BUILDING WPE FOR AN EMBEDDED DEVICE

Supported hardware, WPEBackends, BSPs

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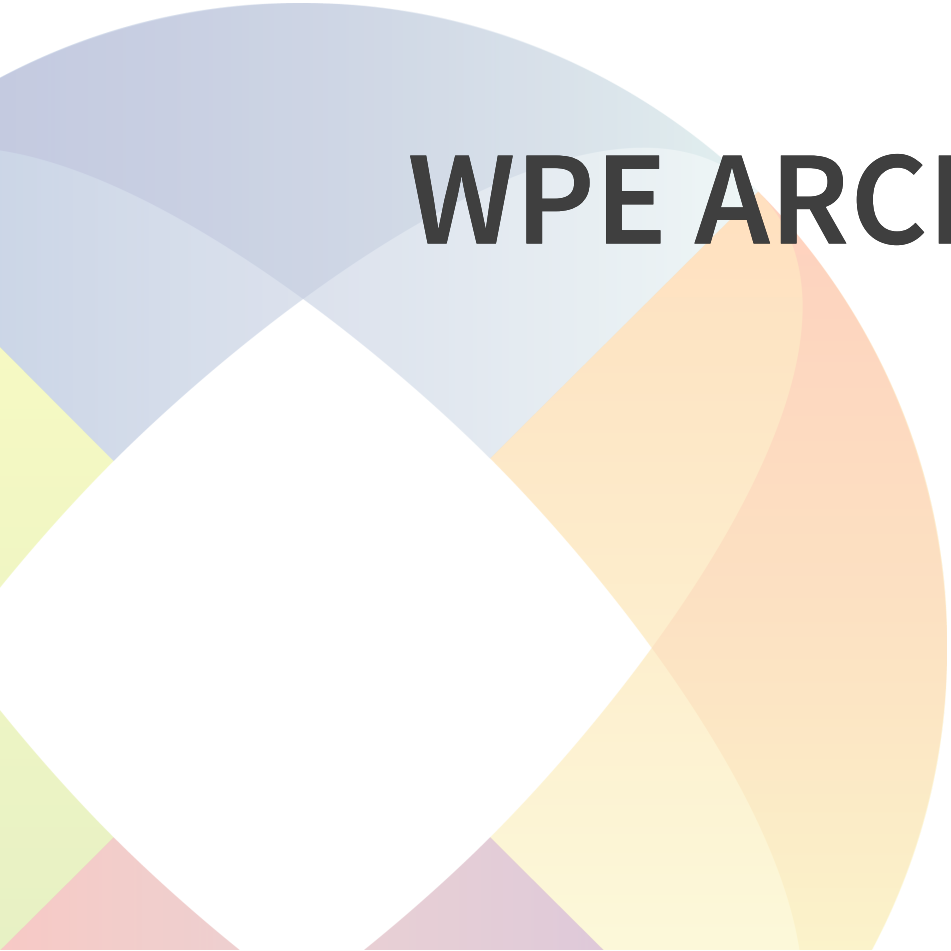
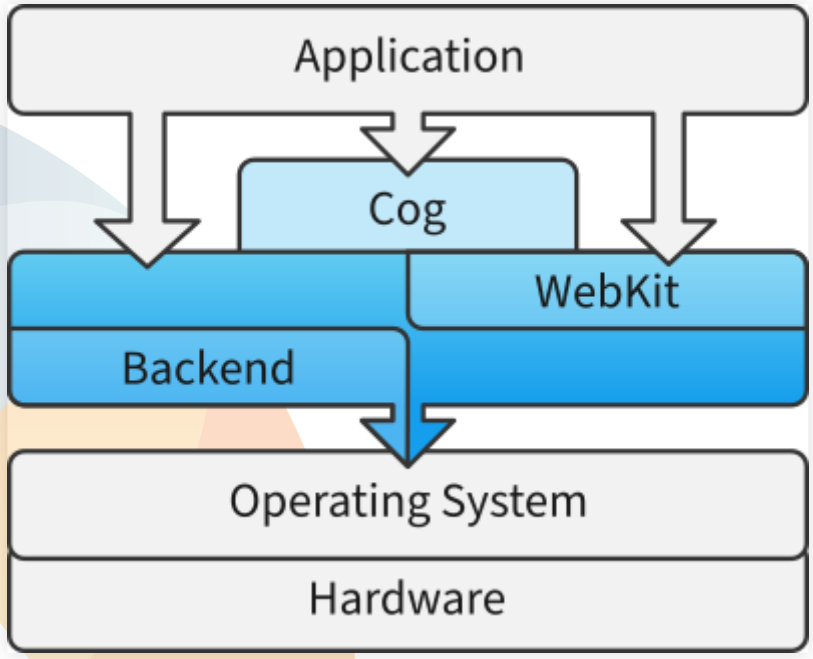
https://people.igalia.com/psaavedra/slides/webengines-hackfest-2021-wpe-embedded

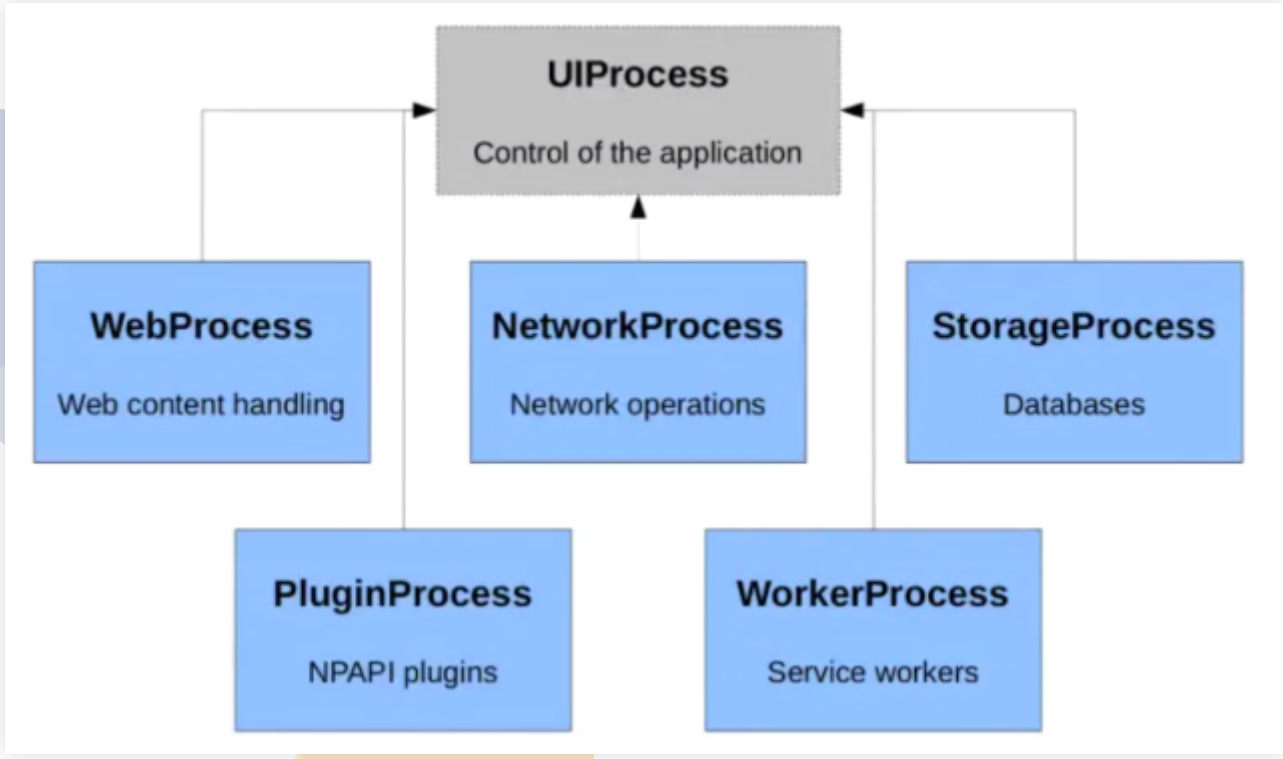


WPE ARCHITECTURE

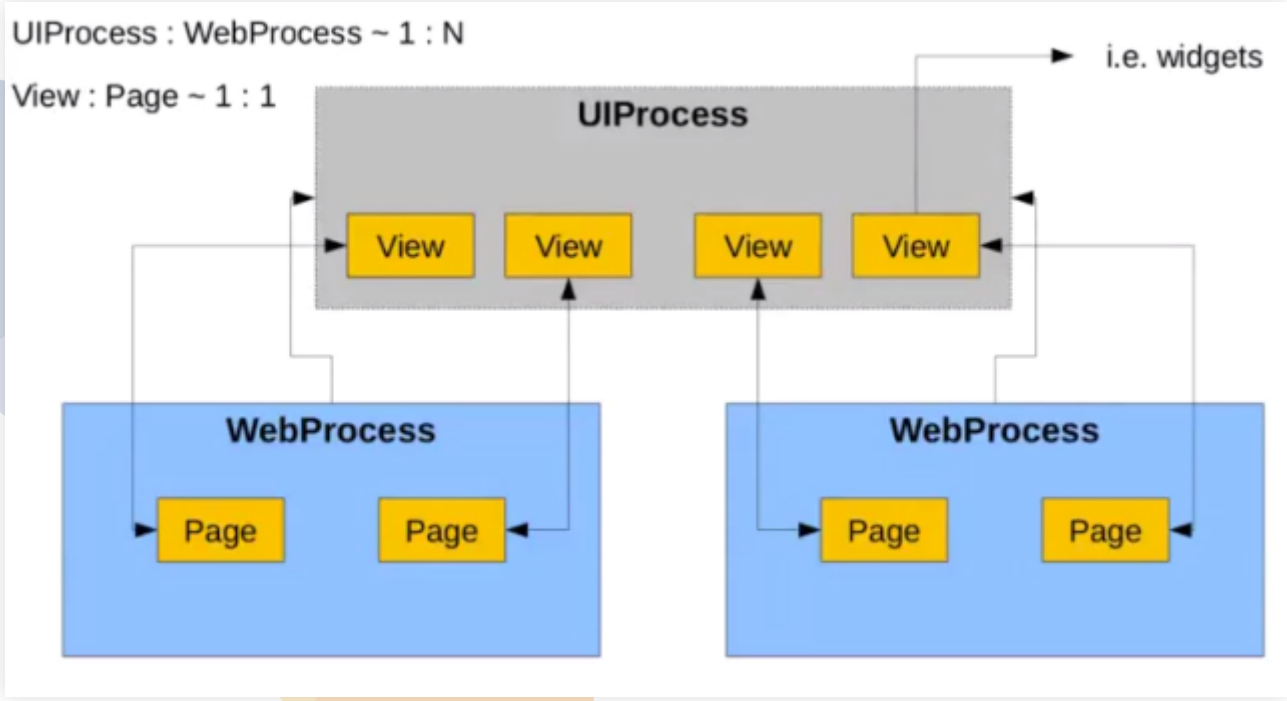
WPE STACK


Application
Cog
WebKit
Backend
Operating System
Hardware

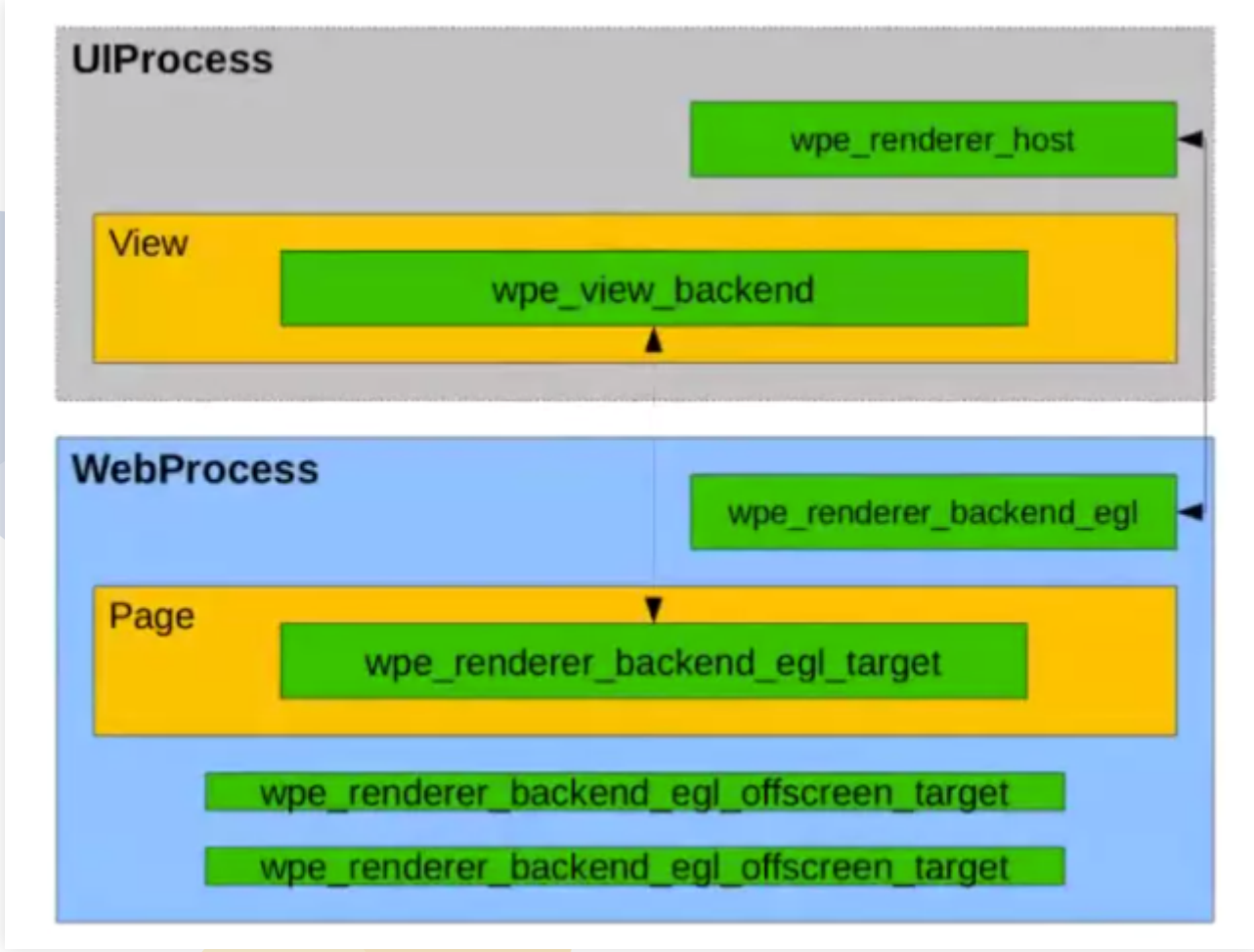
WEBKIT PROCESS MODEL (1/2)



WEBKIT PROCESS MODEL (2/2)



LIBWPE INTERFACES



WPE BACKENDS: LIBWPE IMPLEMENTATIONS

- Used by the WPE port
- Provides the implementation of the interfaces defined by the `libwpe` for rendering and input handling
- Sets EGL resources as requirement for the graphical output consuption (OpenGLv2)
- Several implementations but the most relevant are: `wpebackend-rdk`, `wpebackend-fdo`, ...

WPEBACKEND-RDK

- RDK is a Set-top boxes consortium
- Covers different STB hardware and proptotype boards
- Uses a propietary API (Dispmanx) to lowest level access to the GPU
- It is supported by the propietary RPi Broadcom driver

WPEBACKEND-FDO

- Uses Wayland protocol to coordinate the operations among the interface implementations
- Depends on the Wayland EGL support (`EGL_WL_bin_wayland_display`)
- Relies in GLib as IPC mechanism for comunication in between the host and the backend
- In theory, compatible with any Mesa driver implementation

- **Conclusion 1**: Several libs combinations (`libwpe, libwebkit, cog` ...) and several backend implementations that makes a bit difficult the setup.

WEBKIT'S JAVASCRIPT (JSC) SUPPORT

- Depends on the CPU architecture
- Fully operational for JSC: `armv7, arm64, x86 x86_64, mips32`
- With limitations for 32bits architectures: *FTL JIT and WebAssembly are disabled*.
- Other architectures `risc-v, mips64, powerpc ...` expected to work but only with a less optimized interpreter

- **Conclusion 2**: WPE configuration is sensitive to the underlying hardware and software stack where it has to work

WHAT MAKES A HARDWARE PLATFORM

- System-on-Chip (SoC)
- GPU
- CPU

EXAMPLE (1/3): NXP I.MX 6

- SoC: i.MX6Q
- GPU: Vivante GC2000 / GC320
- CPU: NXP i.MX 6 - Cortex-A9 - quad-core

EXAMPLE (2/3): RASPBERRI PI 4 B

- SoC: BCM2711B0
- GPU: Broadcom VideoCore VI 500MHz
- CPU: A72 - quad-core

EXAMPLE (3/3): QUALCOMM

- SoC: APQ8017
- GPU: Adreno 306
- CPU: Qualcomm - Cortex-A53 CPU

… MORE SUPPORTED HARDWARE

wpewebkit.org/about/supported-hardware

- **Conclusion 3**: WPE works in the top of several multiple different hardware platforms

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BOARD SUPPORT PACKAGE (BSP)

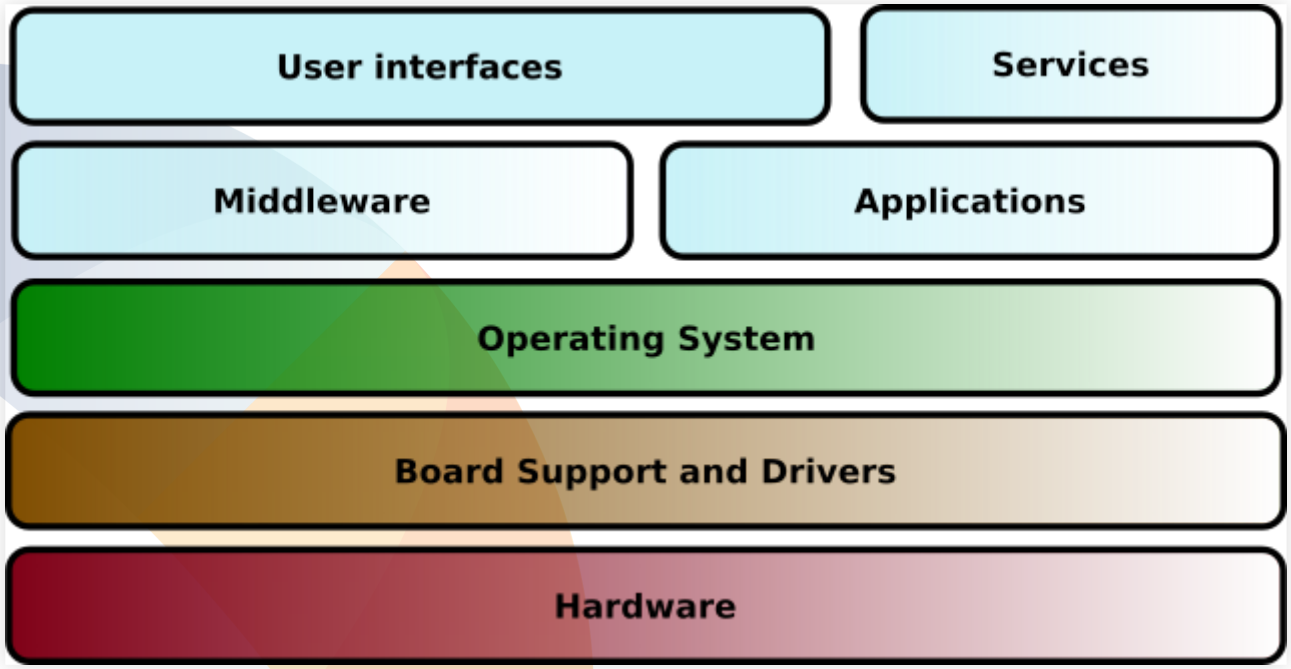
BOARD SUPPORT PACKAGE (BSP)

- **Problem 1**: Several libs and dependencies that makes a bit difficult the the setup.
- **Problem 2**: WPE is sensitive to the underlying hardware and software stack where it has to work
- **Problem 3**: WPE works in the top of several multiple different hardware platforms
- **Solution**: A software layer that enables an hardware-specific platform: BSP

BOARD SUPPORT PACKAGE (1/3)

- Bootloader and Linux kernel
- SoC operative system support:
  - SoC support (peripherals, storage, network, …)
  - Graphics stack support
- Userspace tools and interfaces
- WebKit stack:
  - `libwpe`
  - WPE backend implementation
  - WebKit WPE runtime
  - WPE browser (`cog`)

BOARD SUPPORT PACKAGE (2/3)



BOARD SUPPORT PACKAGE (3/3)

- Assembling all the user space components needed for the system, configure them, develop the upgrade and recovery mechanisms, etc.
- Application development: write the company-specific applications and libraries.
- Building from source
- Cross-compilation
- Recipes for building components

YOCTO VS BUILDROOT

- **Yocto/OpenEmbedded**:
  - Builds a full Linux distro with binary pkgs.
  - Powerful, but somewhat complex, and quite steep learning curve.
- **Buildroot**:
  - Builds a root filesystem image, no binary pkgs.
  - Much simpler to use, understand and modify.
  - WPE recipe in upstream buidroot (thanks `aperezdc`!)

YOCTO (1/2)

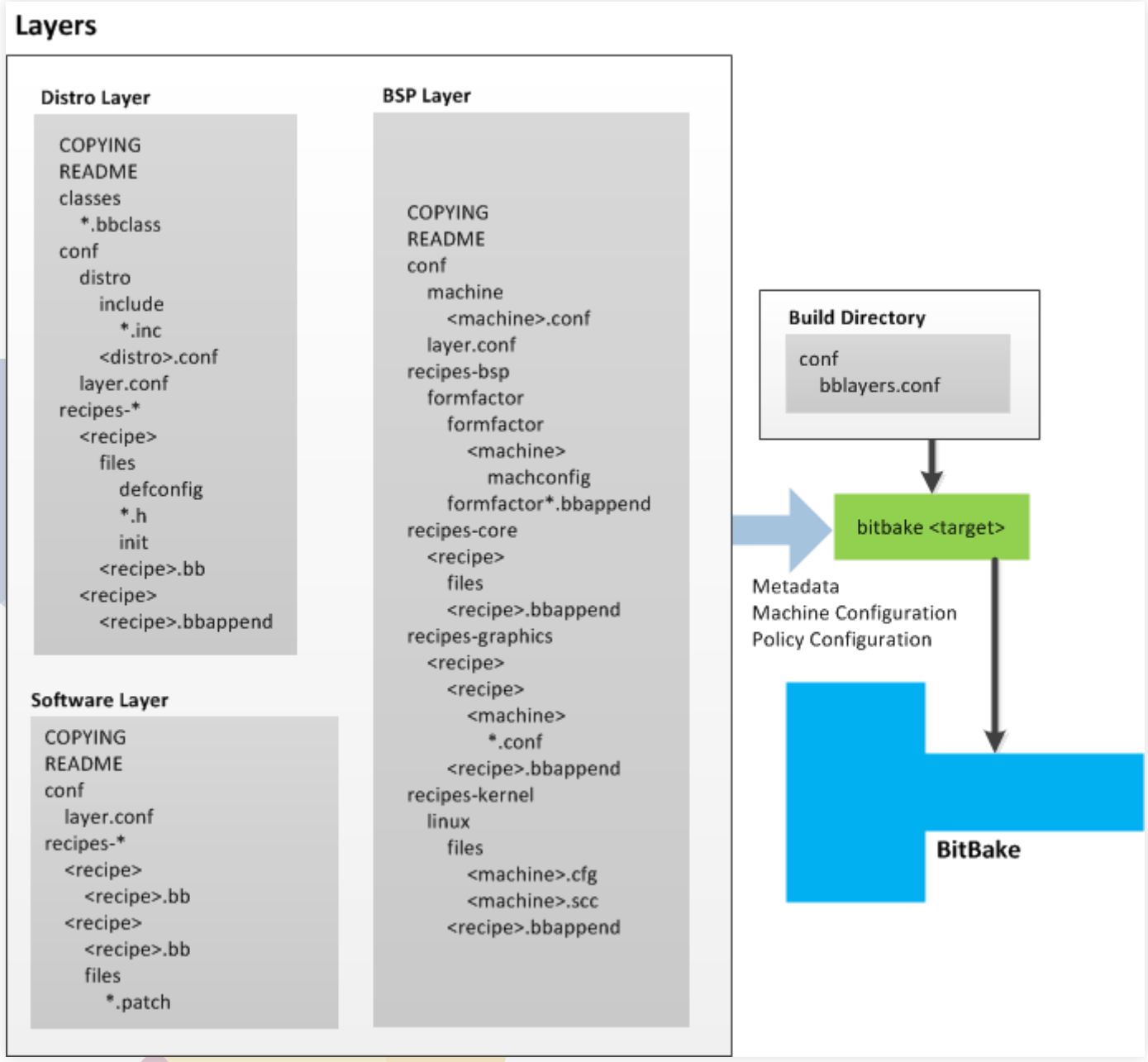
- YP is not a distro but **is something that allow you to build your own distro** …
- *Combines, maintains and validates three key development elements*: …

YOCTO (2/2)

1. A set of integrated tools to make working with embedded Linux successful, including tools for automated building and testing: Bitbake, Wic …
2. Poky: A reference embedded distribution
3. The OpenEmbedded build system, co-maintained with the OpenEmbedded Project

The Yocto build enviroment is structurated in layers. Let’s see the layers like a set of recipes, classes and definitions that extend the base distribution.

Layers


Distro Layer
COPYING
README
classes
*.bbclass
conf
distro
include
*.inc
<distro>.conf
layer.conf
recipes-*
<recipe>
files
defconfig
*.h
init
<recipe>.bb
<recipe>
<recipe>.bbappend
Software Layer
COPYING
README
conf
layer.conf
recipes-*
<recipe>
<recipe>.bb
<recipe>
<recipe>.bb
files
*.patch
BSP Layer
COPYING
README
conf
machine
<machine>.conf
layer.conf
recipes-bsp
formfactor
formfactor
<machine>
machconfig
formfactor*.bbappend
recipes-core
<recipe>
files
<recipe>.bbappend
recipes-graphics
<recipe>
<recipe>
<machine>
*.conf
<recipe>.bbappend
recipes-kernel
linux
files
<machine>.cfg
<machine>.scc
<recipe>.bbappend
Build Directory
conf
bblayers.conf
bitbake <target>
Metadata
Machine Configuration
Policy Configuration
BitBake

META-WEBKIT

- Created on Oct 2015 by Carlos López (blog).
- meta-webkit is an compatible Yocto BSP meta-layer which provides recipes for WebKitGTK and WPE:
  - The runtime and libraries for `wpe` and `webkitgtk`
  - The `libwpe`
  - The WPE backends implementations: `wpebackend-fdo` and `wpebackend-rdk`
  - and the reference WPE browser: `cog`

meta-webkit:

```
├── conf
│   └── layer.conf
├── recipes-browser
│   ├── cog
│   │   └── cog_0.8.0.bb
│   ├── libwpe
│   │   └── libwpe_1.8.0.bb
│   ├── webkitgtk
│   │   └── webkitgtk_2.32.0.bb
│   ├── wpebackend-fdo
│   │   └── wpebackend-fdo_1.8.3.bb
│   └── wpewebkit
│       └── wpewebkit_2.32.0.bb
└── ...
```

HANDS-DOWN

WPE ON A RPI (META-WEBKIT)

1. Specify **architecture**, policies, patches …
2. **Fetches and downloads** the source code
3. **Extracts the sources** into a local work area
4. Build **binary packages**
5. **QA and sanity checks**
6. Build system generates **root file image**
7. Build system generates the **system image** and the extensible SDK (eSDK)

GETTING THE SOURCES AND ACTIVATE THE ENVIRONMENT

```
cd ${HOME}/yocto-rpi3-wpe
git clone https://git.yoctoproject.org/git/poky -b hardknott
git clone git://git.openembedded.org/meta-openembedded -b hardknott
git clone https://github.com/OSSystems/meta-gstreamer1.0 -b master
git clone https://git.yoctoproject.org/git/meta-raspberrypi -b
        master
git clone https://github.com/Igalia/meta-webkit -b master
```

```
$ source poky/oe-init-build-env
```

bblayers.conf:

```
$ cat conf/bblayers.conf

BSPDIR := "${@os.path.abspath(os.path.dirname(d.getVar('FILE',
        True)) + '/../..')}"

BBLAYERS = " ${BSPDIR}/poky/meta \
  ${BSPDIR}/poky/meta-poky \
  ${BSPDIR}/poky/meta-yocto-bsp \
  ${BSPDIR}/meta-openembedded/meta-oe \
  ${BSPDIR}/meta-openembedded/meta-python \
  ${BSPDIR}/meta-gstreamer1.0 \
  ${BSPDIR}/meta-raspberrypi \
  ${BSPDIR}/meta-webkit \
"
```

local.conf:

```
$ cat local.conf
MACHINE = 'raspberrypi3'
MACHINE_FEATURES_append = " vc4graphics"
GPU_MEM_256 = "128"
GPU_MEM_512 = "196"
GPU_MEM_1024 = "396"
EXTRA_IMAGE_FEATURES = "debug-tweaks"
IMAGE_FEATURES_append = " ssh-server-dropbear hwcodecs"
DISABLE_VC4GRAPHICS = "1"
PREFERRED_PROVIDER_virtual/wpebackend = "wpebackend-fdo"
PREFERRED_PROVIDER_virtual/libwpe = "libwpe"
IMAGE_INSTALL_append = " cog wpewebkit"
```

RUN BITBAKE

```
$ bitbake core-image-weston
Loading cache: 100% |###################| Time: 0:00:00
Loaded 3376 entries from dependency cache.
Parsing recipes: 100% |###################| Time: 0:20:00
Build Configuration:
BB_VERSION           = "1.36.0"
BUILD_SYS            = "x86_64-linux"
NATIVELSBSTRING      = "universal"
TARGET_SYS           = "arm-linux-gnueabi"
MACHINE              = "raspberrypi3"
DISTRO               = "poky"
DISTRO_VERSION       = "1.0.0"
meta
meta-poky
meta-yocto-bsp       = "hardknott"
```

```
$ ls tmp/deploy/images/raspberrypi3/*wic
tmp/deploy/images/raspberrypi3/core-image-weston.wic
```

RUNNING COG IN RPI

```
root@raspberrypi3:~# export WAYLAND_DISPLAY=wayland-0
root@raspberrypi3:~# export XDG_RUNTIME_DIR=/run/user/0
root@raspberrypi3:~# cog -P fdo http://wpewebkit.org
```

THANKS

DISCUSSION / QUESTIONS