How to cook the LTSI kernel with Yocto recipe
improve your productivity with LTSI & Yocto

Hisao Munakata
Linux Foundation Consumer Electronics working group

February 20th 2013, ELC2013
Who am I?

- From embedded SoC provider company Renesas
- 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
- Also I have supported various CE customers who develop digital-TV, Blu-ray recorder and Smart-phone

\(^1\)CE = consumer electronics
\(^2\)LTSI = Long Term Stable kernel Initiative
Why you should choose LTS & LTSI kernel?
Linux kernel life-cycle varies according to version

If you choose LTS, you can simply apply serious bug-fix and security-fix patches maintained by the community.
the 3.4 kernel tree will be -longterm

From: Greg KH
Date: Mon Aug 20 2012 - 18:25:09 EST

- Previous message: Shirley Ma: "Re: [RFC PATCH 1/1] fair.c: Add/Export find_idlest_perfer_cpu API"
- Messages sorted by: [ date ] [ thread ] [ subject ] [ author ]

As I'm getting a few questions about this, and I realized that I never sent out an email about this, yes, the 3.4 kernel tree will be the next -longterm kernel that I will be maintaining for at least 2 years.

Currently I'm maintaining the following stable kernel trees for the following amount of time:
3.0 - for at least one more year
3.4 - for at least two years
3.5 - until 3.6.1 is out

Hope this helps clear up any rumors floating around. If anyone has any questions, please let me know.

greg k-h

https://lkml.org/lkml/2012/8/20/675
LTS (long-term stable) kernel rules

Target kernel selection rules

- Maintainer will **choose one LTS version per year**
- **Maintain it for 2 years** from its original release
- Then, we have 2 LTS kernels like 3.0 and 3.4

Patch adoption rules

- Serious security/bug fix small code
- Backport already mainlined code
- No new feature applied to keep 100% compatibility
- See kernel document ```stable_kernel_rules.txt``" for detail
We want to use latest device on LTS kernel, but...

<table>
<thead>
<tr>
<th>LTS</th>
<th>Stable Kernel</th>
<th>Development Start</th>
<th>Merge Window Close</th>
<th>Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0-LTS</td>
<td>long-term stable for 2011</td>
<td>2011.5.18</td>
<td>2011.5.29</td>
<td>2011.7.21</td>
</tr>
<tr>
<td>3.4-LTS</td>
<td>long-term stable for 2012</td>
<td>2012.3.18</td>
<td>2012.3.31</td>
<td>2012.5.20</td>
</tr>
</tbody>
</table>

There is no chance to mainline new device/platform support to LTS kernel, as its development was done.
LTS vs LTSI: What differs? Why we wanted that?

**LF/CEWG LTSI kernel**
- Kernel features back-port from latest mainline
- Device drivers back-port from latest mainline
- Local patch (=not yet mainlined) integration

**Community LTS kernel** (is designed to be conservative)
- Only accept bug-fix back-port
- Only accept security-fix back-port

**Upstream kernel**
- Regularly migrated community kernel

---

Hisao Munakata

How to cook the LTSI kernel with Yocto recipe
Discipline of LTSI project management

- Community **LTS + industry demanded** extra patches.
- Governed by LF/CEWG
- Focus on kernel code\(^a\), not aiming complete BSP
- Therefore, can be combined with existing platform\(^b\)
- CPU architecture and platform neutral
- Comply with upstream rules\(^c\)
- Industry friendly acceptance (**flexible patch forms**, etc)
- Help CE (and others) industry to utilize Linux

---

\(^a\) device drivers are part of kernel, of course

\(^b\) Android, **Yocto**, Tizen, AGL, WebOS and others

\(^c\) e.g. signed-off-by process
Introducing the Yocto Project Development Environment

The Yocto Project through the Poky build system provides an open source development environment targeting the ARM, MIPS, PowerPC and x86 architectures for a variety of platforms including x86-64 and emulated ones. You can use components from the Yocto Project to design, develop, build, debug, simulate, and test the complete software stack using Linux, the X Window System, GNOME Mobile-based application frameworks, and Qt frameworks.

Open embedded Architecture Workflow

User Configuration
Metadata (.bb + patches)
Machine (BSP) Configuration
Policy Configuration
Source Fetching
Patch Application
Configuration / Compile / Autoreconf as needed
Output Analysis for package splitting plus package relationships
.rpmsg Generation
.deb Generation
.ipk Generation
QA Tests
Package Feeds
Images
Application Development SDK
SDK Generation
Image Generation
Output Packages
Process steps (tasks)
Output Image Data
Upstream Source
Metadata/Inputs
Build system
**Synergy of Yocto + LTSI integration**

How LTSI can utilize Yocto infrastructure

- **source code collection (Yocto recipe)**
  - LTSI kernel
  - LTSI off-tree patches
- build automation
- test automation
- various option for userland
  - tiny-root file system
  - full package system
- [https://git.yoctoproject.org/cgit/cgit.cgi/poky/tree/meta](https://git.yoctoproject.org/cgit/cgit.cgi/poky/tree/meta)
## LTSI and Yocto: originally aimed different goal, but..

<table>
<thead>
<tr>
<th></th>
<th>LTSI</th>
<th>Yocto</th>
</tr>
</thead>
<tbody>
<tr>
<td>project focus</td>
<td>stable kernel</td>
<td>BSP creation</td>
</tr>
<tr>
<td>architecture</td>
<td>neutral</td>
<td>ARM, MIPS, PPC, x86</td>
</tr>
<tr>
<td>kernel</td>
<td>LTS</td>
<td>latest</td>
</tr>
<tr>
<td>toolchain</td>
<td>not combined</td>
<td>provided</td>
</tr>
<tr>
<td>userland</td>
<td>not combined</td>
<td>provided</td>
</tr>
<tr>
<td>release cycle</td>
<td>yearly</td>
<td>every 6 month</td>
</tr>
<tr>
<td>distribution support</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>hosted by</td>
<td>Linux Foundation</td>
<td>Linux Foundation</td>
</tr>
</tbody>
</table>

**Yocto + LTSI can generate stable BSP for embedded**
Yocto and LTSI project coordination is just started

Long Term Support Initiative (LTSI)

LTSI is an industry-wide project created and supported by Hitachi, LG Electronics, NEC, Panasonic, Qualcomm Atheros, Renesas Electronics Corporation, Samsung Electronics, Sony and Toshiba and hosted at The Linux Foundation to maintain a common Linux base for use in a variety of consumer electronics products. The project creates and maintains a long-term industry tree, which is expected to be stable in quality for the typical lifetime of a consumer electronics product, typically 2-3 years.

This new initiative is crucial because device makers are doing significant back-porting, bug testing and driver development on their own, which carries substantial cost in terms of time-to-market, as well as development and engineering effort to maintain those custom kernels. Through collaboration in this initiative, these CE vendors will reduce the duplication of effort currently prevalent in the consumer electronics industry.

The LTSI tree is expected to be a usable base for the majority of embedded systems, as well as the base for ecosystem players (e.g., semiconductor vendors, set-vendors, software component vendors, distributors, and system/application framework providers). The LTSI project will combine the innovative features in newer kernels needed by CE vendors with a stable kernel, while helping those vendors get their code upstream to benefit the entire Linux community. The goal is to reduce the number of private trees currently in use in the CE industry and encourage more collaboration and sharing of development resources.
LTSI-3.4 release notes
### LTSI-3.4 development history

<table>
<thead>
<tr>
<th>Item</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream kernel 3.4 release</td>
<td>2012.5.20</td>
</tr>
<tr>
<td>Announce of 2012 LTS kernel version</td>
<td>2012.6.6³</td>
</tr>
<tr>
<td>LTSI-3.4 merge window open</td>
<td>2012.9.19</td>
</tr>
<tr>
<td>3.4 becomes LTS</td>
<td>2012.9.30⁴</td>
</tr>
<tr>
<td>(merge window open period)</td>
<td>(78 days)</td>
</tr>
<tr>
<td>LTSI-3.4-rc1 (=merge window close)</td>
<td>2012.12.6</td>
</tr>
<tr>
<td>LTSI-3.4-rc2</td>
<td>2012.12.17</td>
</tr>
<tr>
<td>(validation period)</td>
<td>(40 days)</td>
</tr>
<tr>
<td>LTSI-3.4 release</td>
<td>2013.1.15</td>
</tr>
</tbody>
</table>

³@LinuxCon Japan  
⁴@upstream kernel 3.6 release
# Why you should choose LTS & LSI kernel?

## LTSI-3.4 release notes

How can you improve productivity with LTSI?

## Conclusion and future action

---

### Development result

#### LTSI-3.4 active contributors (by patch numbers)

<table>
<thead>
<tr>
<th>developer</th>
<th>host</th>
<th>patch</th>
<th>technical area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicolas Ferre</td>
<td>atmel</td>
<td>246</td>
<td>AT91</td>
</tr>
<tr>
<td>Simon Horman</td>
<td>renesas</td>
<td>205</td>
<td>Armaddilo, Marzen,..</td>
</tr>
<tr>
<td>Damian Hobson-Garcia</td>
<td>igel</td>
<td>71</td>
<td>dma-mapping</td>
</tr>
<tr>
<td>Tetsuyuki Kobayashi</td>
<td>kmc</td>
<td>60</td>
<td>KZM-GT</td>
</tr>
<tr>
<td>Greg Kroah-Hartman</td>
<td>LF</td>
<td>62</td>
<td>AF_BUS, others</td>
</tr>
<tr>
<td>Marco Stornelli</td>
<td>sony</td>
<td>18</td>
<td>pramfs</td>
</tr>
<tr>
<td>Aaditya Kumar</td>
<td>sony</td>
<td>15</td>
<td>axfs</td>
</tr>
<tr>
<td>Paul Gortmaker</td>
<td>windriver</td>
<td>9</td>
<td>CoDel</td>
</tr>
</tbody>
</table>

---

677 patches are added on top of community 3.4 kernel
LTSI-3.4: What is added on top of regular 3.4?

- **FIX**: refreshed to be based on 3.4.24
- **BACKPORT**: pramfs now builds properly
- **BACKPORT**: CODEL support patches added
- **BACKPORT**: CMA backport from v3.7
- **BACKPORT**: VFIO backport from v3.7
- **BACKPORT**: AF_BUS patches
- **BACKPORT**: LTTng
- **NEW**: big dma-mapping patches
- **NEW**: azfs (temporary disabled due to build problems)
- **NEW**: Board support for Armadillo 800, AT91, kzm9d, kzm9g, and Marzen platforms
LTSI-3.4 highlight from news release

The Contiguous Memory Allocator (CMA)
This is extremely useful for embedded devices that have very limited hardware resources and will better handle the large memory requirements of multimedia applications. CMA originally was merged into the 3.4.0 kernel release, but its functionality was quite limited. Since then, the feature has been significantly improved in the kernel.org releases and those fixes have been added to the LTSI 3.4 kernel release.

AF_BUS
AF_BUS is a kernel-based implementation of the D-Bus protocol. This feature was created for systems that required a faster D-Bus speed than the existing userspace method could provide, specifically the automotive entertainment systems.

CoDel (controlled delay)
CoDel is a transmission algorithm that optimizes TCP/IP network buffer control, is backported for LTSI 3.4. This is a feature used to help control the "buffer bloat" problem that has been identified by the networking community as an issue that all devices need to be aware of. This feature was backported from the 3.5.0

Platform support
Armadillo 800, AT91, kzm9d, kzm9g, and Marzen platforms to work properly with this release.
Why you should choose LTS & LSI kernel? LTSI-3.4 release notes How can you improve productivity with LSI? Conclusion and future action

LTSI-3.4 release test by Renesas (pass rate = 99.2%)

<table>
<thead>
<tr>
<th>board</th>
<th>item</th>
<th>test case (total=137)</th>
<th>pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armadillo 800EVA (Cortex A9 single)</td>
<td>GPIO-KEY</td>
<td>3 / 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethernet</td>
<td>6 / 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SCIF (serial if)</td>
<td>5 / 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>touch panel</td>
<td>5 / 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LCD controller</td>
<td>2 / 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SDHI (SD card)</td>
<td>12 / 11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMCIF (MMC)</td>
<td>6 / 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FSI (sound)</td>
<td>4 / 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CEU (camera)</td>
<td>2 / 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>USB function</td>
<td>11 / 11</td>
<td></td>
</tr>
<tr>
<td>KZM-A9-GT (Cortex A9 dual)</td>
<td>GPIO-KEY</td>
<td>3 / 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethernet (SMSC LAN911xx)</td>
<td>5 / 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SCIF (serial if)</td>
<td>5 / 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>touch panel</td>
<td>5 / 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LCD controller</td>
<td>2 / 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SDHI (SD card)</td>
<td>12 / 7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FSI (sound)</td>
<td>4 / 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>USB host</td>
<td>25 / 22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>USB function</td>
<td>11 / 11</td>
<td></td>
</tr>
<tr>
<td>Marzen (Cortex A9 quad)</td>
<td>Ethernet (SMSC LAN911xx)</td>
<td>5 / 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SCIF (serial if)</td>
<td>4 / 1</td>
<td></td>
</tr>
</tbody>
</table>

We observed only one degradation from upstream 3.4. Other failures are reproduced also on latest kernel 3.7, not a LSI problem.
How can you improve productivity with LTSI?
kernel selection procedure (distro, LTS and LTSI)

1. kernel selection
   - distribution?
     - yes
     - no
       - choose LTS
         - satisfy?
           - yes
           - no
             - check LTSI
               - satisfy?
                 - yes
                 - no
                   - use distro
                   - cook LTSI
                   - use LTSI
                   - use LTS

2. How you should choose LTS & LTSI kernel?
3. LTSI-3.4 release notes
4. How can you improve productivity with LTSI?
5. Conclusion and future action
6. Adoption of LTSI
7. LTSI cooking
8. Code contribution
Where can you find the LTSI-3.4 kernel?

http://ltsi.linuxfoundation.org/downloads/releases
LTSI kernel cooking

- you want to enhance LTSI?
  - yes: in newer kernel?
    - yes: off-tree patch?
      - yes: get custom LTSI
      - no: backport from upstream
    - no: write your own code
  - no: collect off-tree patches
    - yes: write yocto recipe for automatic merge
    - no: get custom LTSI
You may want to **add new platform support to released LTSI**.

Then you sent patch to LTSI-ML, but it might not be merged.

Patchwork can be the way to **collect such off-tree patches**.

https://patchwork.kernel.org/project/ltsi-dev/list/
You can cherry pick patch from **LTSI-patchwork site**

- Patchwork automatically collect message that contains source code (patch)
- Each patch has unique tag and you can identify patch by tag
- You can write yocto recipe to collect patches in patchwork
Yocto meta file contains .bb (recipe) file

```
munakata@mythen:~/Download/meta-renesas-20130204$ tree recipes-kernel/
recipes-kernel/
    ├── linux
    │   └── files
    │       └── linux-yocto
    │           └── armadillo800eva
    │               └── armadillo800eva-non_hardware.cfg
    │                   └── armadillo800eva-preempt-rt.scc
    │                           └── armadillo800eva-standard.scc
    │                                   └── armadillo800eva.cfg
    │                                           └── armadillo800eva.scc
    │                                               └── defconfig
    │                                                   └── missing_required.cfg
    │                                                       └── required_redefinition.txt
    │                                                               └── specified_non_hdw.cfg
    │                                                                 └── user-config.cfg
    │                                                                         └── user-patches.scc
    │                                                                 └── linux-yocto_3.4.bbappend
    │                                                                 └── linux-libc-headers
    │                                                                     └── linux-libc-headers-rmobile_git.bb
```

.bbappend can contain a pointer to LTSI off-tree patch
Edit recipe to merge LTSI-patchwork off-tree patch

diff --git a/recipes-kernel/linux/linux-yocto_3.4.bbappend b/recipes-kernel/linux/linux-yocto_3.4.bbappend
index 819c65a..0b89004 100644
--- a/recipes-kernel/linux/linux-yocto_3.4.bbappend
+++ b/recipes-kernel/linux/linux-yocto_3.4.bbappend
@@ -19,7 +19,10 @@ SRC_URI_append_armadillo800eva = ``
   file://missing_required.cfg 
   file://required_redefinition.txt 
   file://specified_non_hdw.cfg 
+ https://patchwork.kernel.org/patch/1132821/mbox/;
name=patch1;
downloadfilename=patch-1132821.patch;
apply=yes;
striplevel=1 \n''
+SRC_URI[patch1.md5sum] = ``c5e868f90629a56964c2c6ee731ba1cf''
+SRC_URI[patch1.sha256sum] = ``ea5f81ba7b91c0a1086f7c58f92a9818bae46615c5826aacba842c2aac5222''

COMPATIBLE_MACHINE_armadillo800eva=``armadillo800eva''
KBRANCH_DEFAULT_armadillo800eva = ``armadillo800eva''

download off-tree patch from patchwork site and apply
Description of patchwork integration recipe

- Define patchwork URI

- You need to define target patch name and assign new name for it, as default download file name is shown as index.html

- You need to calculate SUM after file download (md5 and sha256)
Why you should choose LTS & LTSI kernel?
LTSI-3.4 release notes
How can you improve productivity with LTSI?
Conclusion and future action

Adoption of LTSI
LTSI cooking
Code contribution

Merge your code into LTSI via upstream (ideal case)

- write your code
- submit to the current upstream
- backport to next LTSI
- part of next LTSI
- backport to current LTSI staging-tree
- write yocto recipe to integrate off-tree patch

Try upstream first, then backport to LTSI kernel
Upstreaming attempt through LTSI project

1. Write your code
2. Submit and review at LTSI project
3. Forward port to current developing upstream kernel
4. Part of LTSI release
5. Upstream kernel

**LTSI project can help shaping your code for upstream**
Conclusion and future action
If you have a chance to select Linux kernel version, you should choose LTS/LTSI kernel. Because it can reduce your own work to apply security and serious bug-fix patch for maintenance.

LTSI-3.4 is released now, and it includes various attractive 
1) newly mainlined feature from up to 3.7 release, 
2) newly developed function for embedded use of Linux, 
3) new platform/device support on stable kernel. You can download LTSI-3.4 kernel from Linux Foundation project web.

If you want to modify LTSI kernel to fit your product demand, you can cook LTSI kernel by yourself and utilize Yocto recipe to integrate your own enhancement with regular LTSI release. You can find off-tree LTSI patch from patchwork web and Yocto recipe can grab them automatically via http connection.
Call for action for **LTSI-3.4 (now) & LTSI-next**

### For SoC vendor, CPU core provider
- Send your not-yet-mainlined (AKA vendor tree) code to LTSI
- Test LTSI kernel on your environment and feedback test result

### For product producer
- Adopt LTSI kernel with Yocto to reduce your development cost
- Eliminate in-house patch, if any. LTSI patchwork may help.

### For software distributor, integrator
- Adopt and support LTSI + Yocto as your BSP foundation.
- Send us your feedback to improve LTSI and future upstream
### Need rule for after release patch adoption criteria

<table>
<thead>
<tr>
<th>Always acceptable patch</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Bug-fix patch for LTSI extended code</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Case by case adoption patch</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Add new platform support (self contain stuff only)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Following patches may not be accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>- New feature backport form new version kernel</td>
</tr>
<tr>
<td>- Your own enhancement or local fix</td>
</tr>
<tr>
<td>- Out of upstreaming target code</td>
</tr>
</tbody>
</table>
### LTSI workshop meeting meeting inviting LTSI maintainer

- **Feb 21 15:00 - 17:00 @Hearst room, on the 4th floor of the Park55 Hotel**
- Open to public, anyone can attend this workshop

#### Brief Updates of LTSI
- Updates from a partner project: Yocto
- Discussion on after release patch acceptance policy
- Discussion on Super Long Term Support (over 2 years support)
- Discussion on the next LTSI release
LTSI project wants to recruit volunteers who will try to integrate LTSI-3.4 kernel with various existing Linux distribution. Please bring your proposal to LTSI showcase today, and we will select up to 20 developers and give them Raspberry Pi (or similar) board.

**Expected porting target**
- Android, CyanogenMOD, Firefox OS, Gentoo, OpenWRT
- XBMC, Debian, Ubuntu, Fedora, OpenSUSE for ARM, etc

**Please apply your proposal with following idea**
- Target OS (name, version,..)
- Reporting method (code submission, report posting,..)
- Schedule