Creating Eco-System for R-Car LCB

How to develop BSP for SoC and what we did

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AGL advisory board member @ Linux Foundation

March 25th 2015

Why we need eco-system specially for embedded Linux?

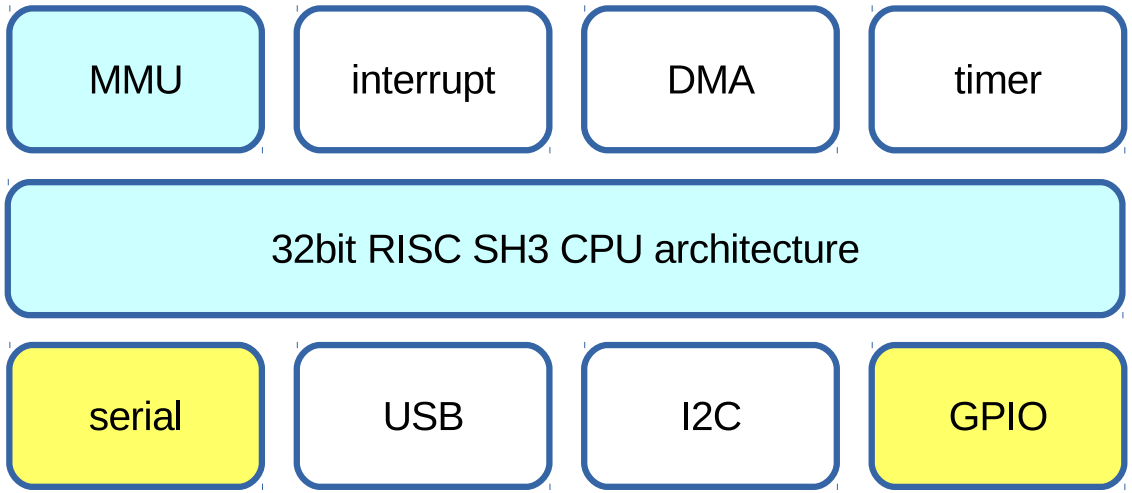
Who am I ?

- From embedded SoC provider company Renesas
- Responsible for OSS software development and delivery for R-Car series SoC
- Working with W/W car OEM and 1st tear IVI customers

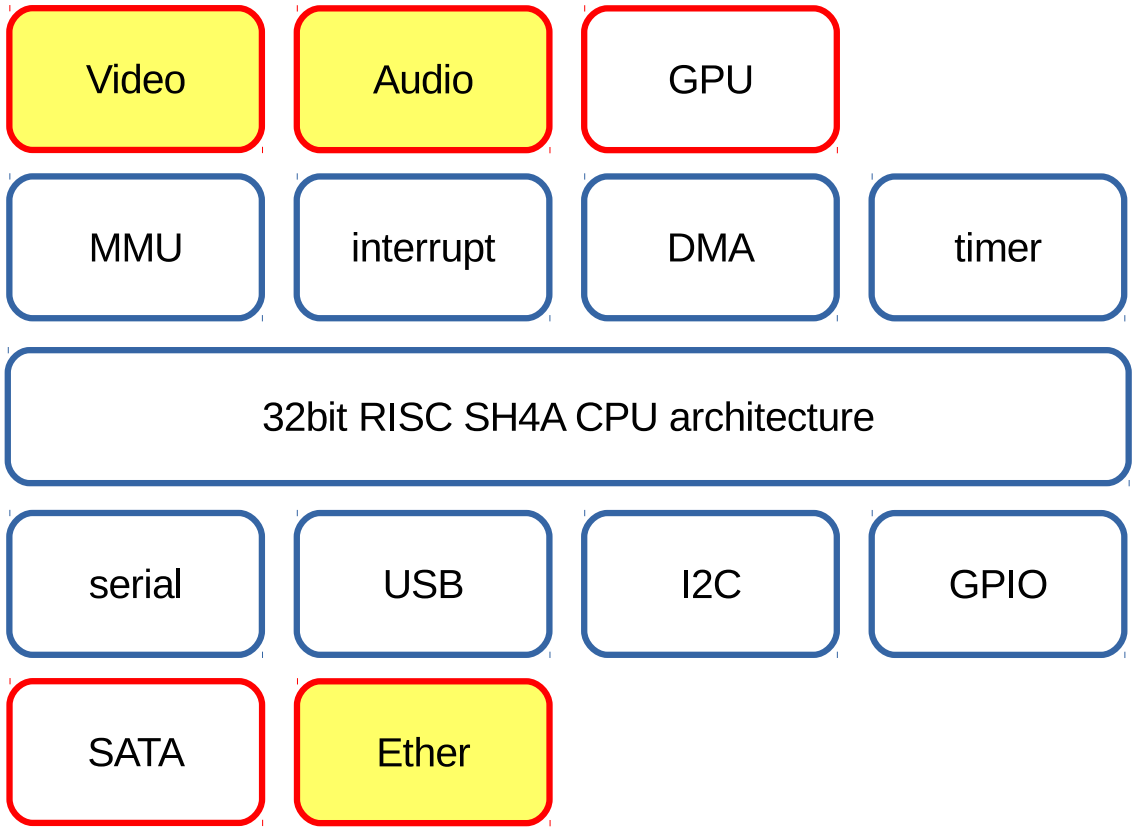
- Linux Foundation CE[1] working Gr. Steering committee member, LF/CEWG Architecture Gr. co-chair
- One of LF/CEWG LTSI[2] project initial proposer
- At my company, I had been encouraging my team developers to send a patches upstream

[1] CE = consumer electronics
[2] LTSI =Long Term Support Initiative

15 years ago, my first Linux kernel port to SH7709

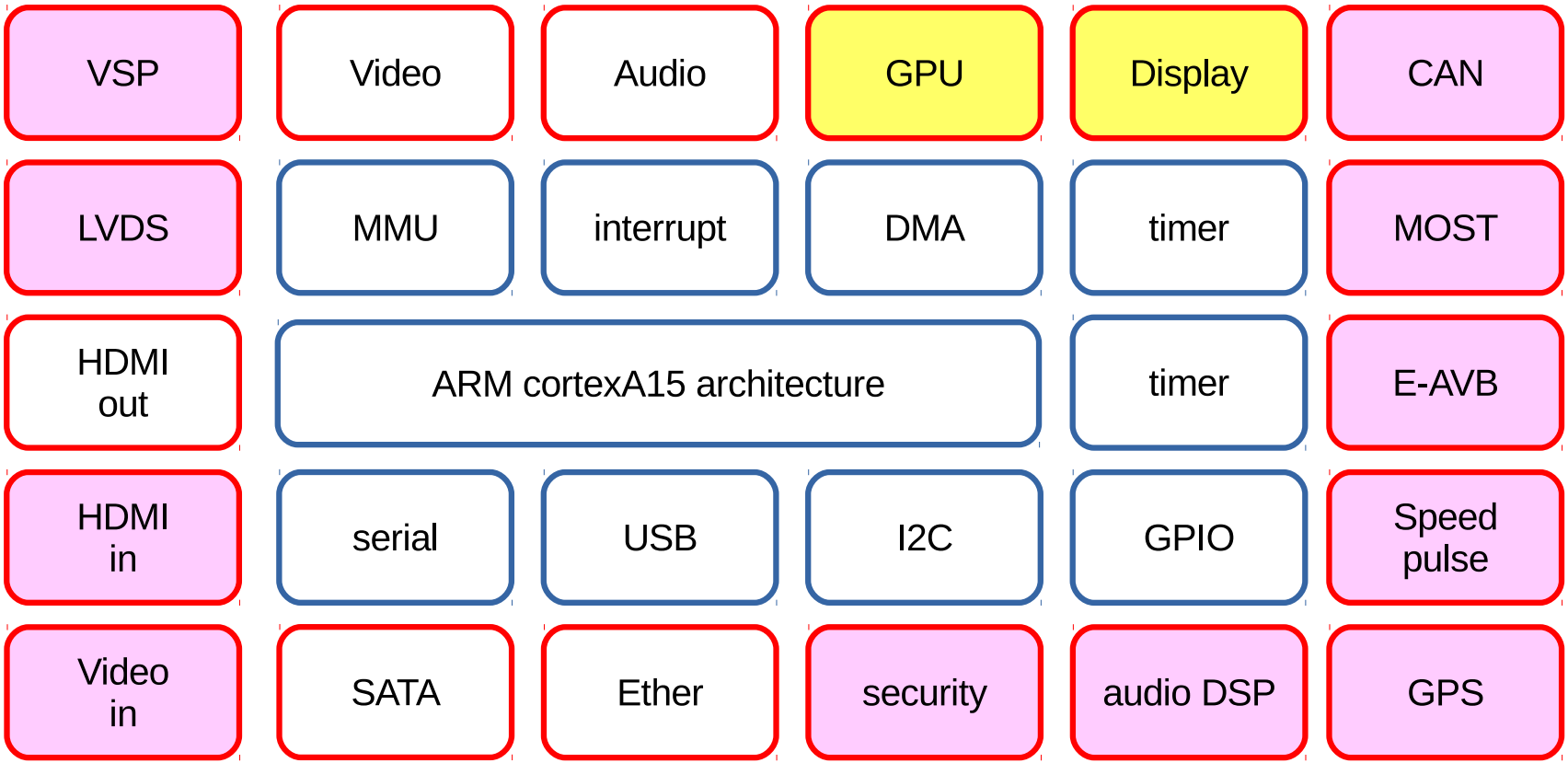


5 years ago, adding more peripherals for early SoC



Audio and video (=OpenMAX/IL) support added to BSP

Now extremely complicated drivers need integration



Unique device (IP) support becomes majority of Linux development work for modern SoC

single Linux installer can boot for all PC variant

Commonalty

Even they looks different

If you have a Linux distribution (like Debian) install DVD, you can boot PC, server and embedded PC with single amd64 binary image as they have commonality

embedded board requires dedicated kernel image

So different !

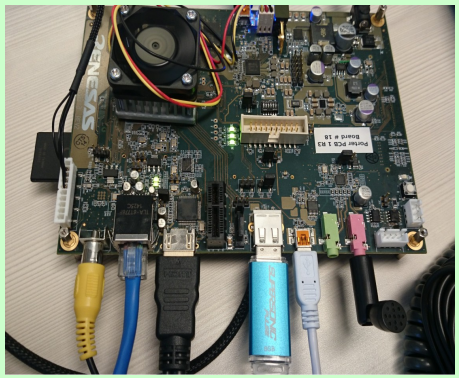
- Reset and PMIC setting
- custom boot sequence
- boot media (eMMC, NOR, SD,..)
- original memory map
- original interrupt assignment
- unique on-chip IP feature (driver)
- complexed pin multiplex
- proprietary block (binary blobs)
- isolated power domain

Every embedded boards behave differently. Your previous experience might not applied to the new SoC, boards. Also, Google can not tell you how to bring your board if that is a minor one. Emdedded Linux bring up is always painful work.

We need to deliver Linux BSP for embedded hardware

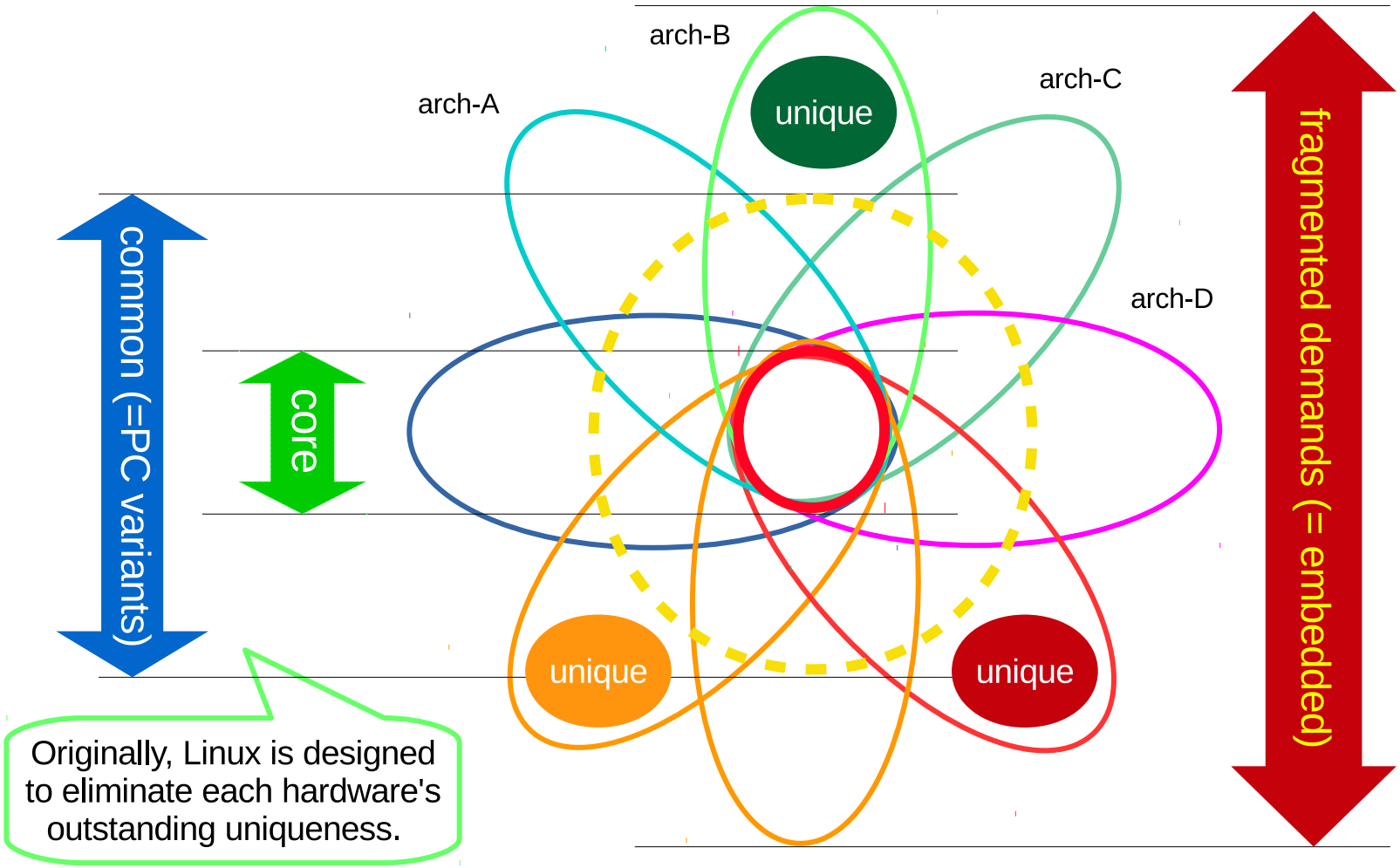
Distribution = verified collection of various Linux programs (=packages)
per-build binary distribution = Debian, Ubuntu, Cent, Fedora
source code distribution = Gentoo, Open Embedded (yocto),...

SDK (Software Development Kit) = subset of distribution designed for specific application = Android, Tizen IVI, MPD, Drone Code



BSP (Board Support Package) = subset of SDK, designed for specific target hardware. Embedded SoC vendor develops BSP for their reference platform. Product producer modify BSP to fit with product hw

Battles between PC variant and embedded



example (window system) : X11 vs. Wayland

design policy comparison (GPU optimization point)

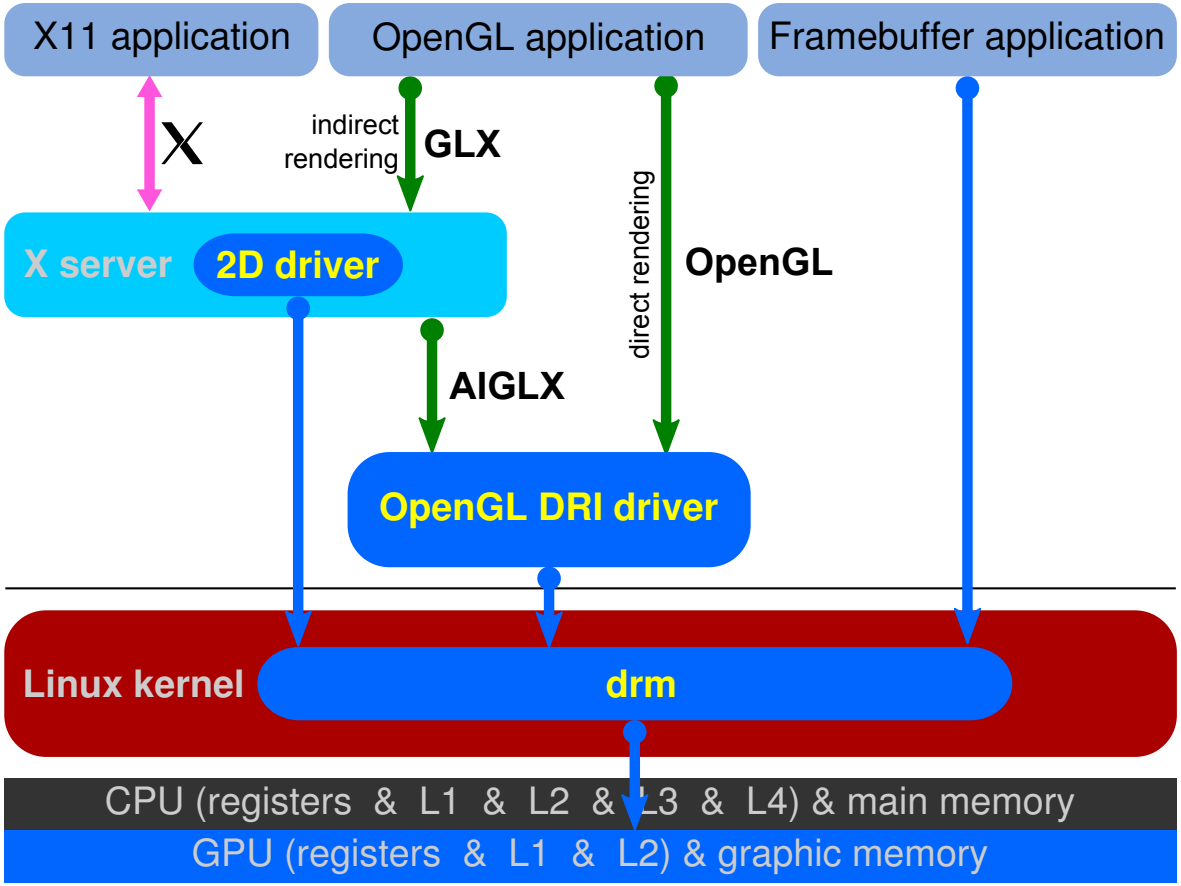
X11 = conservative

- sustainable solid API
- drawing is fully managed by X11 server side
- composition (=window manager) is out of X11 server and it cases bunch of IPC (=overhead)
- display surface allocated by X11 server side

Wayland = aggressive

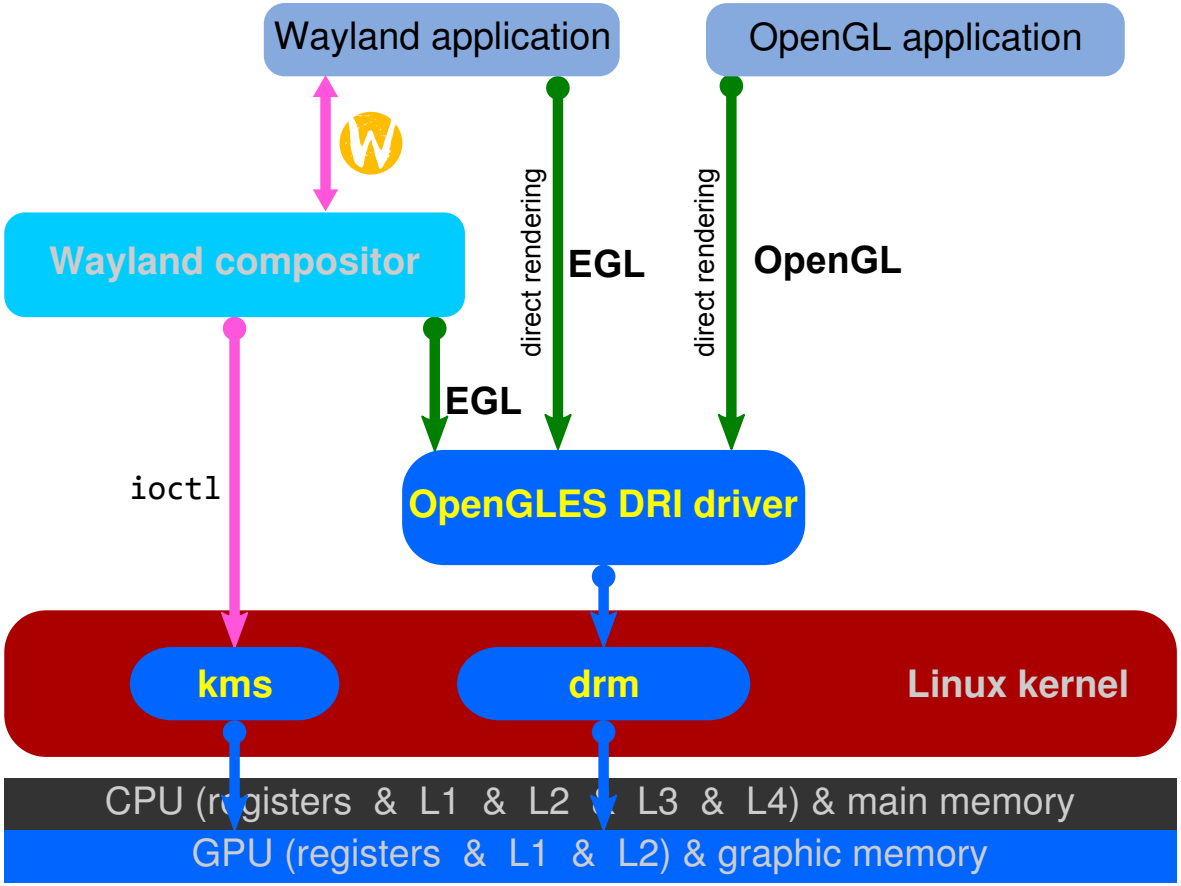
- fully utilize GPU capability
- client(=apps.) can draw directly via DRI
- composition can be integrated to Wayland server and it makes drawing simple
- client reserver surface and send pointer

example (window system) : X11 vs. Wayland



"Linux graphics drivers DRI current" by Shmuel Csaba Otto Traian. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Linux_graphics_drivers_DRI_current.svg#/media/File:Linux_graphics_drivers_DRI_current.svg

example (window system) : X11 vs. Wayland



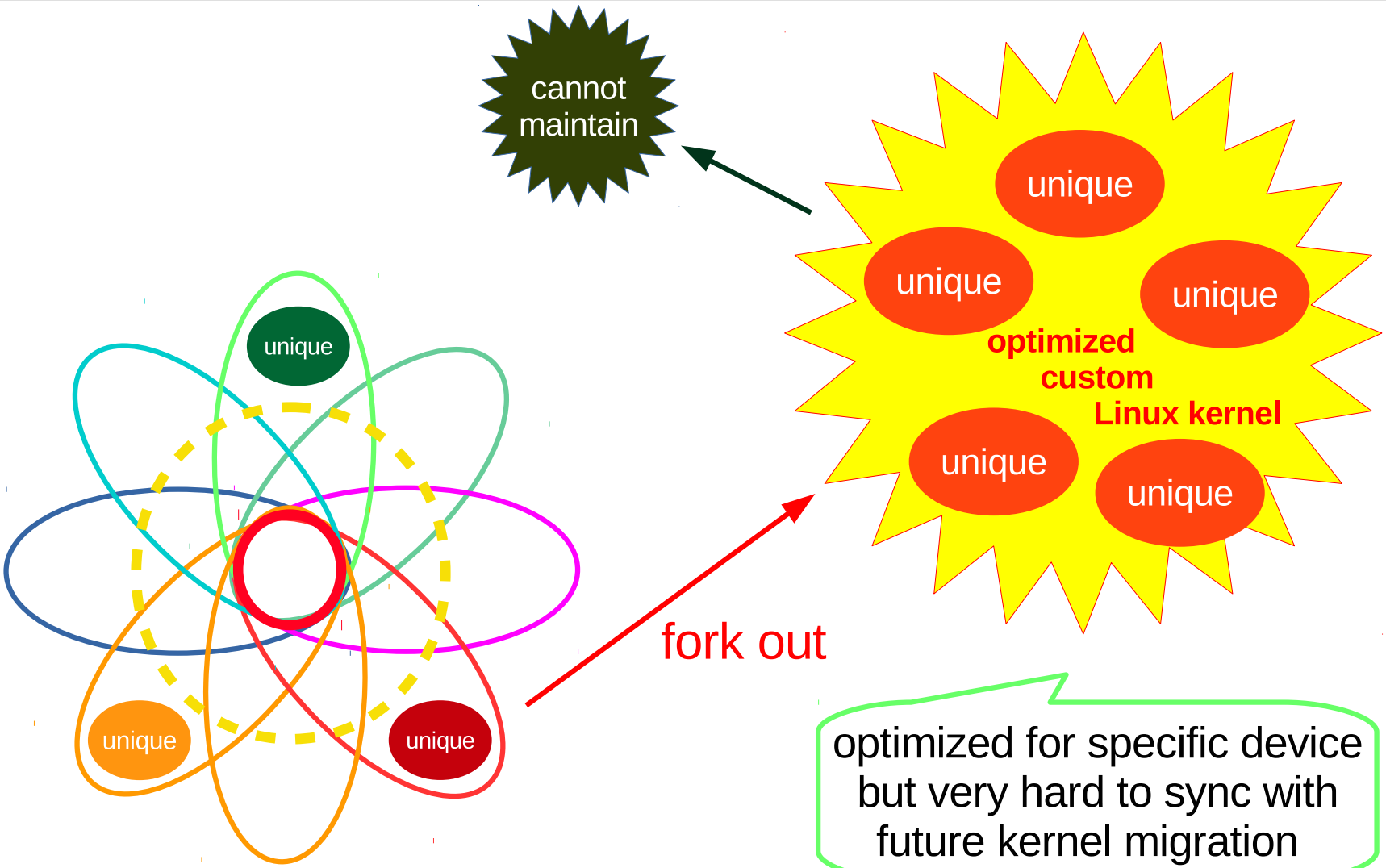
"Linux graphics drivers DRI Wayland" by Shmuel Csaba Otto Traian. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Linux_graphics_drivers_DRI_Wayland.svg#/media/File:Linux_graphics_drivers_DRI_Wayland.svg

DRI drivers contains GPU code

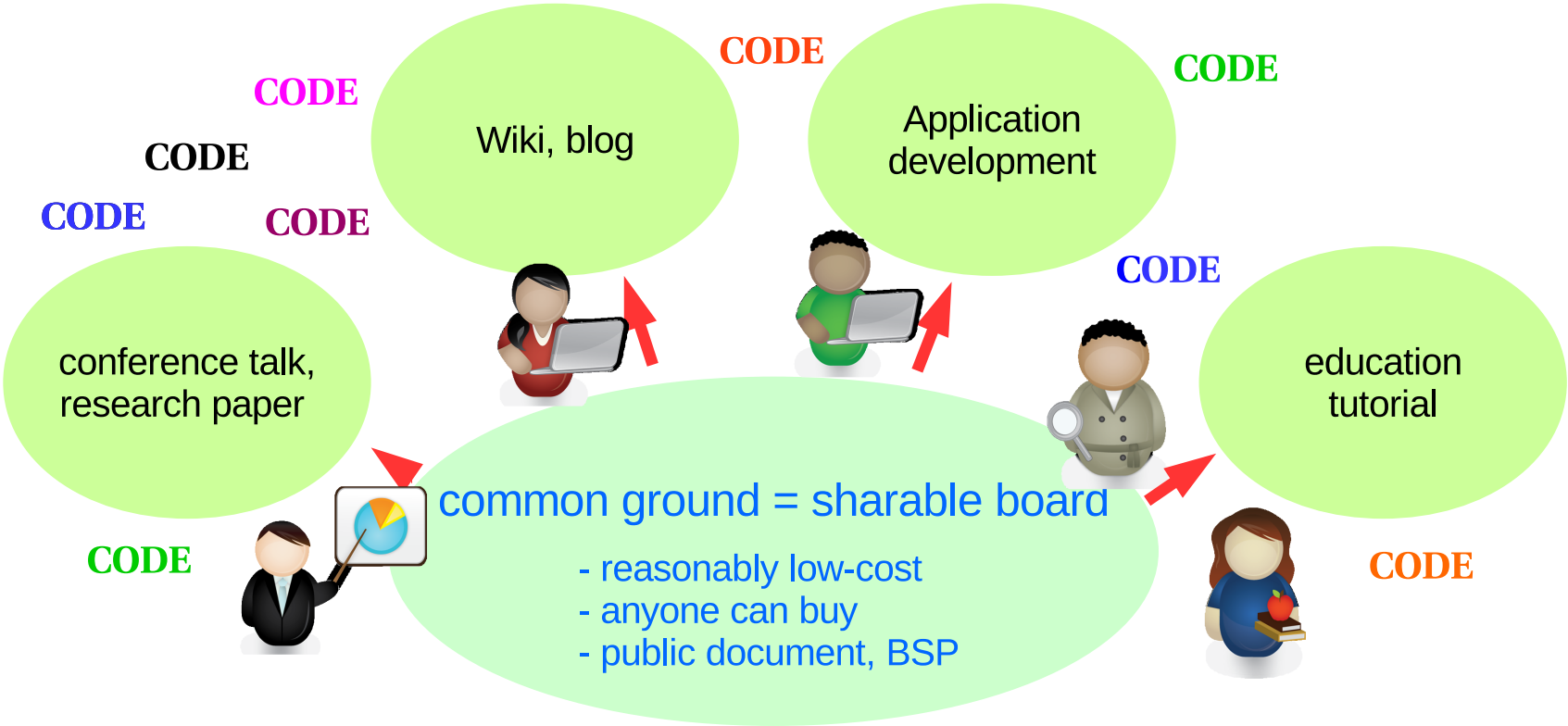
```
munakata@muna-E450: /source/linux$ ls -l /usr/include/libdrm
total 292

drwxr-xr-x  2 munakata munakata  4096 Feb  6 14:31 .
drwxr-xr-x 67 munakata munakata  4096 Feb  6 14:11 ..
-rw-r--r--  1 munakata munakata 25767 Feb  6 13:49 drm.h
-rw-r--r--  1 munakata munakata  7818 Feb  6 13:49 drm_fourcc.h
-rw-r--r--  1 munakata munakata 13152 Feb  6 13:49 drm_mode.h
-rw-r--r--  1 munakata munakata  2629 Feb  6 13:49 drm_sarea.h
-rw-r--r--  1 munakata munakata 29212 Feb  6 13:49 i915_drm.h
-rw-r--r--  1 munakata munakata  7895 Feb  6 13:49 mach64_drm.h
-rw-r--r--  1 munakata munakata 12923 Feb  6 13:49 mga_drm.h
-rw-r--r--  1 munakata munakata  6593 Feb  6 13:49 nouveau.h
-rw-r--r--  1 munakata munakata  5572 Feb  6 13:49 nouveau_drm.h
-rw-r--r--  1 munakata munakata  2555 Feb  6 13:49 omap_drmif.h
-rw-r--r--  1 munakata munakata  4221 Feb  6 13:49 qxl_drm.h
-rw-r--r--  1 munakata munakata  9901 Feb  6 13:49 r128_drm.h
-rw-r--r--  1 munakata munakata 13304 Feb  6 13:49 r600_pci_ids.h
-rw-r--r--  1 munakata munakata  2839 Feb  6 13:49 radeon_bo.h
-rw-r--r--  1 munakata munakata  1991 Feb  6 13:49 radeon_bo_gem.h
-rw-r--r--  1 munakata munakata  1673 Feb  6 13:49 radeon_bo_int.h
-rw-r--r--  1 munakata munakata  5121 Feb  6 13:49 radeon_cs.h
-rw-r--r--  1 munakata munakata  1601 Feb  6 13:49 radeon_cs_gem.h
-rw-r--r--  1 munakata munakata  2173 Feb  6 13:49 radeon_cs_int.h
-rw-r--r--  1 munakata munakata 36015 Feb  6 13:49 radeon_drm.h
-rw-r--r--  1 munakata munakata  5876 Feb  6 13:49 radeon_surface.h
-rw-r--r--  1 munakata munakata  7054 Feb  6 13:49 savage_drm.h
-rw-r--r--  1 munakata munakata  2534 Feb  6 13:49 sis_drm.h
-rw-r--r--  1 munakata munakata  8291 Feb  6 13:49 via_drm.h
```

Easy solution : fork to create original kernel, but...



Linux eco-system = the power of collective wisdom

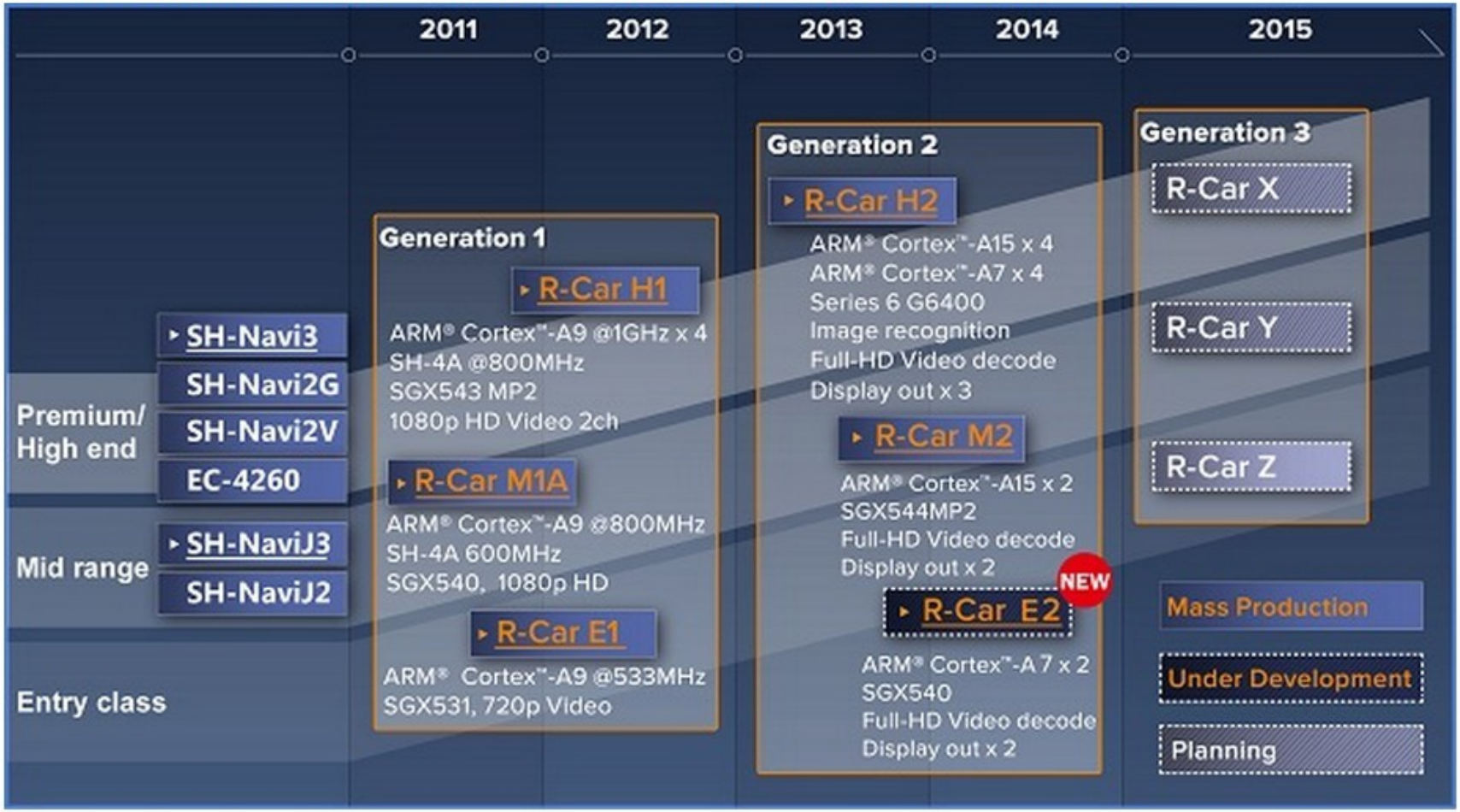


To share embedded Linux experience, eco-system driven by the cheap board is the key

What we are doing for Renesas R-Car Linux development

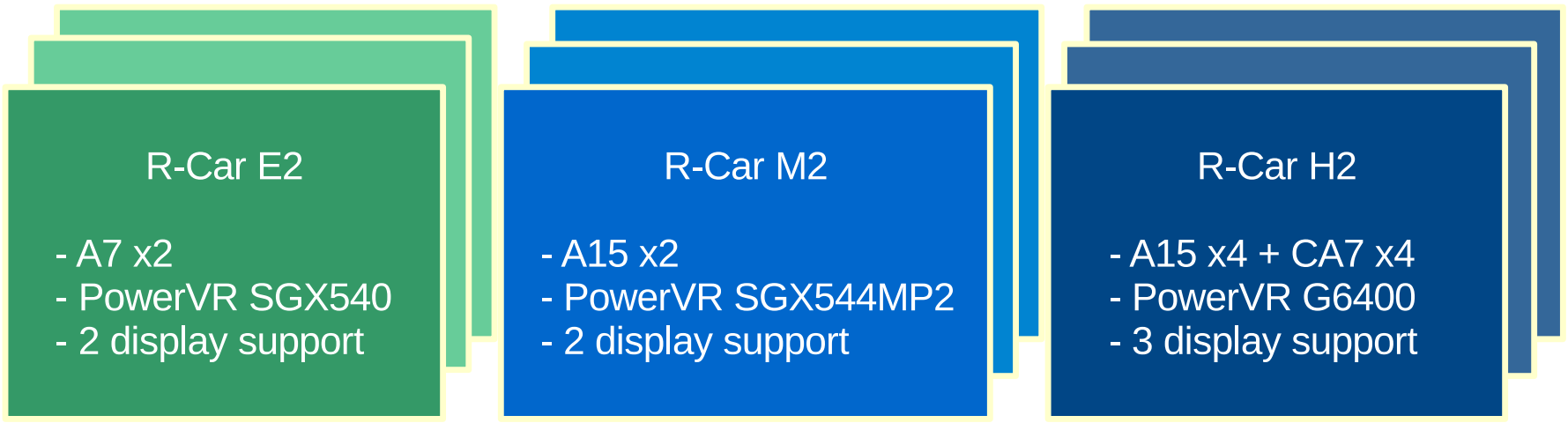
Renesas R-Car series SoC : scalable design concept

* "R-Car" is the nickname for Renesas' lineup of system-on-chips (SoCs) for car information systems.



http://www.renesas.com/applications/automotive/cis/cis_highend/index.jsp

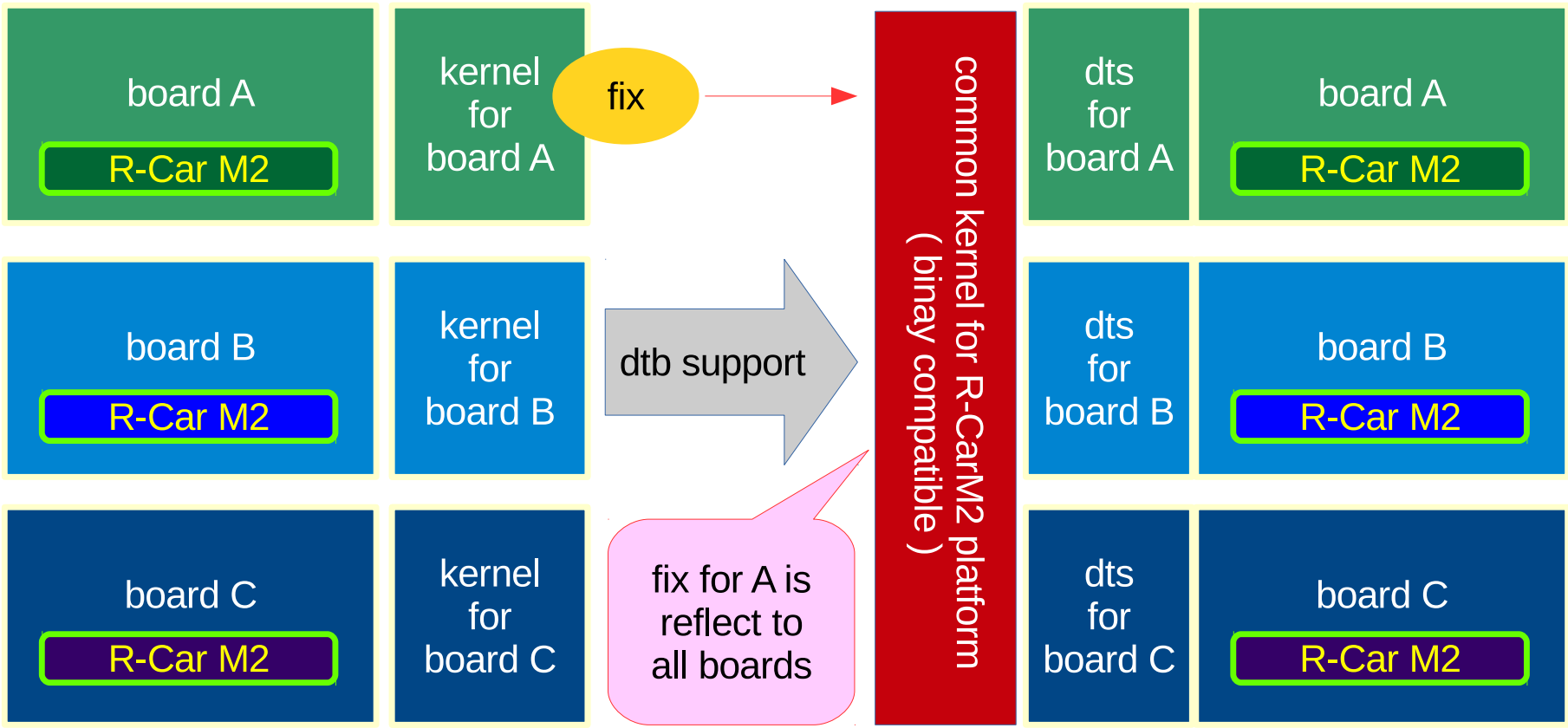
BSP is source level compatible for H2,M2 and E2



R-Car gen2 Linux BSP support E2, M2 and H2 with same code

R-Car gen2 devices are feature and performance scalable design, we develop single Linux BSP can support all variant so that customer can use same code for all.

kernel is binary level compatible across the boards



Renesas R-CarM2 SOC (for mid-range system) 1/3

Product Specifications of the R-Car M2

Item	Specification	
Product number	R8A7791	
Power supply voltage	3.3/1.8 V (IO), 1.5/1.35 V (DDR3), 1.03 V (Core)	
CPU core	ARM®Cortex™-A15 Dual	SH-4A core (device option)
Maximum operating frequency	1.5 GHz	780 MHz
Processing performance	10500 DMIPS	1720 DMIPS
Cache memory	L1 Instruction cache: 32 KB L1 Operand cache: 32 KB L2 Cache: 2 MB	Instruction cache: 32 KB Operand cache: 32 KB
External memory	DDR3-SDRAM Maximum operating frequency: 800 MHz Data bus width: 32 bits × 2 ch (6.4 GB/s × 2)	
Expansion bus	Flash ROM and SRAM, Data bus width: 8 or 16 bits	
	PCI Express2.0 (1 lane)	
Graphics	PowerVR SGX 544MP2 (3D)	
	Renesas graphics processor (2D)	

http://www.renesas.com/press/news/2013/news20130926_s.jsp

Renesas R-CarM2 SOC (for mid-range system) 2/3

Product Specifications of the R-Car M2

Video	Display Out × 2 ch (1 ch: LVDS, 1 ch: RGB888)
	Video Input × 3 ch
	Video codec module (H.264/AVC, MPEG-2/4, VC-1)
	IP conversion module
	JPEG accelerator
	TS Interface × 1 ch
	Video image processing (color conversion, image expansion, reduction, filter processing)
	Distortion compensation module (image renderer) × 1 ch
Audio	Audio DSP
	Sampling rate converter × 10 ch
	Serial sound interface × 10 ch
	MOST DTCP
Storage Interface	USB 3.0 host interface × 1 port (wPHY)
	USB 2.0 host interface × 2 ports (wPHY)
	SD host interface × 3 ch (SDXC, UHS-I)
	Multimedia card interface × 1 ch
	Serial ATA interface × 2 ch
In-car network and automotive peripherals	Media local bus (MLB) Interface × 1 ch (6-pin / 3-pin interface selectable)
	CAN Interface × 2 ch
	IEBus™ Interface
	GPS baseband module (Galileo, GLONASS) (device option)
	Ethernet controller AVB (IEEE802.1BA, 802.1AS, 802.1Qav and IEEE1722, GMII/MII, without PHY)

http://www.renesas.com/press/news/2013/news20130926_s.jsp

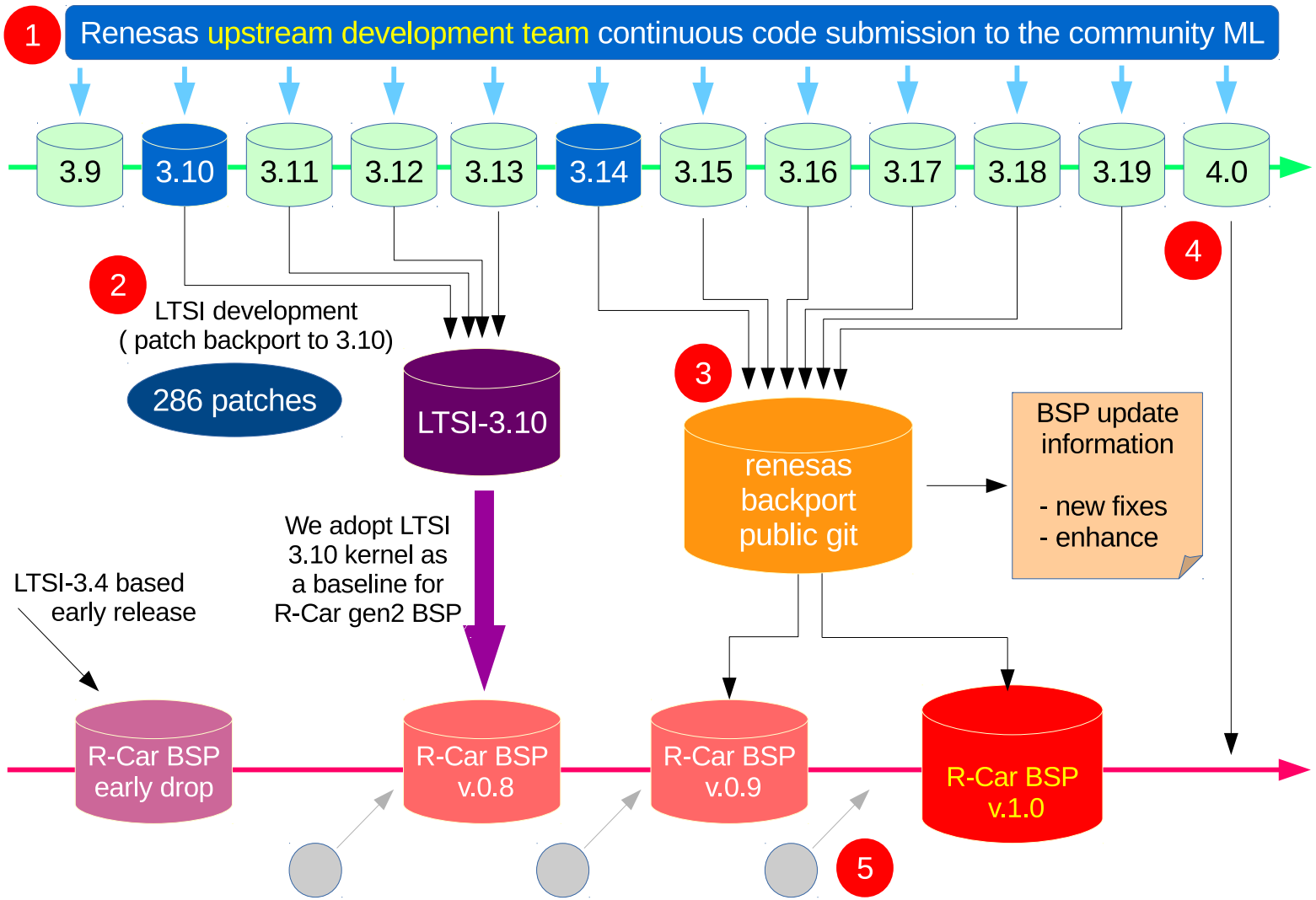
Renesas R-CarM2 SOC (for mid-range system) 3/3

Product Specifications of the R-Car M2

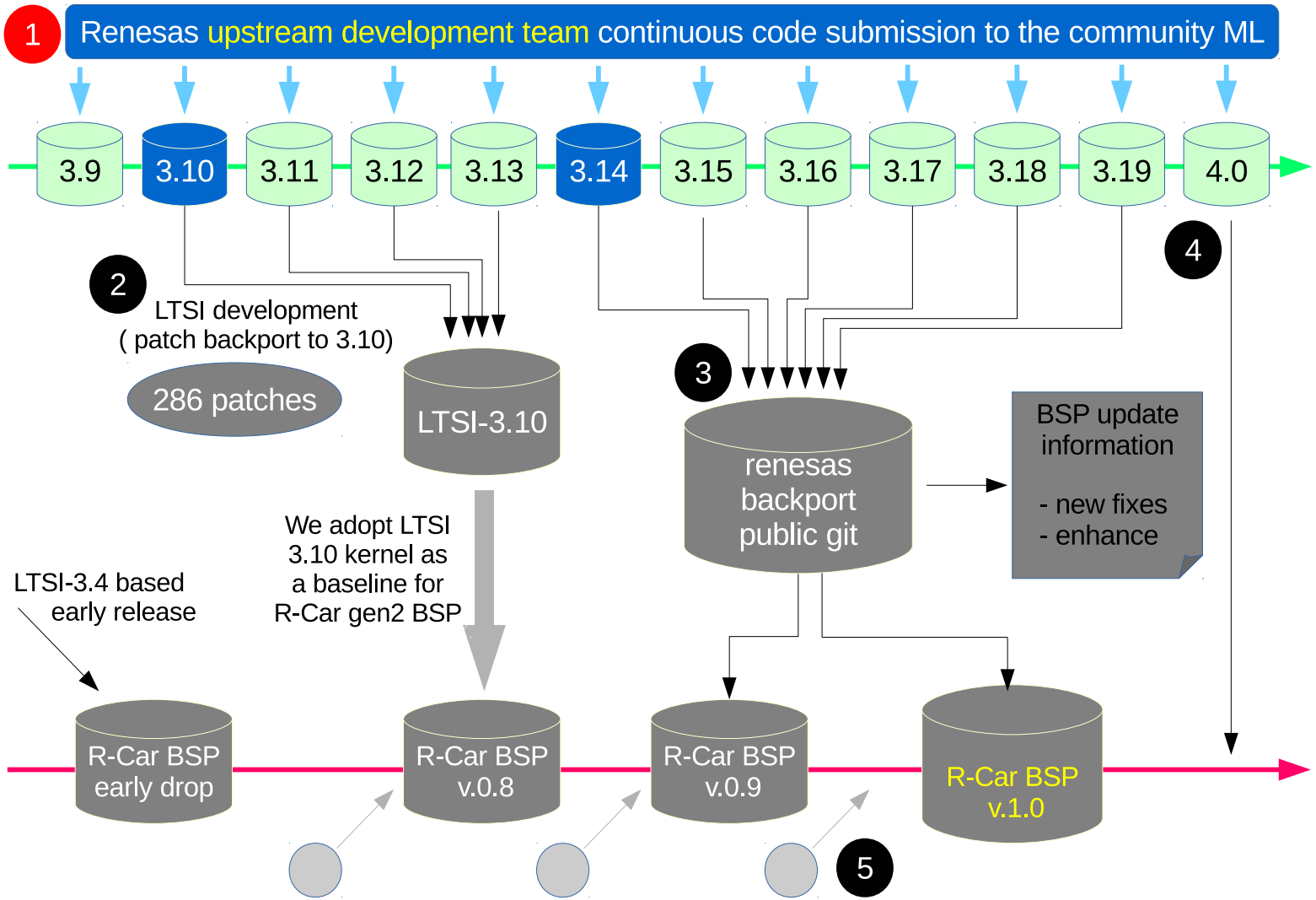
Security	Crypto engine (AES, DES, Hash, RSA)
	Secure RAM
Other peripherals	DMA controller LBSC DMAC: 3 ch / SYS-DMAC : 30 ch / RT-DMAC: 3 ch / Audio-DMAC: 26 ch / Audio (peripheral)-DMAC: 29 ch
	32 bit timer × 12 ch
	PWM timer × 7 ch
	I²C bus interface × 9 ch
	Serial communication interface (SCIF) × 18 ch
	Quad serial peripheral interface (QSPI) × 1 ch (for boot)
	Clock-synchronized serial interface (MSIOF) × 3 ch (SPI/IIS)
	Ethernet AVB controller (IEEE802.1BA/802.1AS/802.1Qav/IEEE1722, GMII/MII, without PHY)
	Ethernet controller (IEEE802.3u, RMII, without PHY)
	Interrupt controller (INTC)
	Clock generator (CPG) with built-in PLL
	On-chip debugger interface
Low power mode	Dynamic Power Shutdown (CPU core, 3D, IMP) AVS and DVFS function DDR-SDRAM power supply backup mode
Package	831-pin Flip Chip BGA (27 mm × 27 mm)

http://www.renesas.com/press/news/2013/news20130926_s.jsp

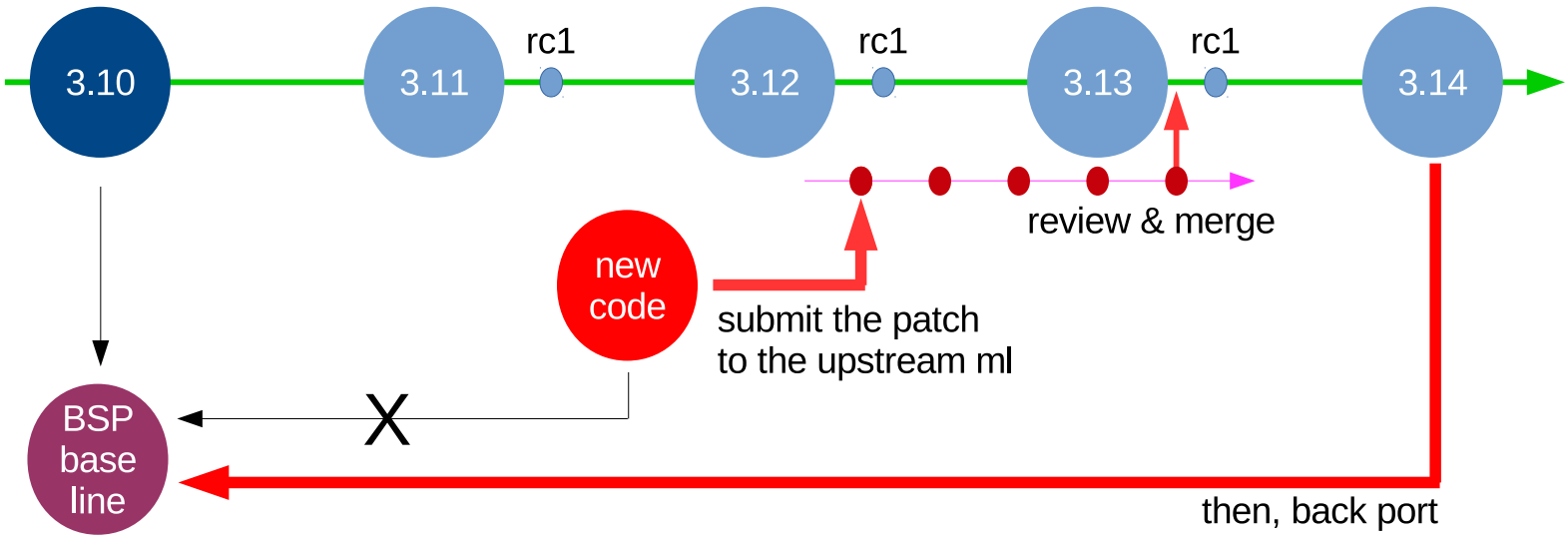
R-Car gen2 Linux BSP whole development process



(1) Upstream lf_pub_whowriteslinux2015.pdf

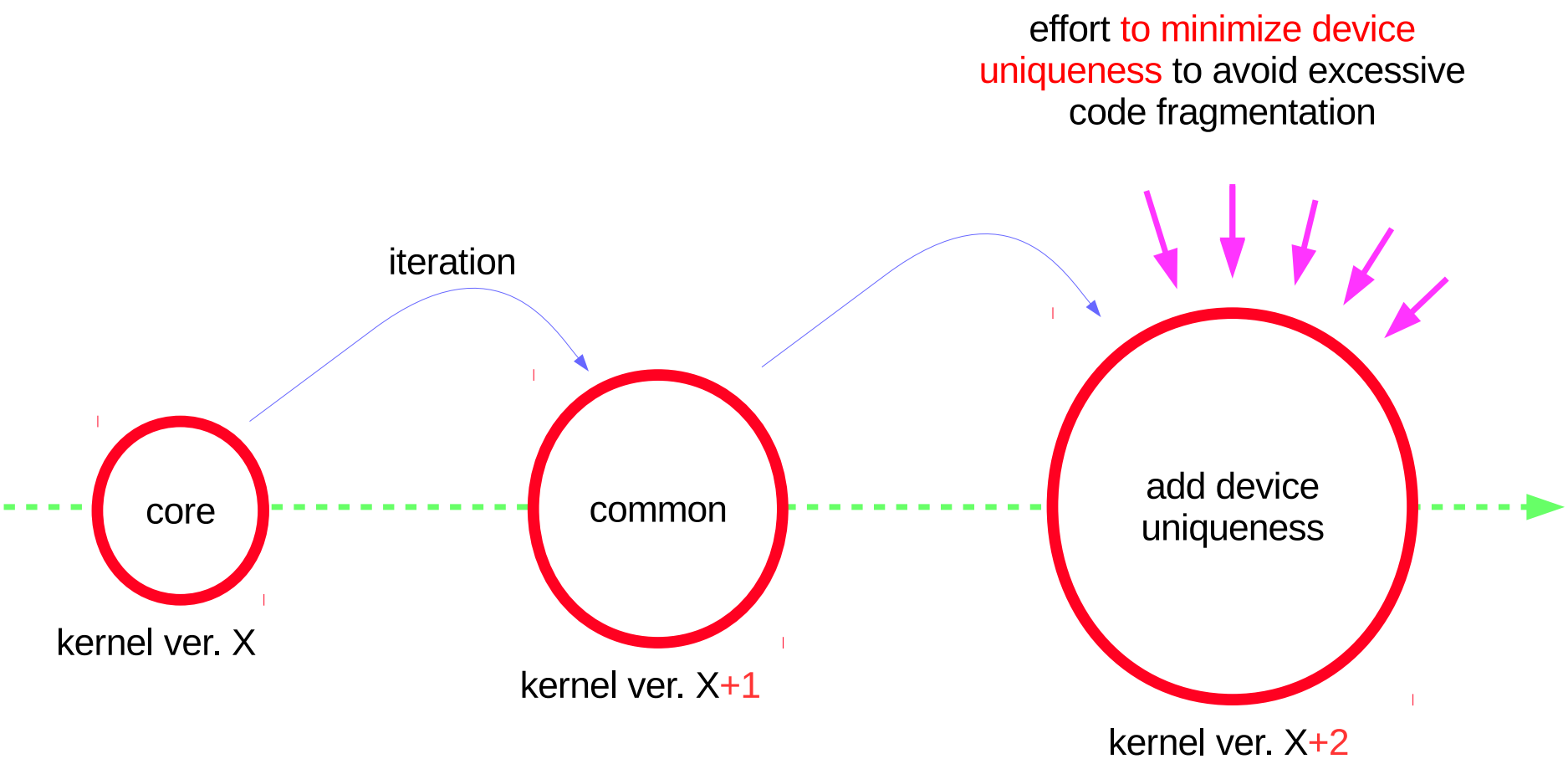


Renesas adopts upstream first strategy

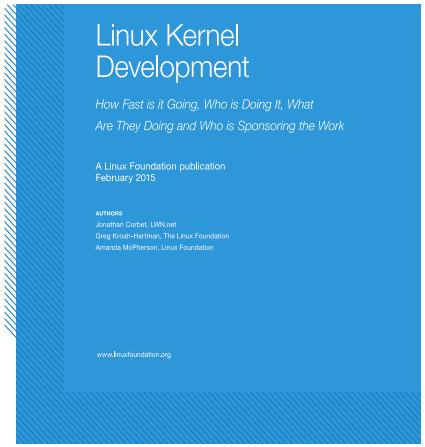


pros	cons
- clean code (reviewed by the community) - coordinated with existing code - merged to the upstream code - no need to keep in-house code	- take time (roughly 6 month) - might need iterative approach (bit b bit) - might need code adjustment

iterative approach to minimize code fragmentation

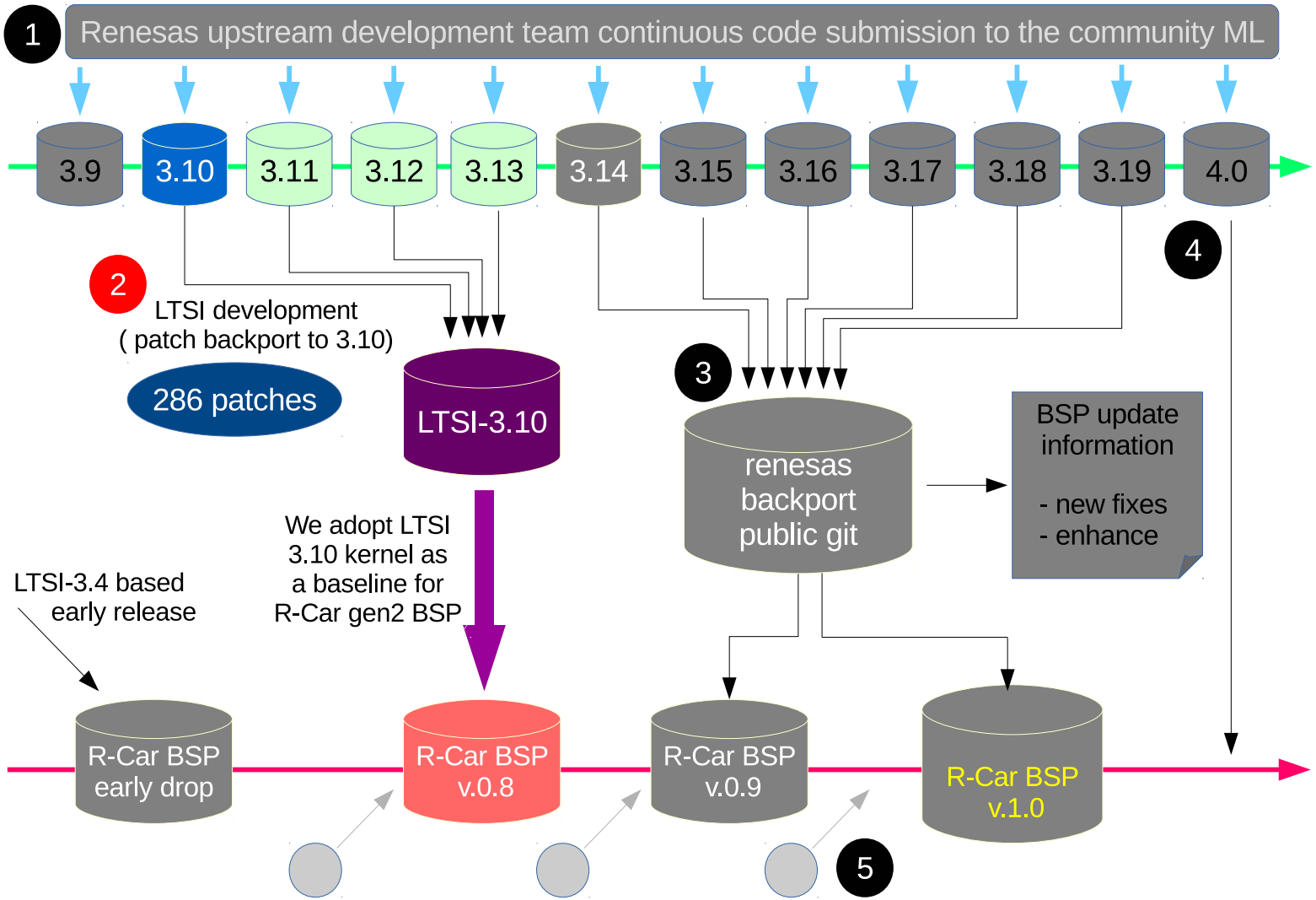


Result of 2014 lf_pub_whowriteslinux2015.pdf



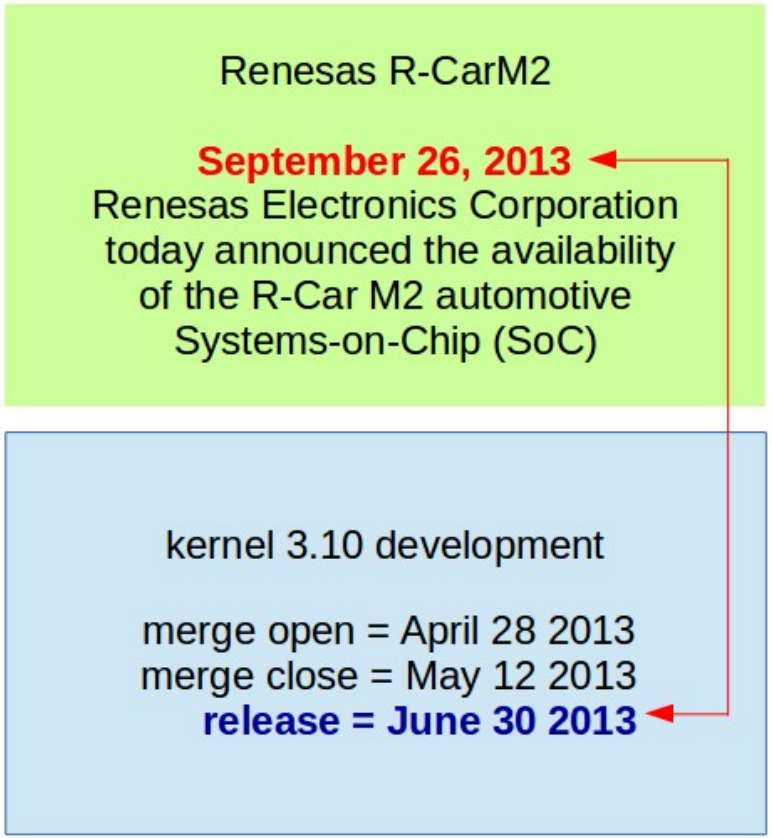
Company	Changes	Total
None	11,968	12.4%
Intel	10,108	10.5%
Red Hat	8,078	8.4%
Linaro	5,415	5.6%
Samsung	4,290	4.4%
Unknown	3,842	4.0%
IBM	3,081	3.2%
SUSE	2,890	3.0%
Consultants	2,451	2.5%
Texas Instruments	2,269	2.4%
Vision Engraving Systems	2,089	2.2%
Google	2,048	2.1%
Renesas Electronics	2,004	2.1%
Freescale	1,690	1.8%
Free Electrons	1,463	1.5%
FOSS Outreach Program for Women	1,418	1.5%
Oracle	1,166	1.2%
AMD	1,109	1.1%
NVidia	1,078	1.1%
Broadcom	1,001	1.0%
Huawei Technologies	971	1.0%
ARM	788	0.8%
Pengutronix	763	0.8%

(2) LTSI development process



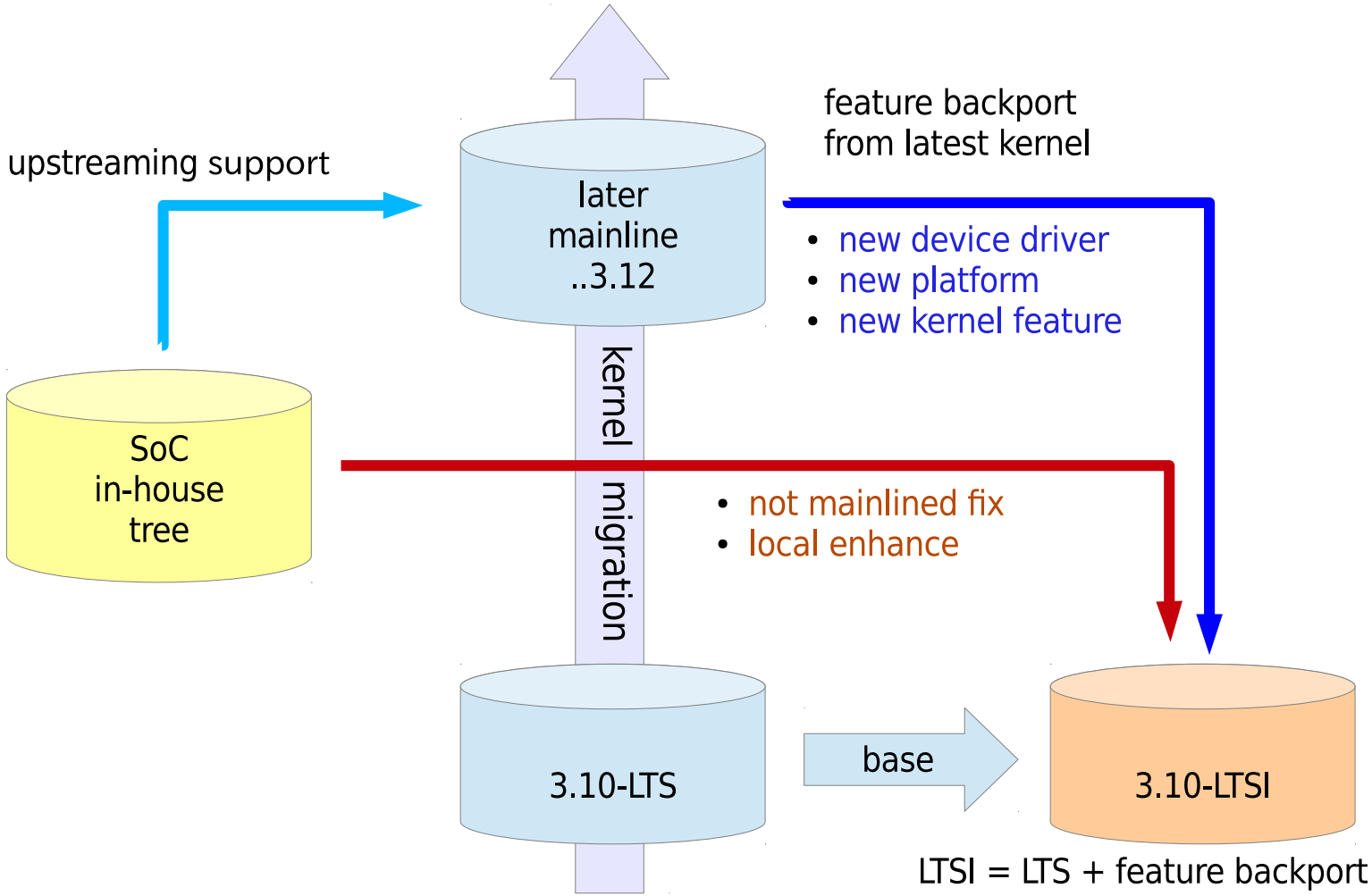
(2) LTSI = cutting edge device on the solid software

version	fixes
v3.3 -> v3.3.8	698
v3.4 -> v3.4.95	4,506
v3.5 -> v3.5.7	816
v3.6 -> v3.6.9	676
v3.7 -> v3.7.10	718
v3.8 -> v3.8.13	996
v3.9 -> v3.9.11	746
v3.10 -> v3.10.69	4,175
v3.11 -> v3.11.10	677
v3.12 -> v3.12.38	4,262
v3.13 -> v3.13.11	903
v3.14 -> v3.14.33	2,786
v3.15 -> v3.15.10	703
v3.16 -> v3.16.7	871

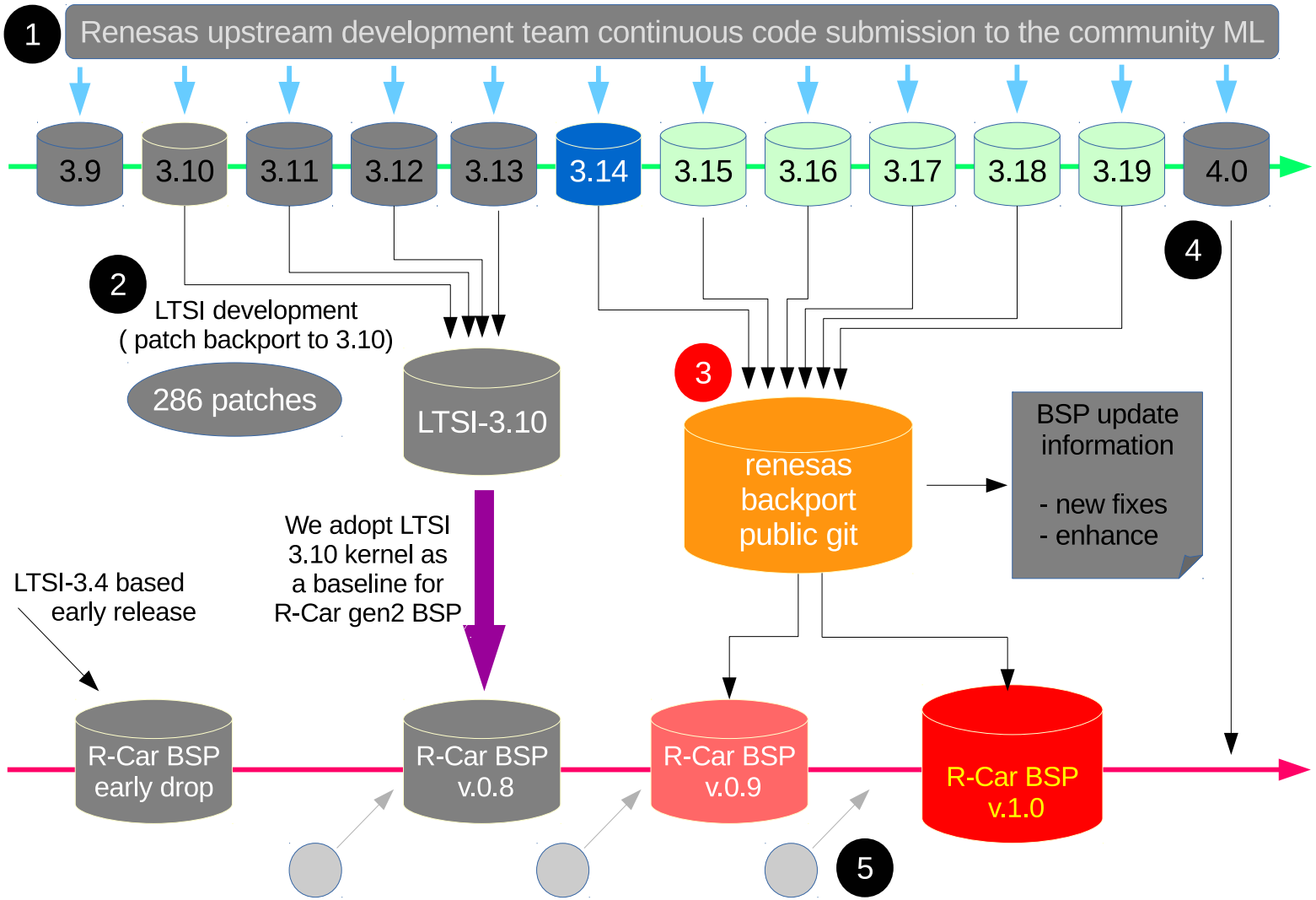


R-CarM2 was released after the release of kernel 3.10

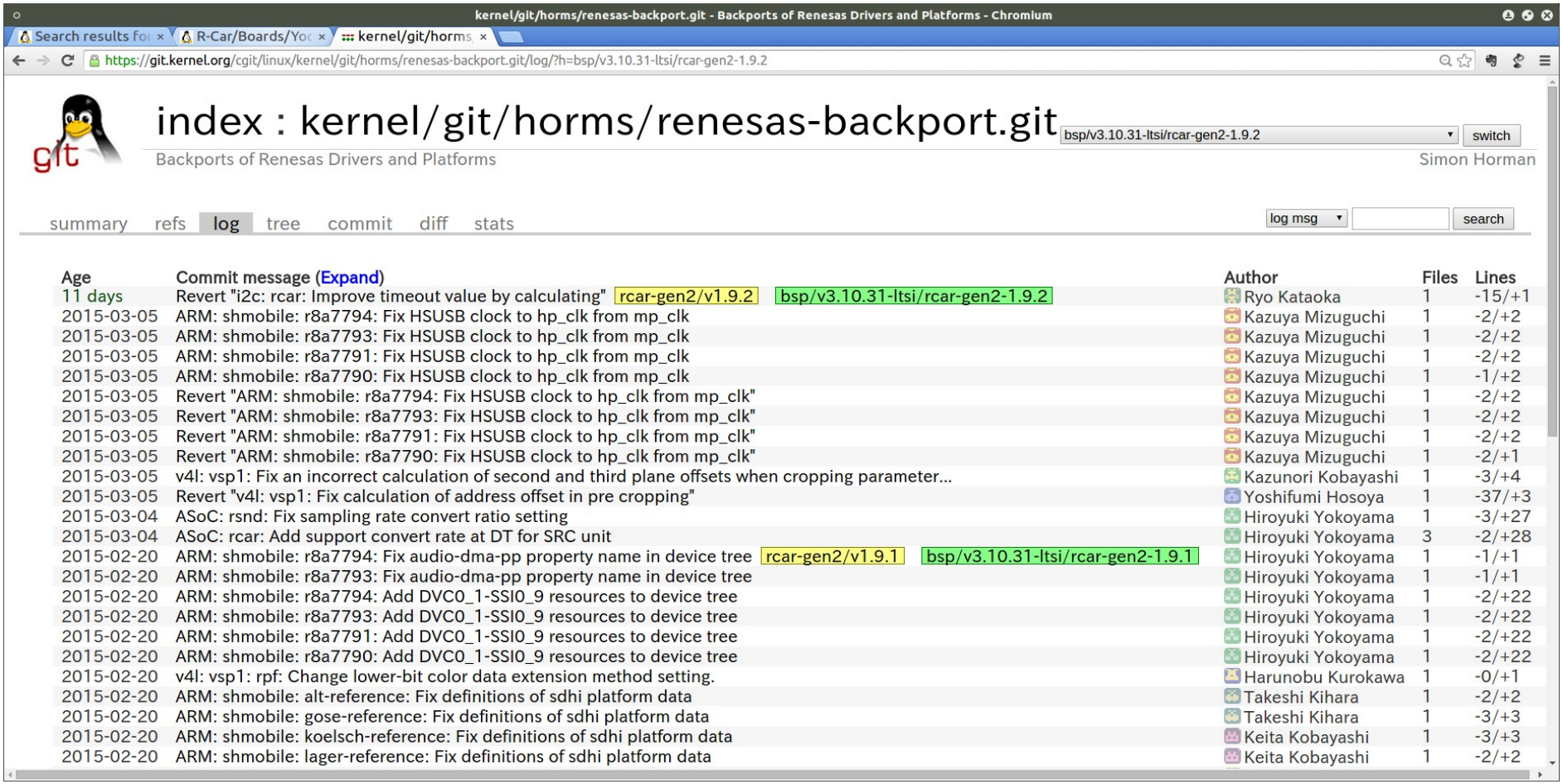
Backported R-carM2 device support to LTSI-3.10



(3) continuous backport after LTSI merge closed



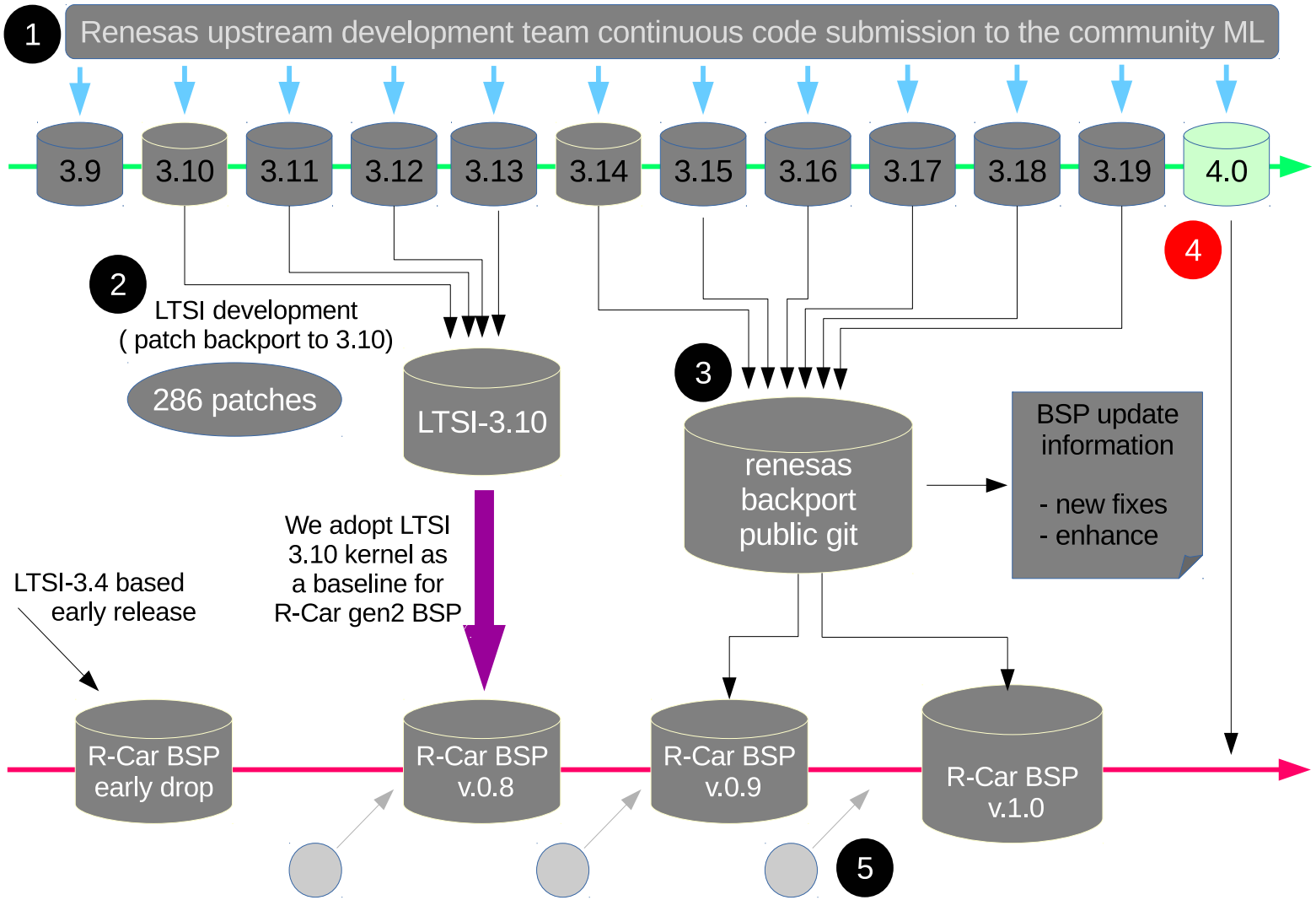
(3) continuous backport after LTSI merge closed



Age	Commit message (Expand)	Author	Files	Lines
11 days	Revert "i2c: rcar: Improve timeout value by calculating" rcar-gen2/v1.9.2 bsp/v3.10.31-ltsi/rcar-gen2-1.9.2	Ryo Kataoka	1	-15/+1
2015-03-05	ARM: shmobile: r8a7794: Fix HSUSB clock to hp_clk from mp_clk	Kazuya Mizuguchi	1	-2/+2
2015-03-05	ARM: shmobile: r8a7793: Fix HSUSB clock to hp_clk from mp_clk	Kazuya Mizuguchi	1	-2/+2
2015-03-05	ARM: shmobile: r8a7791: Fix HSUSB clock to hp_clk from mp_clk	Kazuya Mizuguchi	1	-2/+2
2015-03-05	ARM: shmobile: r8a7790: Fix HSUSB clock to hp_clk from mp_clk	Kazuya Mizuguchi	1	-1/+2
2015-03-05	Revert "ARM: shmobile: r8a7794: Fix HSUSB clock to hp_clk from mp_clk"	Kazuya Mizuguchi	1	-2/+2
2015-03-05	Revert "ARM: shmobile: r8a7793: Fix HSUSB clock to hp_clk from mp_clk"	Kazuya Mizuguchi	1	-2/+2
2015-03-05	Revert "ARM: shmobile: r8a7791: Fix HSUSB clock to hp_clk from mp_clk"	Kazuya Mizuguchi	1	-2/+2
2015-03-05	Revert "ARM: shmobile: r8a7790: Fix HSUSB clock to hp_clk from mp_clk"	Kazuya Mizuguchi	1	-2/+1
2015-03-05	v4l: vsp1: Fix an incorrect calculation of second and third plane offsets when cropping parameter...	Kazunori Kobayashi	1	-3/+4
2015-03-05	Revert "v4l: vsp1: Fix calculation of address offset in pre cropping"	Yoshifumi Hosoya	1	-37/+3
2015-03-04	ASoC: rsnd: Fix sampling rate convert ratio setting	Hiroyuki Yokoyama	1	-3/+27
2015-03-04	ASoC: rcar: Add support convert rate at DT for SRC unit	Hiroyuki Yokoyama	3	-2/+28
2015-02-20	ARM: shmobile: r8a7794: Fix audio-dma-pp property name in device tree rcar-gen2/v1.9.1 bsp/v3.10.31-ltsi/rcar-gen2-1.9.1	Hiroyuki Yokoyama	1	-1/+1
2015-02-20	ARM: shmobile: r8a7793: Fix audio-dma-pp property name in device tree	Hiroyuki Yokoyama	1	-1/+1
2015-02-20	ARM: shmobile: r8a7794: Add DVC0_1-SSI0_9 resources to device tree	Hiroyuki Yokoyama	1	-2/+22
2015-02-20	ARM: shmobile: r8a7793: Add DVC0_1-SSI0_9 resources to device tree	Hiroyuki Yokoyama	1	-2/+22
2015-02-20	ARM: shmobile: r8a7791: Add DVC0_1-SSI0_9 resources to device tree	Hiroyuki Yokoyama	1	-2/+22
2015-02-20	ARM: shmobile: r8a7790: Add DVC0_1-SSI0_9 resources to device tree	Hiroyuki Yokoyama	1	-2/+22
2015-02-20	v4l: vsp1: rpf: Change lower-bit color data extension method setting.	Harunobu Kurokawa	1	-0/+1
2015-02-20	ARM: shmobile: alt-reference: Fix definitions of sdhi platform data	Takeshi Kihara	1	-2/+2
2015-02-20	ARM: shmobile: gose-reference: Fix definitions of sdhi platform data	Takeshi Kihara	1	-3/+3
2015-02-20	ARM: shmobile: koelsch-reference: Fix definitions of sdhi platform data	Keita Kobayashi	1	-3/+3
2015-02-20	ARM: shmobile: lager-reference: Fix definitions of sdhi platform data	Keita Kobayashi	1	-2/+2

`https://git.kernel.org/cgit/linux/kernel/git/horms/renesas-backport.git/log/?h=bsp/v3.10.31-ltsi/rcar-gen2-1.9.2`

(4) super-long term security fix adoption



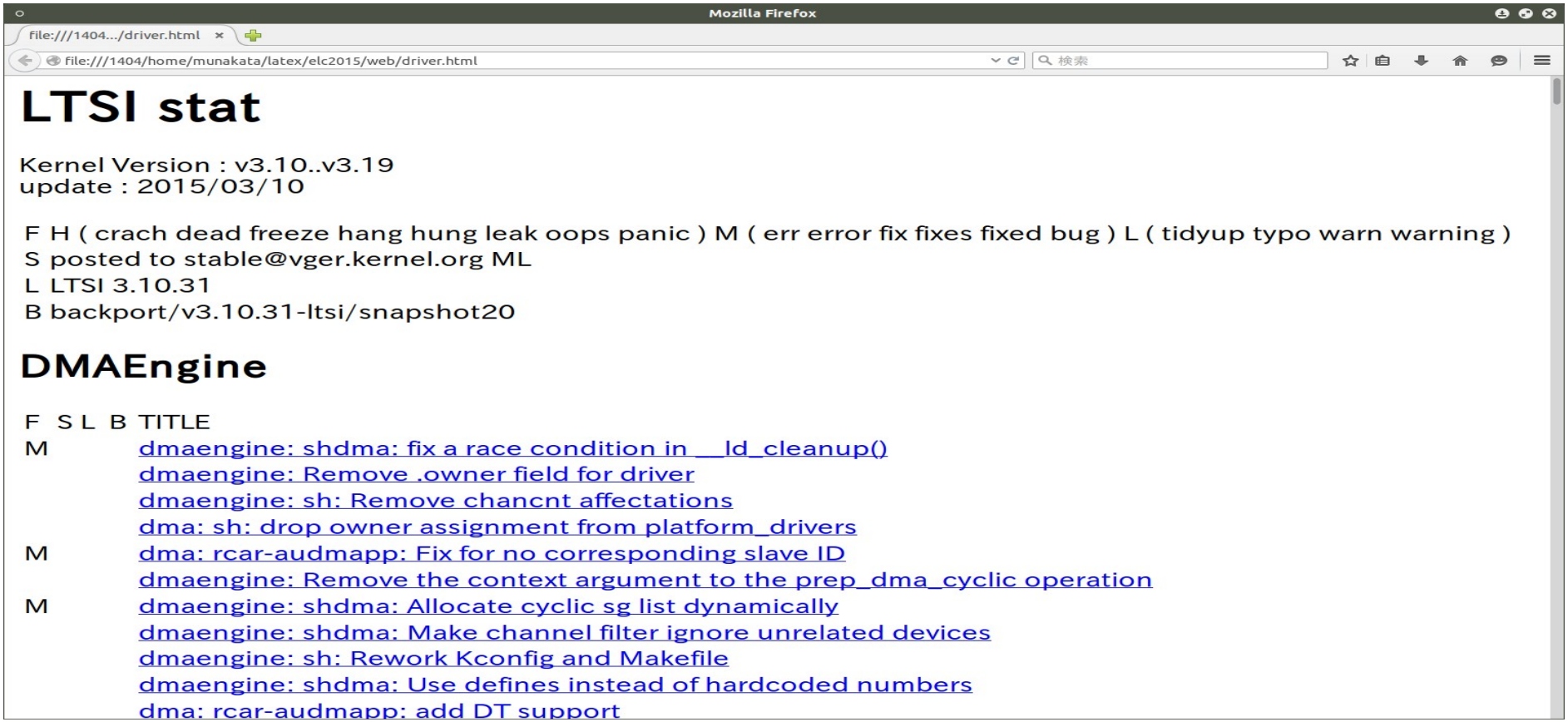
BSP maintenance : new bug-fix patch tracking

We continue check if new fixes is available

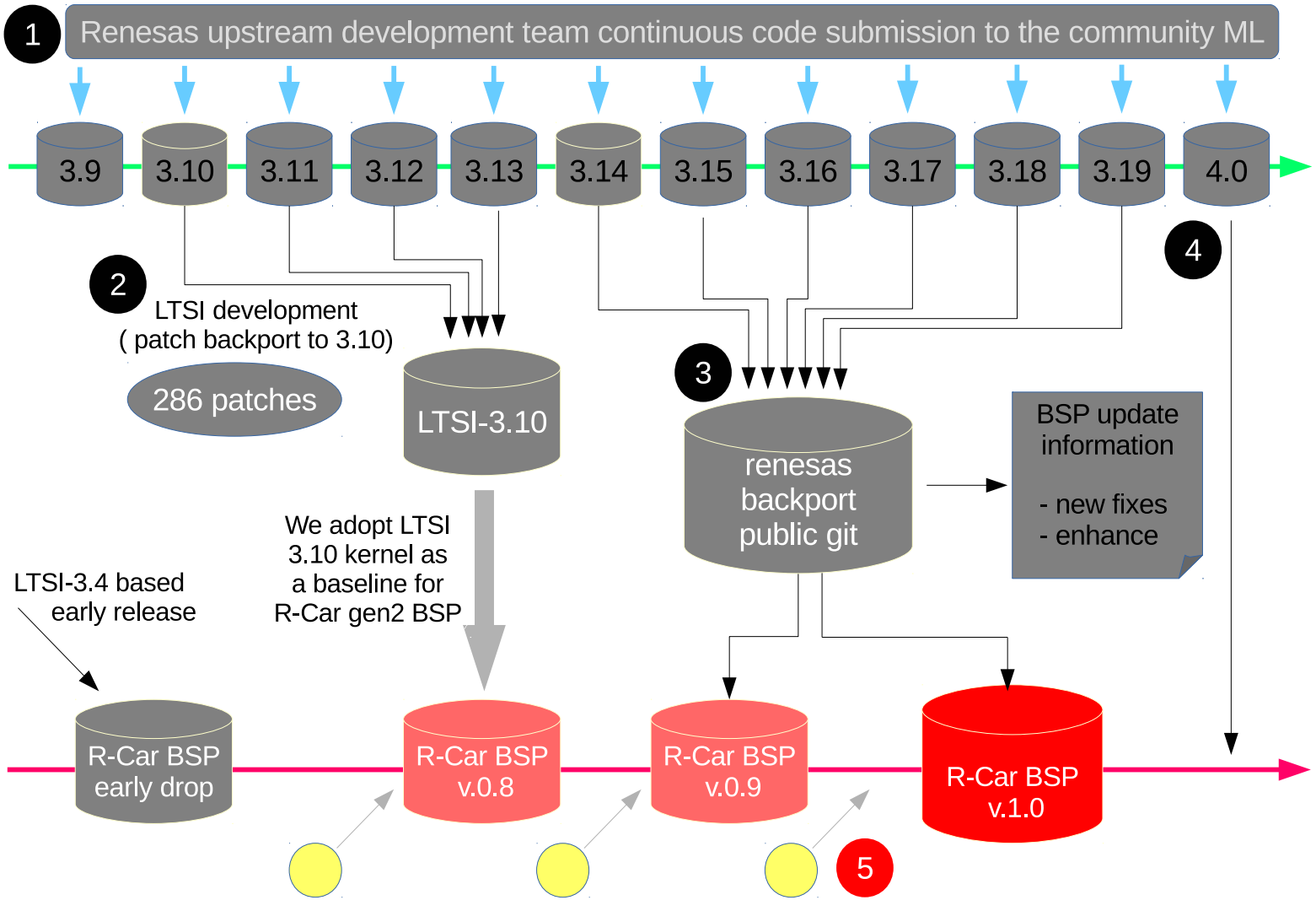
- automated upstream patch scan from git
- crawling scope is own code or modified code
- F : patch severity parsing
  - H : crash, dead, freeze, hang, hung, leak, oops, panic
  - M : err, error, fix, fixes, fixed, bug
  - L : tidyup, typo, warn, warning
- S :check if this patch is cc'd to stable@vger.kernel.org
- L :check if this patch is already a part of LTSI kernel
- B :check if this patch is send to renesas-backport git

BSP maintenance : new bug-fix patch tracking

actual scan result example (comparing upstream 3.10..3.19)



(5) local in-house patch adoption and elimination



(5) local in-house patch adoption and elimination

we try to eliminate in-house code from our BSP, however

- Due to time constraint (=up to six months needed for upstream-first attempt), we still need to manage some in-house patch.
- We start up-porting challenge (in-house code to the upstream flow) to eliminate (at least reduce) in-house code.
- It requires an extra code polish to comply with latest mainline kernel patch adoption criteria. But we believe this is the valuable challenges.

embedded Linux eco-system

R-Car low-cost reference board intro. @ eLinux wiki

Hardware Pages

The following hardware pages have LOTS of information on this site:


BeagleBoard


BeagleBone


BeagleBoneBlack


BeagleBone Capes


MinnowBoard


Raspberry Pi


UDOO


Improv

OpenPhoenux


Jetson TK1


Mainline Linux
on Tegra


Parallella


MIPS Creator CI20


Banana Pi


Renesas R-Car SILK

http://elinux.org/R-Car/Boards/Porter

Renesas R-CarM2 Porter board on eLinux

R-Car/Boards/Porter

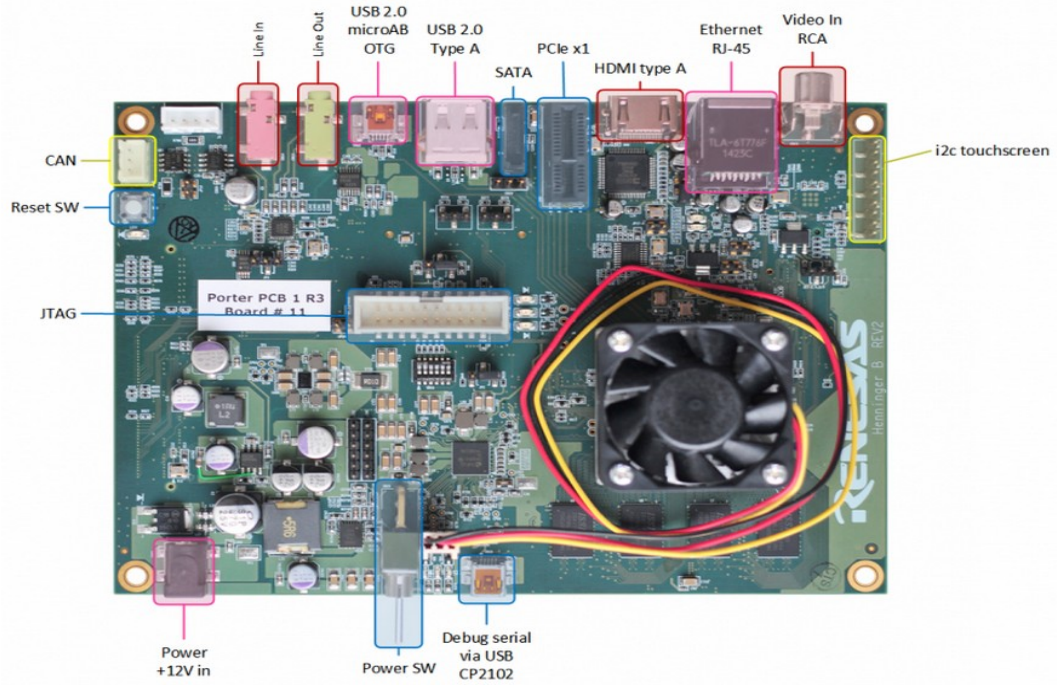
< R-Car

Introduction

This is the official Wiki for Renesas R-Car M2 Porter board.

Refer to R-Car page for Renesas R-Car SoC family. Information on Renesas R-Car E2 SILK board is on a separate page.

Hardware



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http://elinux.org/R-Car/Boards/Porter

Renesas R-CarE2 SILK board on eLinux

R-Car/Boards/SILK

< R-Car

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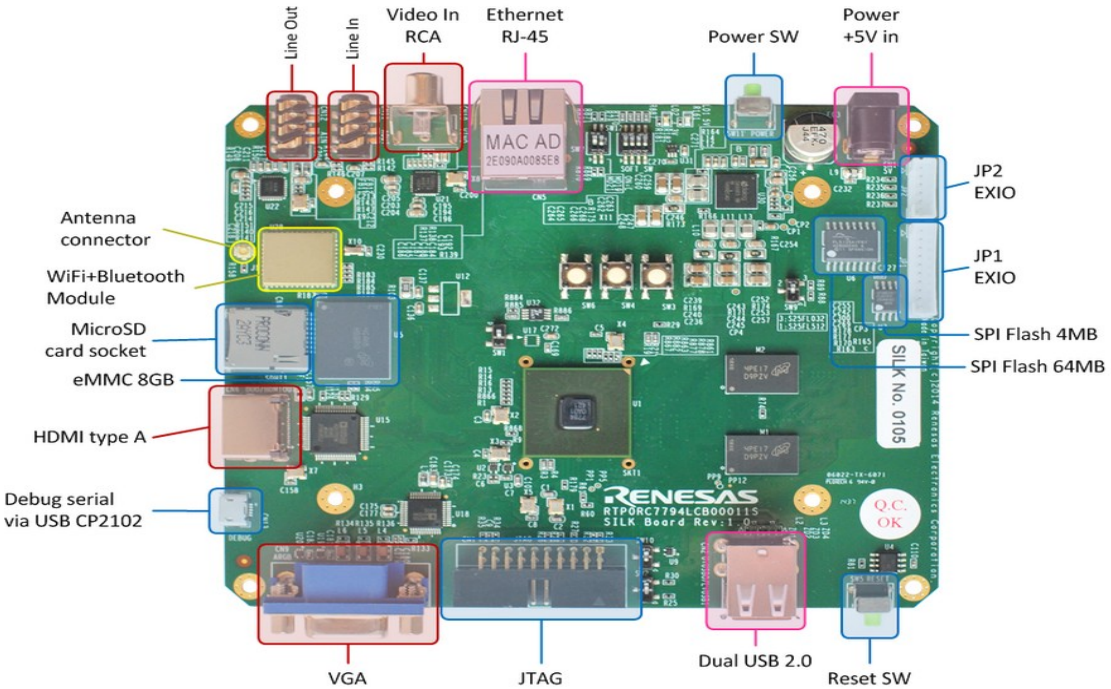

Contents [hide]

http://elinux.org/R-Car/Boards/SILK

Renesas R-CarM2/E2 yocto instruction on eLinux

R-Car/Boards/Yocto

< R-Car

This page contains information on building and running Yocto on Renesas R-Car E2 SILK and Renesas R-Car M2 Porter boards.

Contents [hide]

Yocto versions

Poky-1.6.1 is supported. Specific commit of meta-openembedded is required.

Preliminary steps

1. Download proprietary graphics and multimedia drivers from Renesas. Evaluation version is available at
   http://www.renesas.com/secret/r_car_download/rcar_demoboard.jsp
   Graphic drivers are required for X11 and Wayland. Multimedia drivers are optional.

2. Install required packages

   Ubuntu and Debian

```
sudo apt-get install gawk wget git-core diffstat unzip texinfo gcc-multilib ¥
     build-essential chrpath socat libsdl1.2-dev xterm
```

   Fedora

```
sudo yum install gawk make wget tar bzip2 gzip python unzip perl patch ¥
     diffutils diffstat git cpp gcc gcc-c++ glibc-devel texinfo chrpath ¥
     ccache perl-Data-Dumper perl-Text-ParseWords perl-Thread-Queue socat ¥
     SDL-devel xterm
```

   Refer to Yocto Project Quick Start for more information.

Building the BSP for Renesas R-Car SILK and Porter

1. Create a directory and switch to it
   Warning! Yocto builds require a lot of disk space (up to 100 GB). Make sure you have got enough before starting the build.

http://elinux.org/R-Car/Boards/Yocto

conclusion

Conclusion

- Introduced why embedded Linux requires BSP and what is the potential problem of too unique embedded feature adoption to the Linux kernel.
- Introduced Renesas R-Car gen2 Linux BSP development process and result.
- Introduced newly opened public web (eLinux) where you can obtain R-Car Linux BSP and related information.

Resources

- R-CarH2 intro = http://am.renesas.com/applications/automotive/cis/cis_highend/rcar_h2/index.jsp
- R-CarM2 intro = http://am.renesas.com/applications/automotive/cis/cis_highend/rcar_m2/
- R-CarE2 intro = http://am.renesas.com/applications/automotive/cis/cis_highend/rcar_e2/index.jsp
- R-Car series road map = http://www.renesas.eu/products/soc/assp/automotive/index.jsp

- R-CarM2 Porter board = http://elinux.org/R-Car/Boards/Porter
- R-CarE2 SILK board = http://elinux.org/R-Car/Boards/SILK
- R-Car gen2 public yocto intro = http://elinux.org/R-Car/Boards/Yocto
- R-Car gen2 GFX/MMF evaluation download = http://www.renesas.com/secret/r_car_download/rcar_demoboard.jsp

- e-mail = Hisao Munakata (hisao.munakata.vt(at)renesas.com)