Contributions to meta-renesas
  • rcar-gen2: libegl: Update SRCREV.
  • rcar-gen2: gles-user-module: Add symlink for the GLESv2 library.
Contributions upstream

- Contributions to Ozone-Wayland
  - a12c78e Add support for receiving drag data from external processes
  - 5b0b336 Add an error message when running with software rendering
  - 3bc3655 tools/jhbuild: moduleset requires the full path
  - b0988bb WindowManagerWayland: guard against invalid window handles
  - Some additional commits and more under development now
What's next

• Build on top of meta-ivi
• Run on the GENIVI Demo Platform
• Continue with the development of Ozone-Wayland
Thank you!