TOSHIBA
Leading Innovation >>>

Chromium OS Build system

Mitsuhiro Kimura
TOSHIBA CORPORATION

2012/ 3/23
CELF Japan Technical
Jamboree #40

Toshiba Group contributes to
the sustainable future of planet Earth.

Chrome OS History

2009.07.07 Chrome OS announcement

2009.11.19 source code exposure

2010.02
“徹底解説ChromeOSの全貌”
by 日経Linux

2010.12.07 Cr-48 reference laptop（not retail sales）

2011.05.11 Chromebook（Acer, Samsung）at Google I/O

Changed significantly
especially build system

Chromium

- Chromium is an open source version of Chrome
- The Chromium Projects include Chromium browser and Chromium OS

	Browser	OS
Official	Chrome	Chrome OS
Open source	Chromium	Chromium OS

http://www.chromium.org/chromium-os/chromium-os-faq

Chromium

- Chromium is an open source version of Chrome
- The Chromium Projects include Chromium browser and Chromium OS

	Browser	OS
Official	Chrome	Chrome OS
Open source	Chromium	Chromium OS

Today's topic

Information

- The Chromium Projects (http://www.chromium.org/)
- Chromium OS (http://www.chromium.org/chromium-os)
  - Developer Guide
  - FAQ
  - Overview of the source
- Gitweb (http://git.chromium.org/)
  - Repo + Git
- developer wiki (http://code.google.com/p/chromium-os/)
  - for developer-contributed or unofficial content about the Chromium OS project

Version

Active branches: Stable/Beta/Developer preview

(2012/03)

Stable: 0.16.1193.194.0 (2012/ 1/24)

Beta: 0.18.1660.34.0 (2012/ 2/16)

Dev: 0.18.1660.20.0 (2012/ 2/12)

<MAJOR.MINOR.BUILD.PATCH>

(0.16.1193.194: MAJOR=0, MINOR=16, BUILD=1193, PATCH=194)

MAJOR and MINOR track updates to the Google Chrome stable channel.

Each branch version grows as Dev → Beta → Stable

http://www.chromium.org/releases/version-numbers

This presentation is based on the survey about 0.15.877

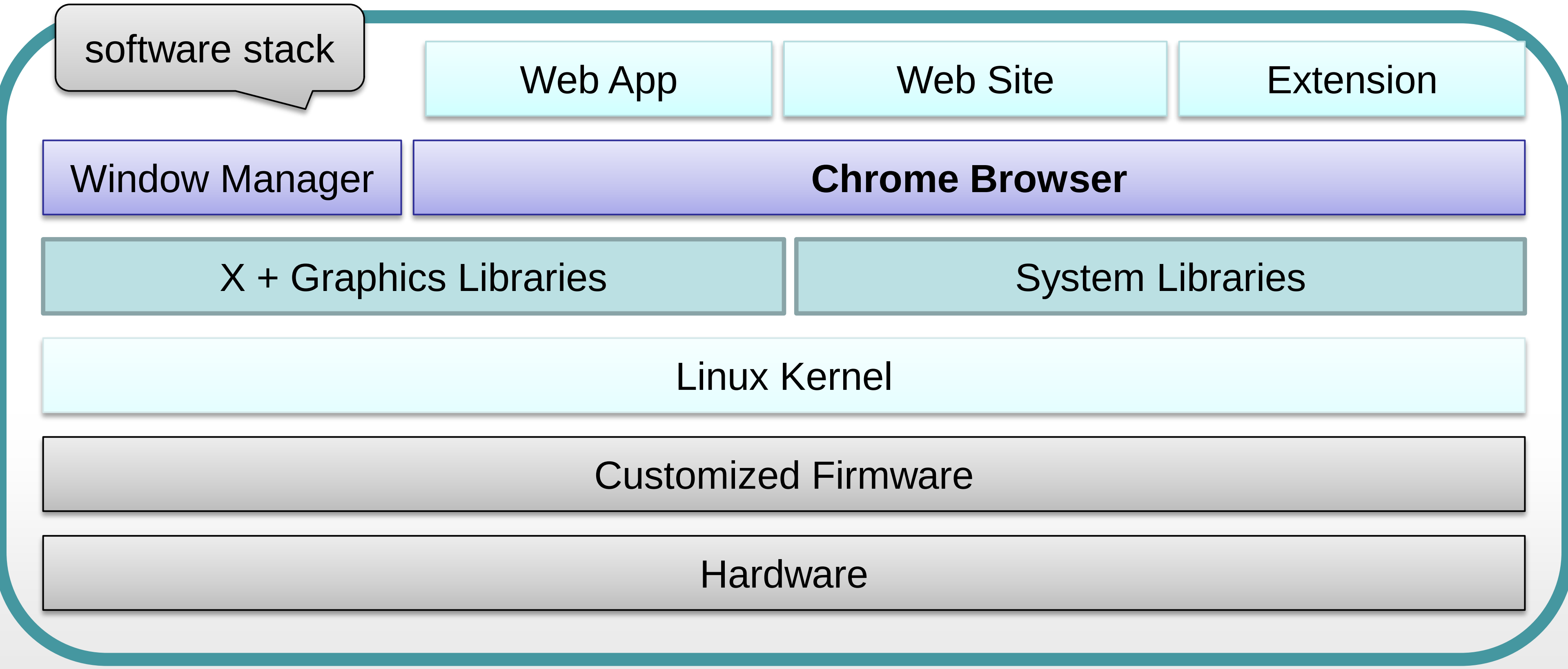
Features

- Log in to your Google account
  - Multiple people can log in alternately to one device
- Chrome Browser is started after login
  - Available web application by Chrome Web Store
  - Share bookmark across multiple devices
- Mechanism of fast boot
  - Chrome OS original BIOS

Architecture

- Specializes in operating Chrome browser
  - improved boot performance by removing a lot of complexity that is normally found in PC firmware

http://www.chromium.org/chromium-os/chromiumos-design-docs/software-architecture



Topic

- Chromium OS Build system
  - Get toolchain ～ Build image

Recommended environment
Ubuntu 10.04 (Lucid) 64bit 9.10(Karmic) is not to work
4GB RAM linking the browser uses 4GB
4GB USB memory For writing a boot image
sudo access to run *chroot*

http://www.chromium.org/chromium-os/developer-guide

Getting source/toolchain

```
$ mkdir chromiumos
$ cd chromiumos
$ repo init -u
    https://git.chromium.org/chromiumos/manifest.git ¥
    -m minilayout.xml
    --repo-url https://git.chromium.org/external/repo.git
$ repo sync
$ ls
AUTHORS LICENSE chromite/ src/
$ ls src/
overlays/platfrom/ repohooks/ scripts/ third_party/
$ ls src/third_party/
chromiumos-overlay/ portage/ portage-stable/
```

Download minimum src/tool
Other can get when you need

Chromium OS build steps

(cr): run inside the chroot

1. $ chromite/bin/cros_sdk
   To make sure everyone uses the same exact environment and tools chroot

2. (cr) ./setup_board --board=x86-generic --default
   Initialize the build for a board

3. (cr) ./build_packages
   The rough equivalent of make all in a standard Makefile system

4. (cr) ./build_image --noenable_rootfs_verification
   Build a disk image for a board

5. (cr) ./image_to_usb.sh --to=/dev/sdc
   Put a disk image on a USB disk

1. cros_sdk

To make sure everyone uses the same exact environment and tools chroot.

At first time, this command downloads sdk (521MB) and creates the chroot.

Second and subsequent, check update of sdk and enter the chroot. (and you'll be in the ~/trunk/src/scripts)

http_proxy is taken over when created chroot by cros_sdk

ftp_proxy, *all_proxy* are also. But *no_proxy* is not.

http_proxy is necessary to download sdk or packages through proxy.

If you share packages inside proxy network at the same time, *no_proxy* also necessary.

Patch for *no_proxy*

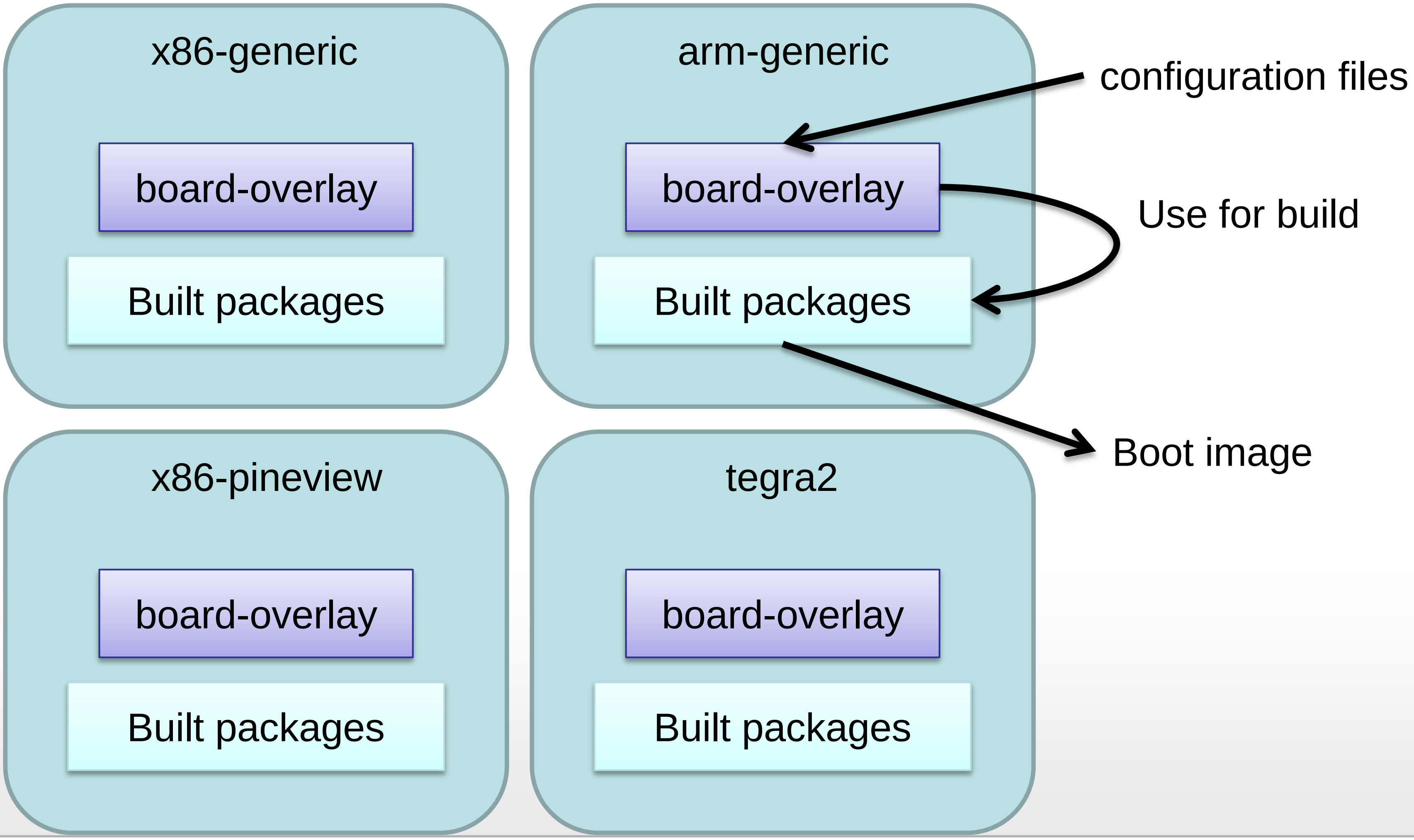
Take over *no_proxy* in the same way as *http_proxy, ftp_proxy, all_proxy*

src/scripts/sdk_lib/enter_chroot.sh		
389	389	CHROMEOS_VERSION_DEVSERVER=${CHROMEOS_VERSION_DEVSERVER}"
390	390	
391	391	# Pass proxy variables into the environment.
392		for type in http_proxy ftp_proxy all_proxy GIT_PROXY_COMMAND GIT_SSH; do
	392	for type in http_proxy ftp_proxy all_proxy no_proxy GIT_PROXY_COMMAND GIT_SSH; do
393	393	eval value=¥$${type}
394	394	if [-n "${value}"]; then
395	395	CHROOT_PASSTHRU="${CHROOT_PASSTHRU} ${type}=${value}"

src/scripts/sdk_lib/make_chroot		
170	170	bash_chroot "echo Defaults env_keep += http_proxy >> /etc/sudoers"
171	171	bash_chroot "echo Defaults env_keep += ftp_proxy >> /etc/sudoers"
172	172	bash_chroot "echo Defaults env_keep += all_proxy >> /etc/sudoers"
	173	bash_chroot "echo Defaults env_keep += no_proxy >> /etc/sudoers"
173	174	bash_chroot "echo %adm ALL=¥(ALL¥) ALL >> /etc/sudoers"
174	175	bash_chroot "echo root ALL=¥(ALL¥) ALL >> /etc/sudoers"
175	176	bash_chroot "echo $USER ALL=NOPASSWD: ALL >> /etc/sudoers"
...	...	
293	294	CHROOT_PASSTHRU=(CROS_WORKON_SRCROOT="$CHROOT_TRUNK" PORTAGE_USERNAME="$USER")
294	295	
295	296	# Pass proxy variables into the environment.
296		for type in http ftp all; do
	297	for type in http ftp all no; do
297	298	value=$(env | grep ${type}_proxy || true)
298	299	if [-n "${value}"]; then
299	300	CHROOT_PASSTHRU=("${CHROOT_PASSTHRU[@]}" "$value")

2. setup_board

Choose a board for your first build in src/overlays/
Built packages put into chroot/build/<board>



board, variant

Different classes of computers are referred to by Chromium OS as different target "boards"

cf. src/overlays/README

- board
- variant

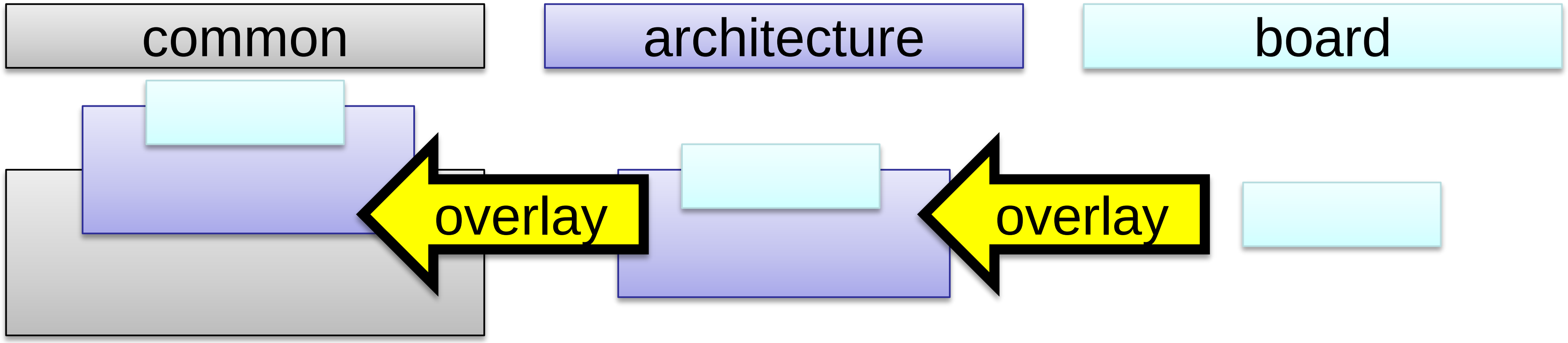
  variant of board

ex.)

- arch: x86, arm
- board: x86-pineview, tegra2, x86-generic, arm-generic
- variant: tegra2-seaboard, tegra2-dev-board

overlay

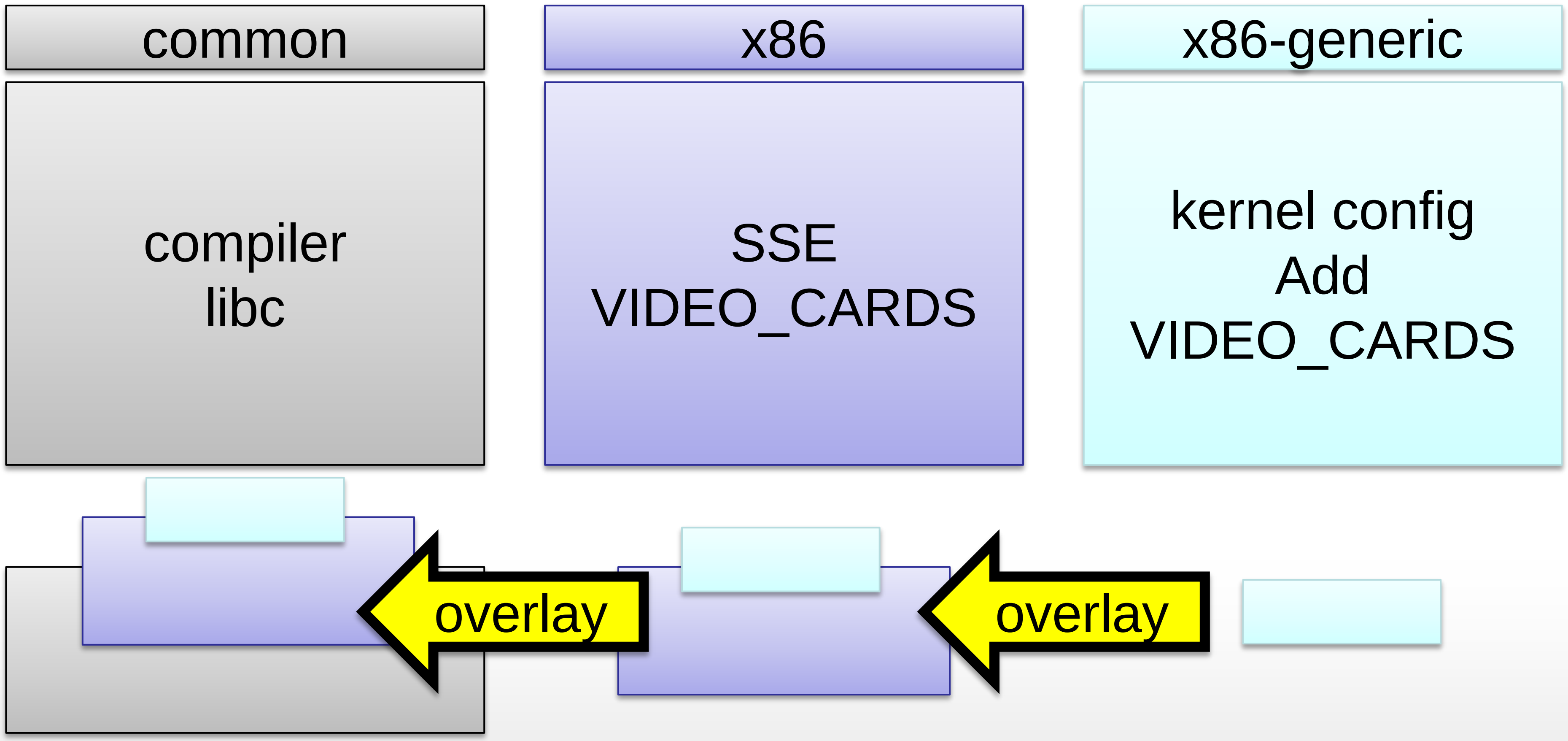
- Separate common config, arch, board



Easily support different models
Avoid redundant description

Example

- x86-generic overlay



overlay-x86-generic/make.conf

VIDEO_CARDS = VIDEO_CARDS + intel, nouveau, radeon

```
CHROMEOS_KERNEL_SPLITCONFIG="chromiumos-i386"

# PORTAGE_BINHOST is pulled in from prebuilt.conf
source prebuilt.conf

VIDEO_CARDS="${VIDEO_CARDS} intel nouveau radeon“

MARCH_TUNE="-march=core2 -mfpmath=sse"
CFLAGS="-O2 -pipe ${MARCH_TUNE} -ggdb"
CXXFLAGS="${CFLAGS}"
LDFLAGS=""
```

src/third_party/chromiumos-overlay/chromeos/config/make.conf.x86-target

```
# Copyright (c) 2009 The Chromium OS Authors. All rights reserved.
# Use of this source code is governed by a BSD-style license that can be
# found in the LICENSE file.

(...omission...)

# Recommended x86-specific USE flags.
USE="${USE} mmx sse sse2 dri hardened"

# Recommended MARCH_TUNE, CFLAGS, etc.
MARCH_TUNE="-march=atom -mtune=atom -mfpmath=sse"
CFLAGS="-O2 -pipe ${MARCH_TUNE} -ggdb"
CXXFLAGS="${CFLAGS}"
LDFLAGS=""

VIDEO_CARDS="intel vmware vesa"
INPUT_DEVICES="evdev synaptics"

# Allow a board to override or define additional settings.
source make.conf.board
```

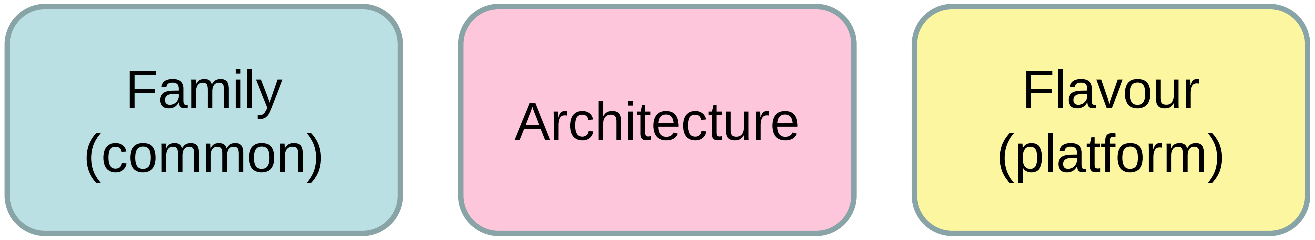
Config for x86 architecture

Linux Kernel in Chromium OS

Version: 2.6.38.3 (Chromium OS version 0.15.877)

Kernel src: src/third_party/kernel/files/

config: files/chromeos/config/ (Hierarchical)



script: files/chromeos/scripts/

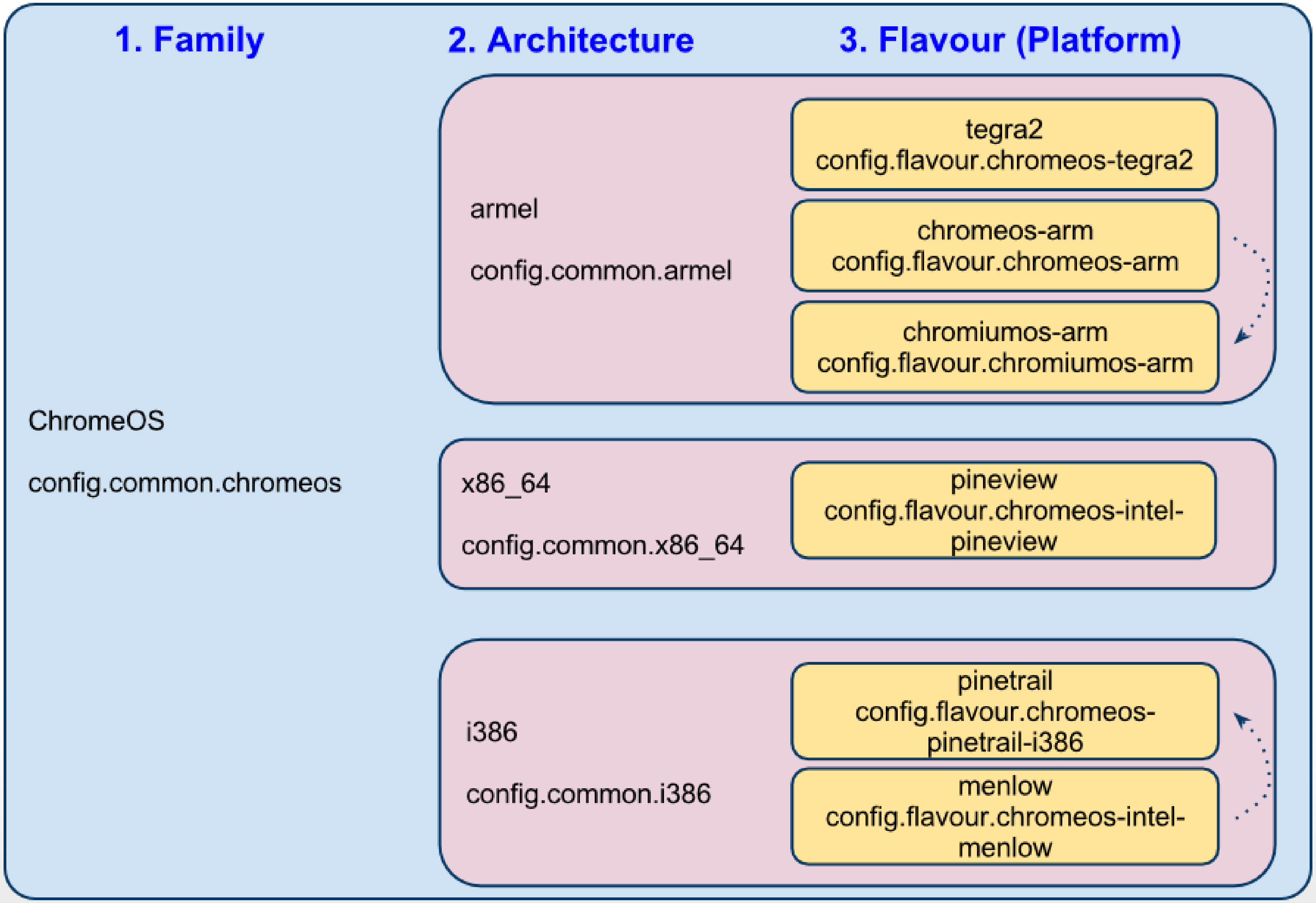
kernelconfig

prepareconfig

splitconfig

Cf. http://www.chromium.org/chromium-os/how-tos-and-troubleshooting/kernel-configuration

Kernel config hierarchy



http://www.chromium.org/chromium-os/how-tos-and-troubleshooting/kernel-configuration

Edit kernel config

1. Look for the kernel config option you want to edit
   If you want to add new option, edit Flavour.
2. Edit that file to change the config
3. Run script to recreate configs based on your changes

```
$ kernelconfig oldconfig
```

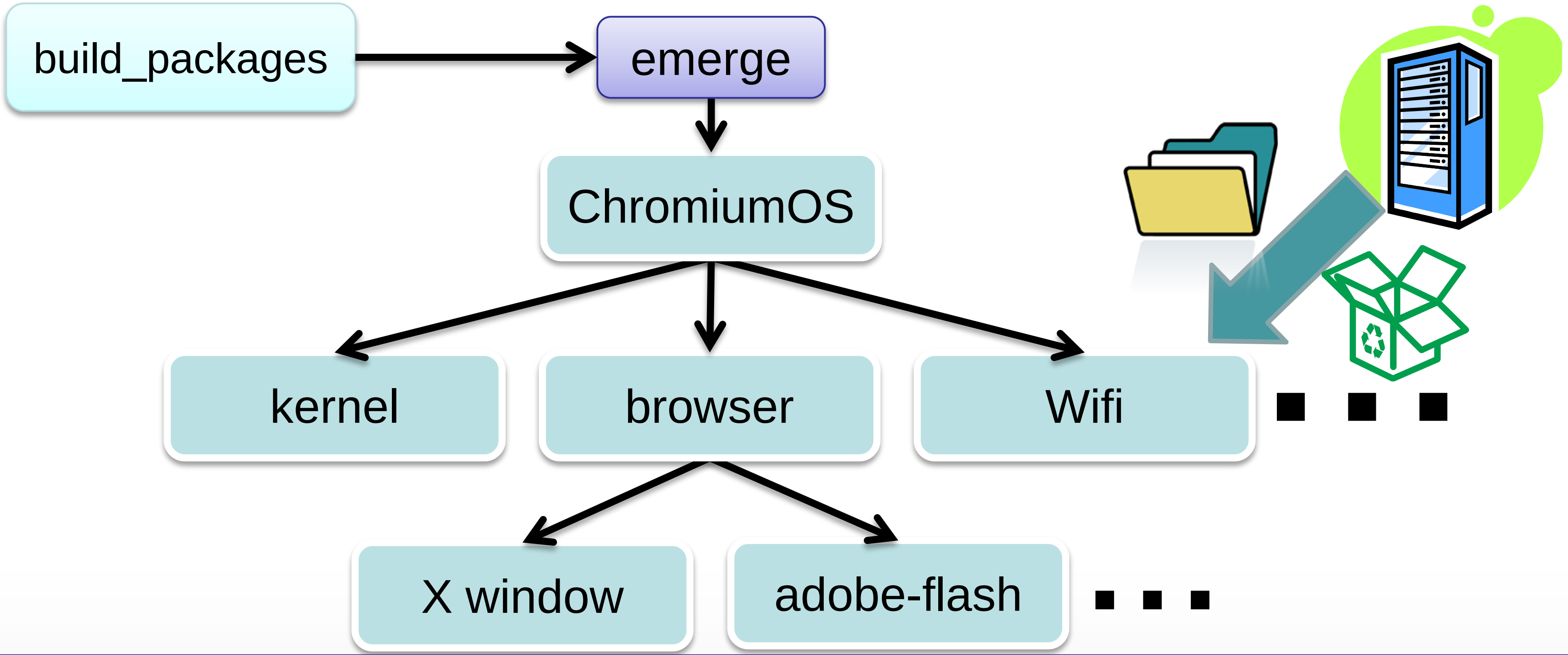
Family
(common)

Architecture

Flavour
(platform)

3. build_packages

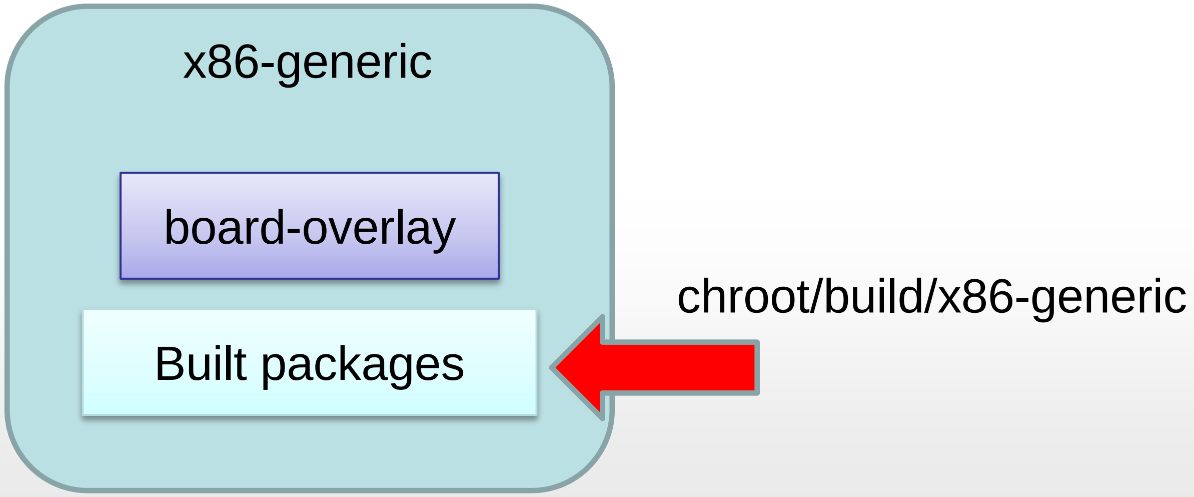
- Portage of Gentoo Linux is adopted
- Pre-built packages are distributed



Can skip the download / compile source code
Can be compiled code only the parts that need to change

3. build_packages

- It will take a long time in the first time you run
  - It must build every package, and also download about 1.7GB of source packages and 1.3GB of binary packages.
  - (around 90 minutes on a four core machine)
- By default, packages other than Chrome will be compiled in debug mode.
- For remove debugging constructs, supply --nowithdebug
- Built packages put into chroot/build/<board>



4. build_image

Build a disk image for your board

Supply argument to specify the type of image to build

Lower order of priority of options

kind	feature	argument
Developer image	Include developer packages	(default)
Pristine Image	Without developer packages	--nowithdev
Test image	Start sshd on boot Can run_remote_tests.sh through the ethernet.	--test
Factory image	Run factory test automatically Include packages that Test image include.	--factory
Factory install image	Install factory image to device	--factory_install

the time of version 0.15.877

--noenable_rootfs_verification

turns off verified boot allowing you to freely modify the root file system

TOSHIBA Leading Innovation >>>

4. build_image

Build a disk image for your board

Supply argument to specify the type of image to build

kind	feature	argument
Developer image	Include developer packages	dev
Pristine Image	Without developer packages	base
Test image	Start sshd on boot Can run_remote_tests.sh through the ethernet.	test
Factory image	Run factory test automatically Include packages that Test image include.	factory_test
Factory install image	Install factory image to device	factory_install

2012/03

--noenable_rootfs_verification

turns off verified boot allowing you to freely modify the root file system

5. image_to_usb.sh

Put your image on a USB disk

```
(cr) ./image_to_usb.sh --to=/dev/sdc
```

Boot from your USB disk

after that, you can install to HDD by /usr/sbin/chromeos-install from console

(Another way) Build an image to run in a virtual machine

```
(cr) ./image_to_vm.sh
```

Install to HDD

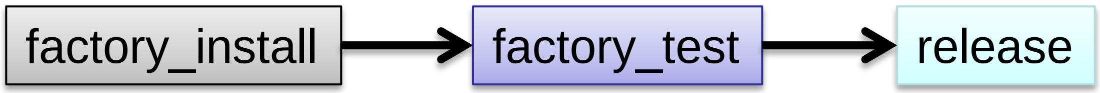
This operation wipes HDD clean

If your image includes developer packages,
you can open console by 'Ctrl+Alt+F2',
and install image to HDD by run */usr/sbin/chromeos-install.*

build_image --nowithdev

not include the developer packages
→ can not open console
→ can not install image to HDD
by /usr/sbin/chromeos-install from console
→use factory_install image

Factory_install image



Prepare 3 images

1. factory_install image
2. factory_test image
3. release image（finally installed image)

A) Make a image that integrates the three images

```
(cr) ./make_factory_packages.sh ¥
        --usbimg output_image
        --install_shim factory_install_image
        --factory factory_test_image
        --release release_image
```

Not support legacy BIOS (0.15.877)

B) Prepare the server that provide a image to be installed

```
(cr) ./make_factory_packages.sh ¥
        --factory factory_test_image
        --release release_image
```

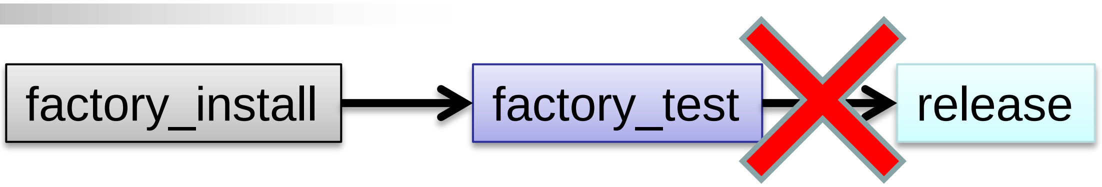
Start server: python2.6 devserver.py --factory_config miniomaha.conf

Boot target with factory_install image

Factory_install image

Prepare 3 images

1. factory_install image
2. factory_test image
3. release image（finally installed image）



If test fails,
release image is not installed

A）Make a image that integrates the three images

```
(cr) ./make_factory_packages.sh ¥
        --usbimg output_image
        --install_shim factory_install_image
        --factory factory_test_image
        --release release_image
```

Not support legacy BIOS (0.15.877)

B）Prepare the server that provide a image to be installed

```
(cr) ./make_factory_packages.sh ¥
        --factory factory_test_image
        --release release_image
```

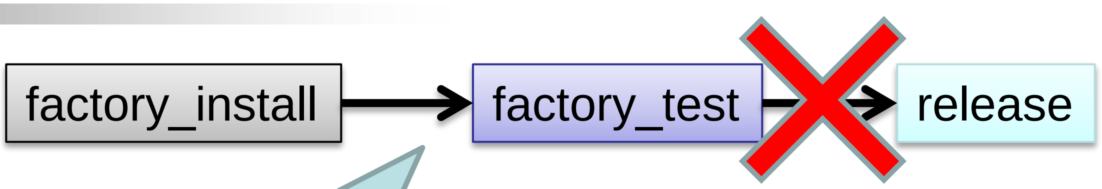
Start server: python2.6 devserver.py --factory_config miniomaha.conf

Boot target with factory_install image

Factory_install image

Prepare 3 images

1. factory_install image
2. factory_test image
3. release image (finally installed im



If test failed,
Don't install release image

A) Make a image that in e three images

(cr) ./make_f

-

-

-

-

B) Prepare the

(cr) ./make

-

-

Start server:

You can write any image to HDD instead of factory test image.

Boot target with factory_install image

Partitions of boot image

partition	type	purpose	size
1	ext3	Stateful partition	1GB
2		kernel A (bootloader & kernel for Chrome OS BIOS)	16MB
3	ext2	rootfs A (include kernel for EFI BIOS)	858MB
4		kernel B (use for upgrade)	16MB
5		rootfs B (use for upgrade)	512B
6		kernel C (placeholder for future use only)	512B
7		rootfs C (placeholder for future use only)	512B
8		OEM Customization	16MB
9		Future use	512B
10		Future use	512B
11		Read/Write firmware	8MB
12	vfat	EFI System Partition (temporary)	16MB

Empty when you create the image

Cf. src/scripts/chromeos-common.sh

Partitions of boot image

partition	type	purpose	size
1	ext3	Stateful partition	1GB
2		kernel A (bootloader & kern	16MB
3	ext2	rootfs A (include kernel for EFI BIOS)	858MB
4		kernel B (use for upgrade)	16MB
5		rootfs B (use for upgrade)	512B
6		kernel C (placeholder for future use only)	512B
7		rootfs C (placeholder for future use only)	512B
8		OEM Customization	16MB
9		Future use	512B
10		Future use	512B
11		Read/Write firmware	8MB
12	vfat	EFI System Partition (temporary)	16MB

Use for factory_test image

Use for release image

Empty when you create the image

Cf. src/scripts/chromeos-common.sh

Boot with NFSROOT

- Boot from USB disk + use NFSROOT as rootfs
  - use chroot/build/<board> as NFSROOT
- Necessary operation:
  - Exclude the impact of building factory_test packages (later)
  - add CONFIG_*IP_PNP=y, CONFIG_IP_PNP_DHCP=y, CONFIG_R8169=y* to src/third_party/chromiumos-overlay/sys-kernel/chromeos-kernel/files/nfs.config
  - edit script so that you can specify kernel cmdline root=/dev/nfs (later)
  - (cr) USE="nfs" ./build_image --boot_args="noinitrd pci=noacpi rw nfsroot=xxx.xxx.xxx.xxx:/path_to_chroot/chroot/build/<board> ip=dhcp" --noenable_rootfs_verification
  - disable iptables (later)

content of --boot_args	description
pci=noacpi	Need to be recognized NIC Root cause is unknown
rw	mount rootfs with readable/writeable
xxx.xxx.xxx.xxx	IP address of NFS server
ip=dhcp	get IP address by DHCP

edit src/scripts/build_library/create_legacy_bootloader_templates.sh

```
--- a/create_legacy_bootloader_templates.sh
+++ b/create_legacy_bootloader_templates.sh
@@ -111,6 +111,13 @@ EOF
   fi
   info "Emitted ${SYSLINUX_DIR}/default.cfg"

+  if [[ ${common_args} == *nfsroot=* ]]; then
+    FLAGS_usb_disk="/dev/nfs"
+    usb_root="/dev/nfs"
+  else
+    usb_root="/dev/sdb3"
+  fi
+
   cat <<EOF | sudo dd of="${SYSLINUX_DIR}/usb.A.cfg" 2>/dev/null
 label chromeos-usb.A
   menu label chromeos-usb.A
@@ -191,7 +198,7 @@ menuentry "verified image B" {

 # FIXME: usb doesn't support verified boot for now
 menuentry "Alternate USB Boot" {
-  linux (hd0,3)/boot/vmlinuz ${common_args} root=/dev/sdb3 i915.modeset=1 cros_efi
+  linux (hd0,3)/boot/vmlinuz ${common_args} root=${usb_root} i915.modeset=1 cros_efi
 }
 EOF
   if [[ ${FLAGS_enable_rootfs_verification} -eq ${FLAGS_TRUE} ]]; then
```

specify kernel cmdline
root=/dev/nfs

Exclude the impact of building factory_test packages

--withfactory options in build_packages is enabled by default. (add --nowithfactory to disable)

Changed boot sequence in build_packages --withfactory

→Get in the way of NFSROOT

Once build_packages --withfactory, need to do below for exclude the impact of building factory_test packages.

```
(cr) emrge-x86-generic --depclean chromeos-base/chromeos-factoryinstall # uninstall chromeos-base/chromeos-factoryinstall
(cr) emrge-x86-generic --depclean chromeos-base/factorytest_init       # uninstall chromeos-base/factorytest_init
(cr) sudo rm -f /build/x86-generic/root/.leave_firmware_alone          # remove files that chromeos-base/chromeos-factoryinstall creates
(cr) emerge-x86-generic -av chromeos-base/chromeos-init                # reinstall chromeos-base/chromeos-init tofix init script
(cr) emerge-x86-generic -av app-laptop/laptop-mode-tools               # reinstall app-laptop/laptop-mode-tools to restore 99-laptop-mode.rules
```

disable iptables

edit two files

chroot/build/x86-generic/etc/init/iptables.conf

chroot/build/x86-generic/etc/init/ip6tables.conf

```
--- iptables.conf.org
+++ iptables.conf
@@ -6,7 +6,7 @@
 author          "chromium-os-dev@chromium.org"

 # We must run eventually even if the UI doesn't come up correctly.
-start on starting failsafe
+start on never #start on starting failsafe

 script
  iptables -P INPUT DROP
```

Other than NFSROOT

If the test image, such as sshd is up and running…

- image_to_live.sh update image and reboot via ethernet
- update_kernel.sh update kernel and reboot via ethernet
- gmerge (run on target) request packages to devserver via ethernet
  - (cr) ./start_devserver on host to use devserver

http://www.chromium.org/chromium-os/testing/running-tests
http://www.chromium.org/chromium-os/how-tos-and-troubleshooting/kernel-faq
http://www.chromium.org/chromium-os/how-tos-and-troubleshooting/using-the-dev-server

Two ways to start sshd on Developer image

- change before build

  add below to create_base_image() in build_image

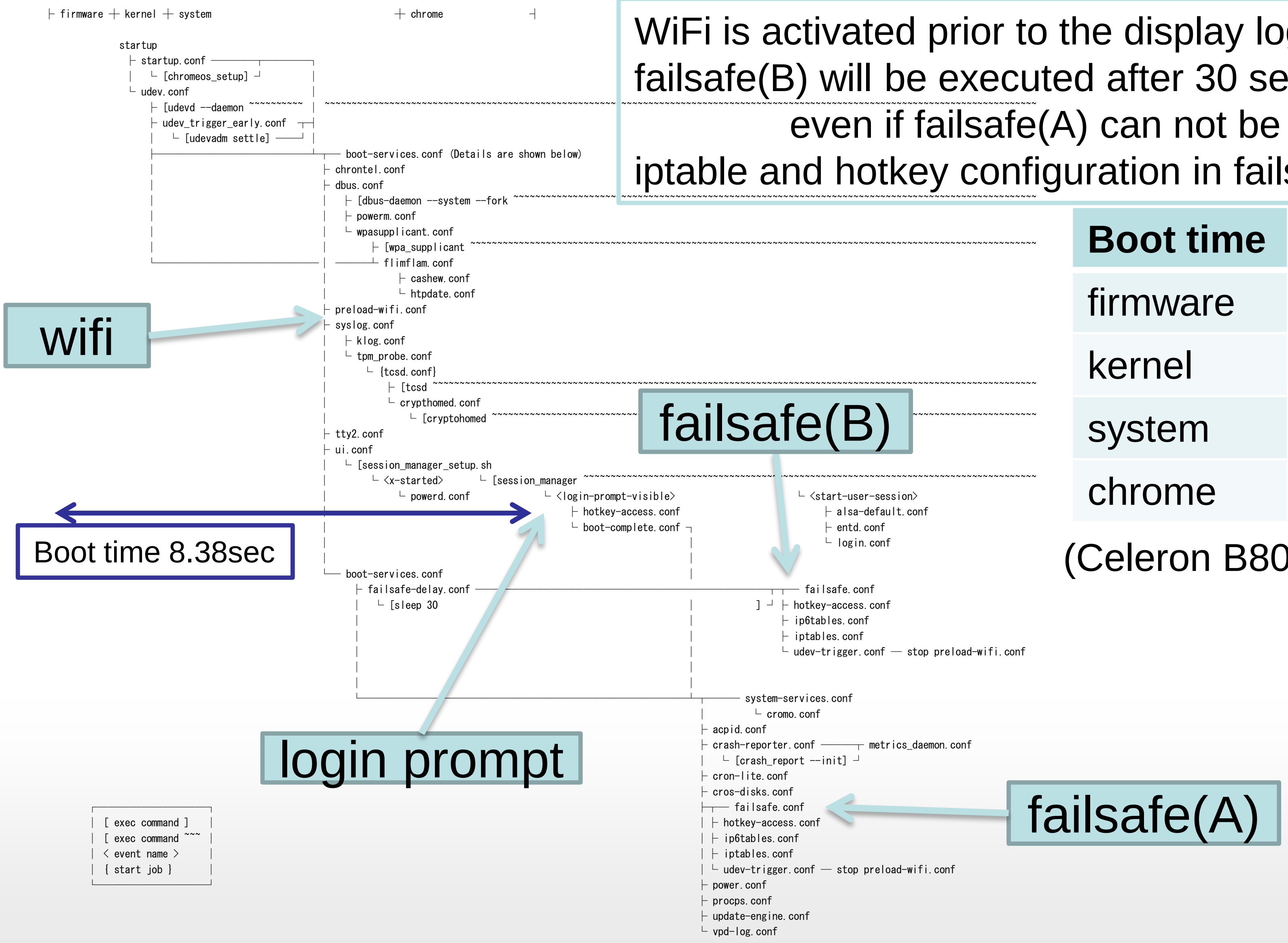
  ```
  sudo sed -i 's/#for_test //' "${ROOT_FS_DIR}/etc/init/openssh-server.conf"
  ```

- change after boot

  add below to /etc/init/openssh-server.conf

  ```
  start on stopped iptables and ip6tables
  ```

Boot sequence



```
├ firmware ┼ kernel ┼ system                    ┼ chrome          ┤

          startup
           ├ startup.conf ───────────┐
           │   └ [chromeos_setup] ┘   │
           └ udev.conf                │
               ├ [udevd --daemon ~~~~~~~~~~   ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
               ├ udev_trigger_early.conf ─┤
               │    └ [udevadm settle] ──┘
               ├─────────────────────────┴── boot-services.conf (Details are shown below)
               │                         ├ chrontel.conf
               │                         ├ dbus.conf
               │                         │  ├ [dbus-daemon --system --fork ~~~~~~~~~~~~~~~~~~
               │                         │  ├ powerm.conf
               │                         │  └ wpasupplicant.conf
               │                         │        ├ [wpa_supplicant ~~~~~~~~~~~~~~~~~~~~~~~~~~
               └─────────────────────────│ ─────┴ flimflam.conf
                                         │            ├ cashew.conf
                                         │            └ htpdate.conf
                                         ├ preload-wifi.conf
                                         ├ syslog.conf
                                         │  ├ klog.conf
                                         │  └ tpm_probe.conf
                                         │     └ {tcsd.conf}
                                         │        ├ [tcsd ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
                                         │        └ crypthomed.conf
                                         │           └ [cryptohomed ~~~~~~~~~~~~~~~~~~~~~~~~~~
                                         ├ tty2.conf
                                         ├ ui.conf
                                         │  └ [session_manager_setup.sh
                                         │     └ <x-started>      └ [session_manager ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
                                         │        └ powerd.conf      └ <login-prompt-visible>          └ <start-user-session>
                                         │                              ├ hotkey-access.conf             ├ alsa-default.conf
                                         │                              └ boot-complete.conf ┐           ├ entd.conf
                                         │                                                   │           └ login.conf
                                         │                                                   │
                                         └── boot-services.conf                              │
                                               ├ failsafe-delay.conf ────────────────────────┼──────────┬┬── failsafe.conf
                                               │   └ [sleep 30                               │        ] ┘├ hotkey-access.conf
                                               │                                             │           ├ ip6tables.conf
                                               │                                             │           ├ iptables.conf
                                               │                                             │           └ udev-trigger.conf ─ stop preload-wifi.conf
                                               │                                             │
                                               └─────────────────────────────────────────────┴─┬──── system-services.conf
                                                                                               │        └ cromo.conf
                                                                                               ├ acpid.conf
                                                                                               ├ crash-reporter.conf ────┬ metrics_daemon.conf
                                                                                               │   └ [crash_report --init] ┘
                                                                                               ├ cron-lite.conf
                                                                                               ├ cros-disks.conf
                                                                                               ├┬── failsafe.conf
                                                                                               │├ hotkey-access.conf
                                                                                               │├ ip6tables.conf
                                                                                               │├ iptables.conf
                                                                                               │└ udev-trigger.conf ─ stop preload-wifi.conf
                                                                                               ├ power.conf
                                                                                               ├ procps.conf
                                                                                               ├ update-engine.conf
                                                                                               └ vpd-log.conf

  [ exec command ]
  [ exec command ~~~
  < event name >
  { start job }
```

WiFi is activated prior to the display login prompt.
failsafe(B) will be executed after 30 seconds even if failsafe(A) can not be executed.
iptable and hotkey configuration in failsafe(A/B)

Boot time	8.38 (sec)
firmware	4.98
kernel	1.06
system	1.09
chrome	1.25

(Celeron B800 Note PC)

Conclusion/reference

- Conclusion
  - 5 scripts to build
  - Build system using Portage
  - Can use NFSROOT
  - Mechanism of fast boot
- Reference
  - http://www.chromium.org/chromium-os
- Trademarks

TOSHIBA

Leading Innovation >>>