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Leading Innovation

Using RT Preempt patch with LTSI kernel

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Who am I?

- **Yoshitake Kobayashi (YOSHI)**
  - Chief Specialist at
    Corporate Software Engineering Center,
    TOSHIBA CORPORATION

- Work on embedded operating systems
  - Linux
  - RTOS
    - TOPPERS (uITRON), VxWorks
  - Open source software license

Focus of talk

- **How to use RT patch with LTSI kernel**
  - Source code is available at the following URL:
    https://github.com/ystk/linux-ltsi

- **Expected experience level: Beginner**

Overview

- **Recipe**
- **Four steps to make LTSI-RT**
  - Step 1: Basic steps to use LTSI kernel patch
  - Step 2: Merge RT patch with LTSI kernel
  - Step 3: Resolve conflicts
  - Step 4: Test
- **Conclusion**

Recipe

- **Ingredients**
  - Stable kernel
    - http://git.kernel.org/?p=linux/kernel/git/stable/linux-stable.git
  - LTSI kernel
    - http://ltsi.linuxfoundation.org/
  - RT Preempt patch
    - http://git.kernel.org/?p=linux/kernel/git/rt/linux-stable-rt.git
    - https://www.kernel.org/pub/linux/kernel/projects/rt/

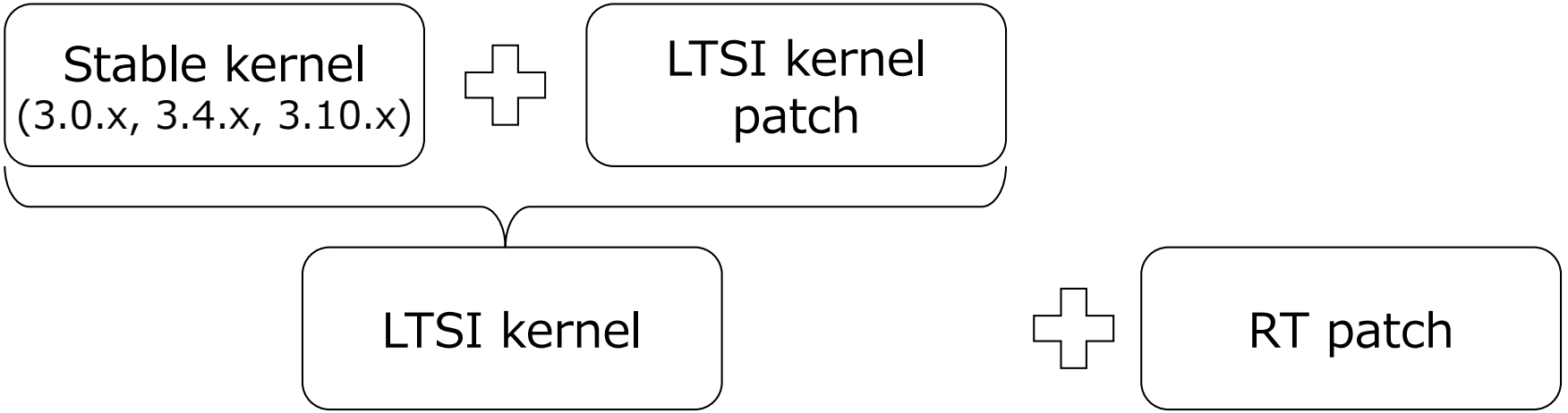
- **Commands**
  - Git
  - grep
  - Text editors
  - Merge tools

References for Real-time patch

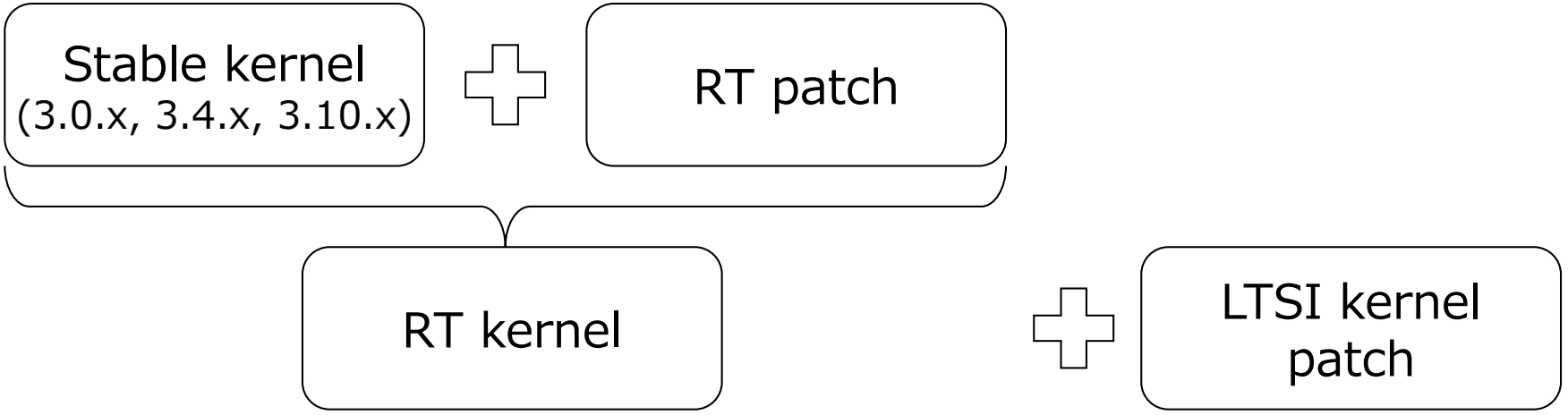
- **A realtime preemption overview**
  - http://lwn.net/Articles/146861/
- **Presentation materials**
  - Frank Rowand
    - Real-Time Failure
      - http://elinux.org/images/b/be/Real_time_linux_failure.pdf
    - Status of Linux 3.x Real Time and Changes From 2.6
      - http://elinux.org/images/5/54/Status_of_real_time.pdf
  - Steven Rostedt
    - Inside The RT Patch
      - http://elinux.org/images/b/ba/Elc2013_Rostedt.pdf

Scenarios to create LTSI-RT

- **Scenario 1**

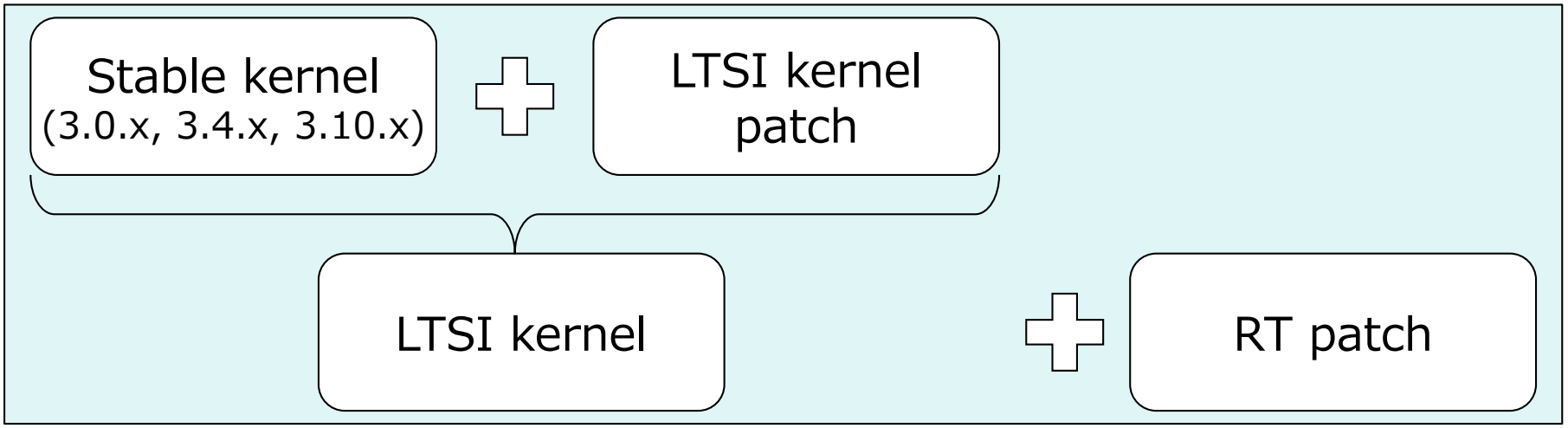


- **Scenario 2**

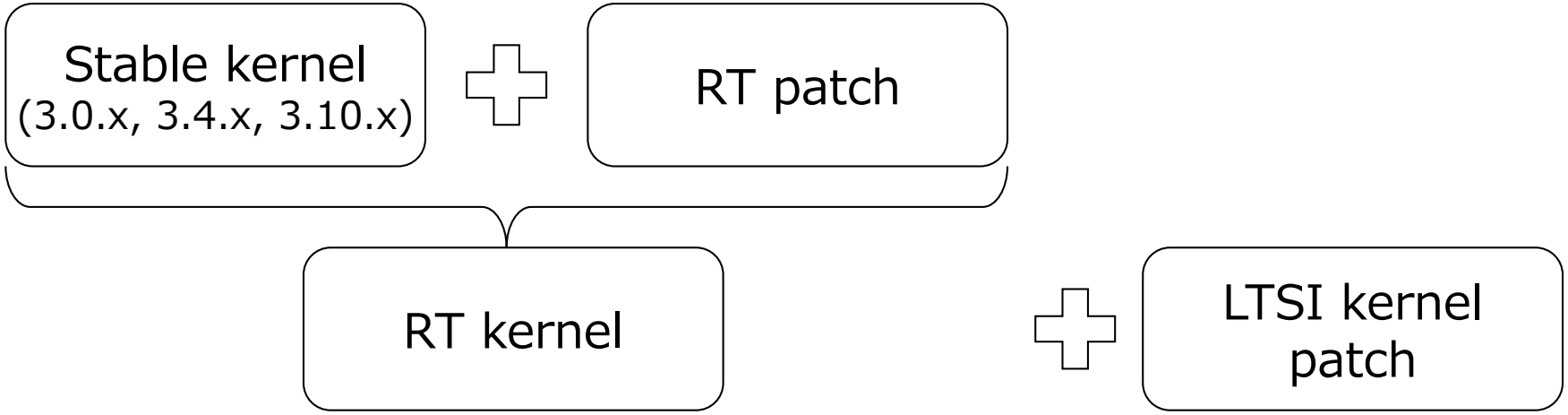


Scenario

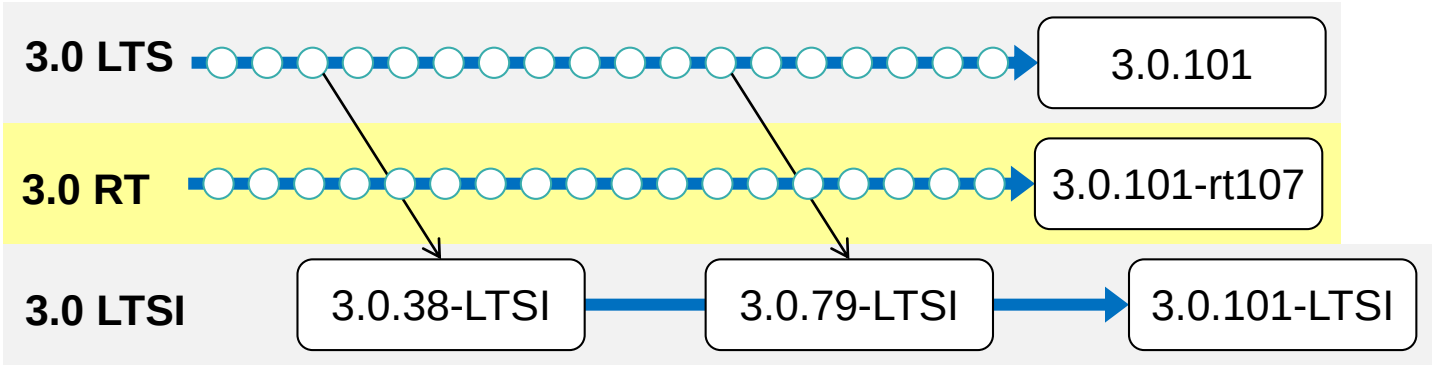
Scenario 1

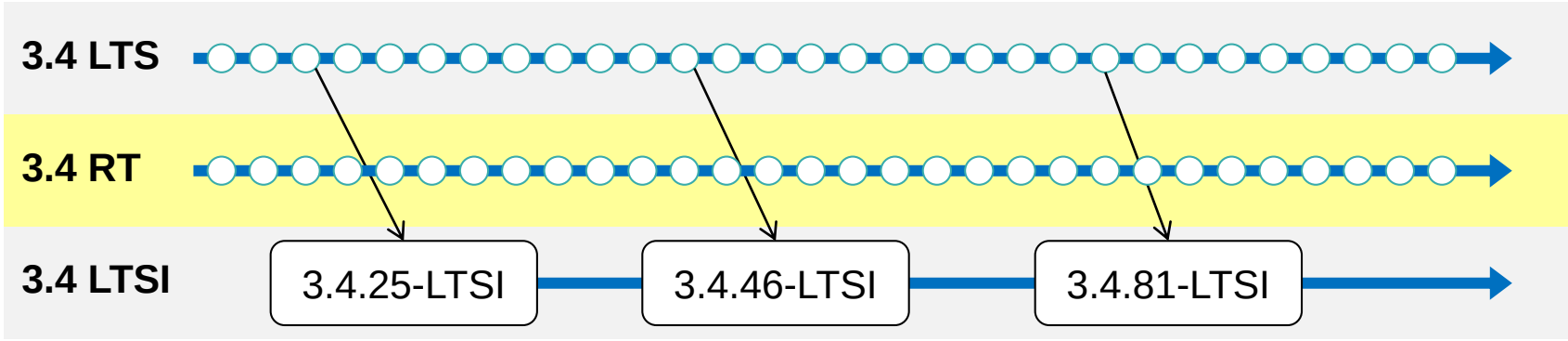


Scenario 2

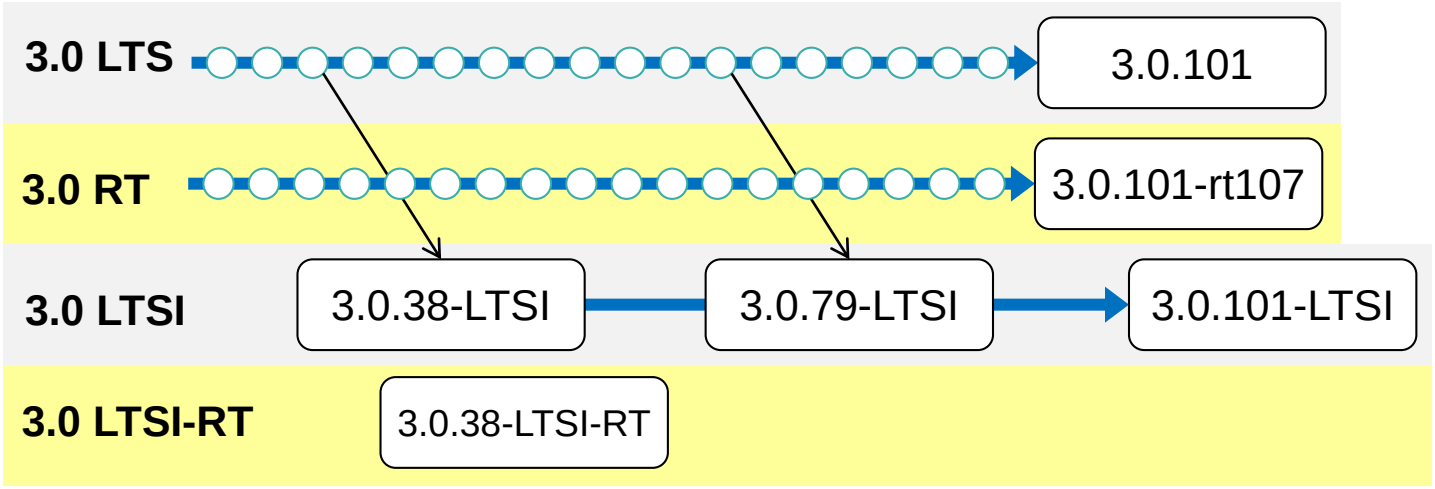


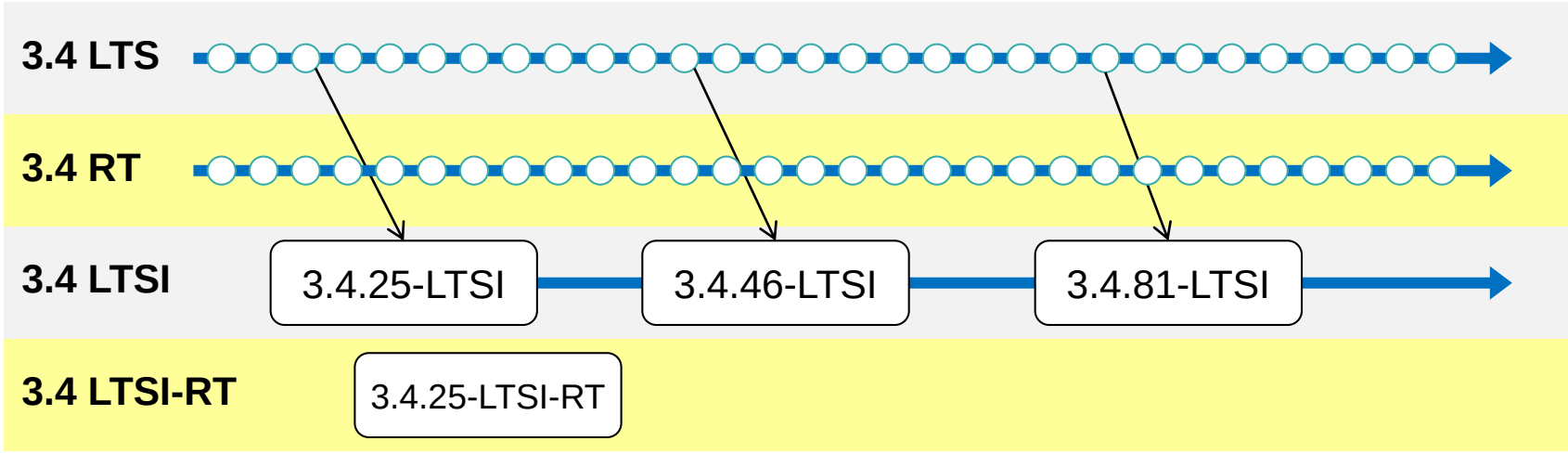
LTSI development cadence



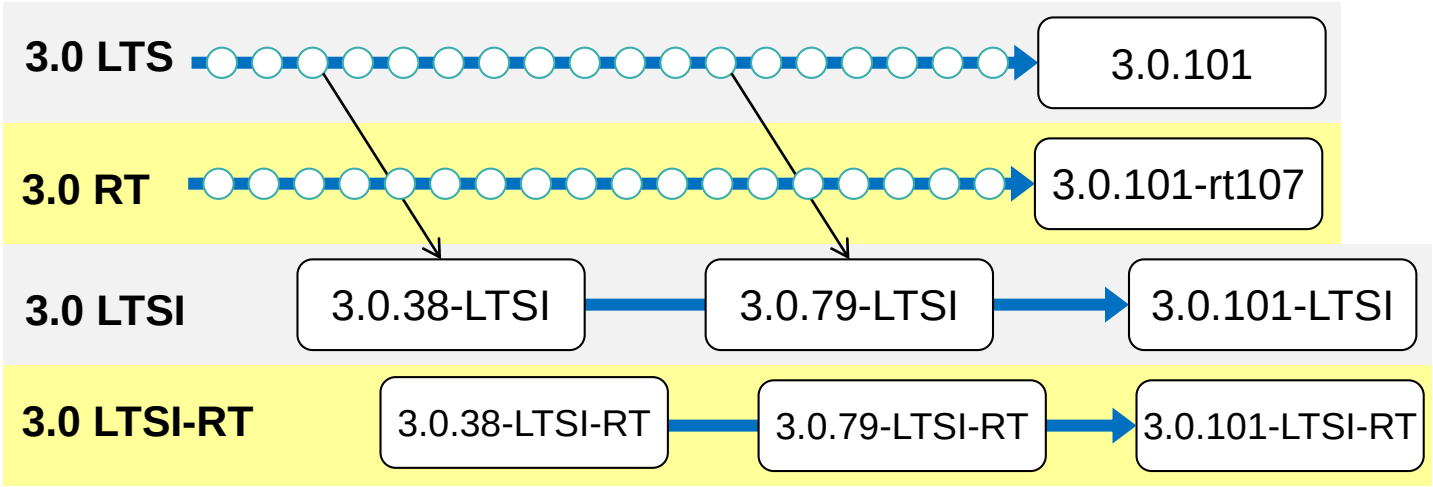


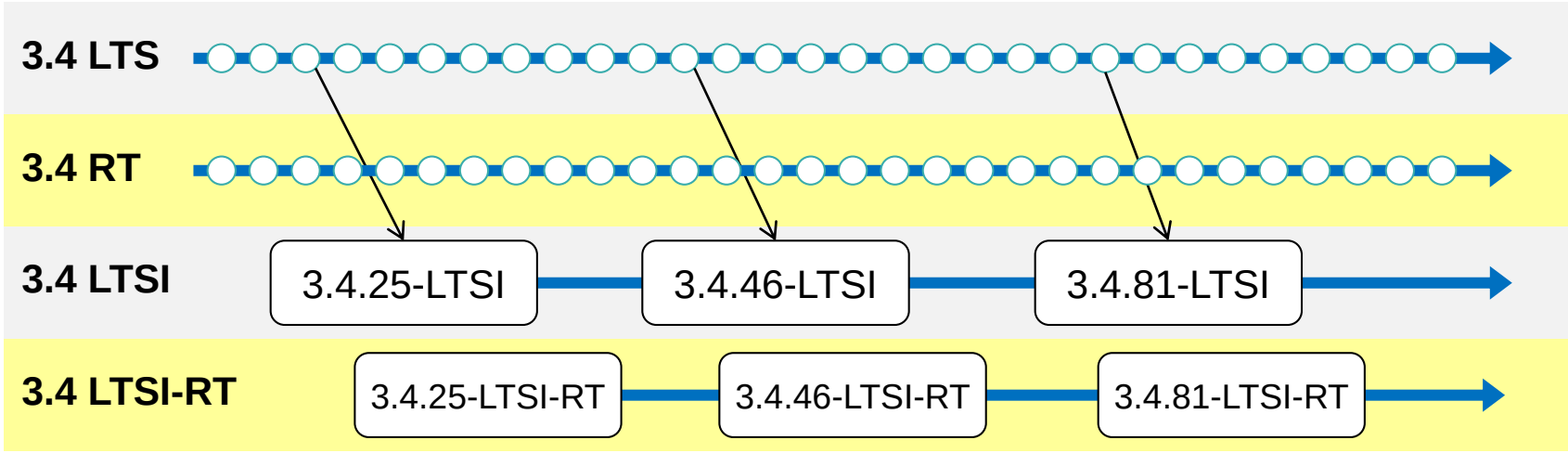
LTSI development cadence



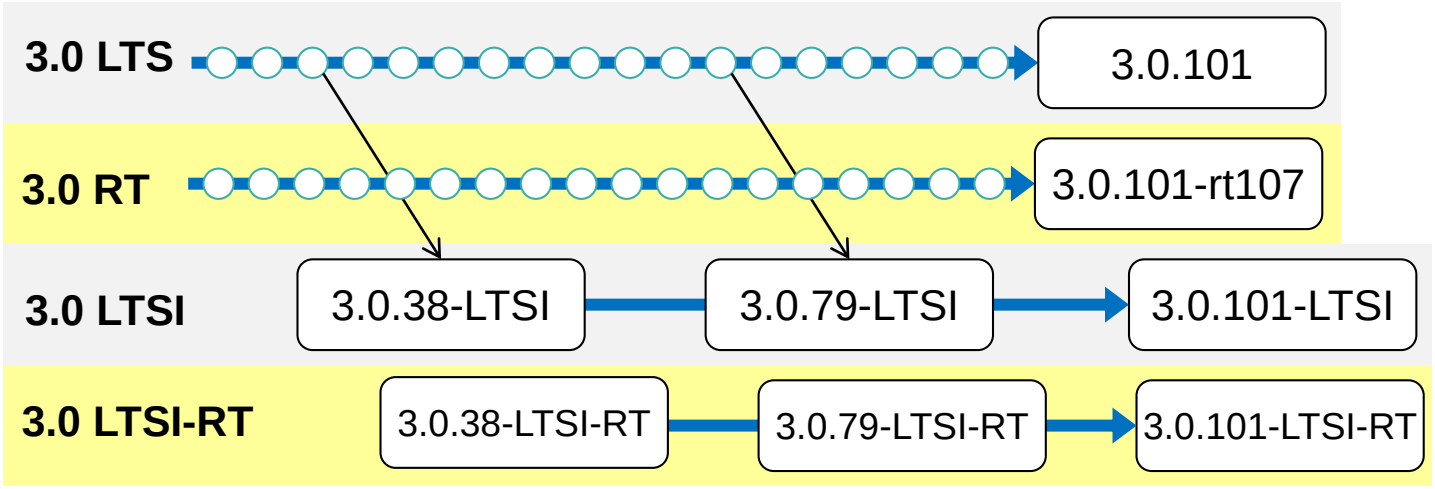


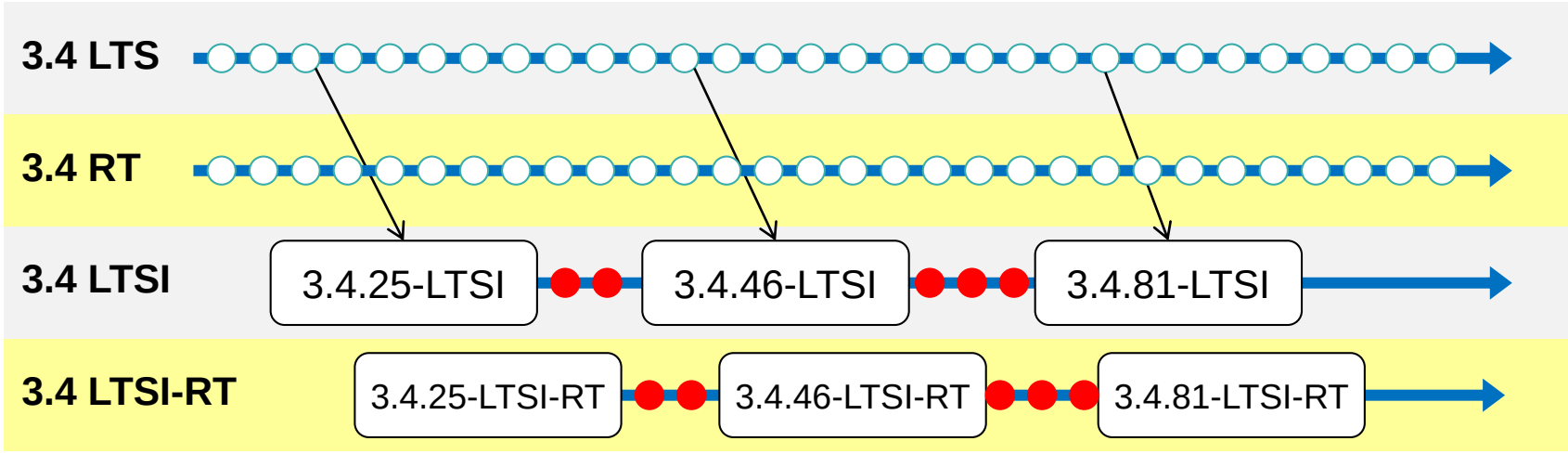
LTSI development cadence



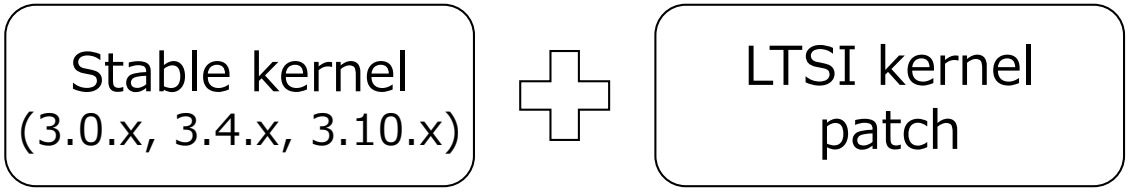


LTSI development cadence





Step 1: Basic steps to use LTSI patch



- **An example to prepare LTSI kernel**

1. Prepare a stable kernel source tree

```
$ git clone git://git.kernel.org/pub/scm/linux/kernel/git/stable/linux-stable.git
$ cd linux-stable/
$ git checkout v3.4.46 -b v3.4.46-ltsi-tmp
```

2. Prepare a LTSI patch tree

```
$ git clone http://git.linuxfoundation.org/ltsi-kernel.git
$ cd ltsi-kernel/
$ git checkout -b v3.4.46-ltsi-tmp v3.4.46-ltsi
```

3. Apply LTSI patch to stable kernel

```
$ export QUILT_PATCHES=../ltsi-kernel
$ git quiltimport
$ git tag v3.4.46-ltsi
```

Step 2: Basic steps to use RT patch

- **Merge RT patch with LTSI kernel**

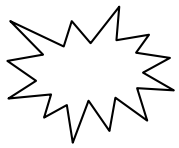
1. Add stable-rt for reference

```
$ git remote add stable-rt git://git.kernel.org/pub/scm/linux/kernel/git/rt/linux-stable-rt.git
$ git remote update
```

2. Merge RT tree and LTSI kernel tree

```
$ git merge v3.4.46-rt61
```

…… (CONFLICTS) ……



Step 3: Resolve conflicts

- **Modification policy**
  - Bug fixes need to be merged
  - API changes might be resolved
  - When a part of LTSI patch modifies core kernel function
    - Try to fix
    - Simply ignore a patch

Conflicts to make v3.4.46-ltsi-rt

```
$ git merge v3.4.46-rt61
CONFLICT (content): Merge conflict in drivers/net/ethernet/cadence/at91_ether.c
CONFLICT (content): Merge conflict in mm/page_alloc.c
```

- **Which patch was made changes on conflicted code?**
  - RT?
  - LTSI?

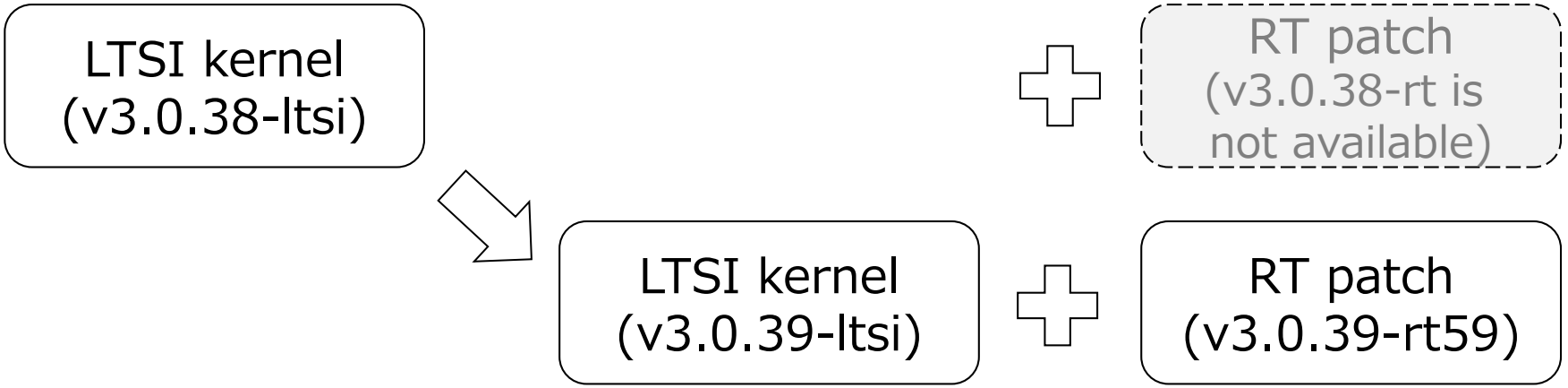
```
$ lv drivers/net/ethernet/cadence/at91_ether.c
$ grep –r drivers/net/ethernet/cadence/at91_ether.c ../ltsi-kernel
$ grep drivers/net/ethernet/cadence/at91_ether.c  patch-3.4.46-rt61.patch

$ lv mm/page_alloc.c
$ grep –r mm/page_alloc.c ../ltsi-kernel
$ grep mm/page_alloc.c patch-3.4.46-rt61.patch
```

Make v3.0.y-ltsi-rt

1. Prepare the v3.0.38 kernel source tree and LTSI tree

```
$ cd linux-stable/
$ git checkout v3.0.38 –b v3.0.38-ltsi-tmp
$ cd ltsi-kernel/
$ git checkout –b v3.0.38-ltsi-tmp v3.0.38-ltsi
$ cd ../linux-stable/
$ git quiltimport
```

2. Find a relative RT tree
3. Marge v3.0.39's changes with v3.0.38-ltsi
4. Merge RT path with v3.0.39-ltsi



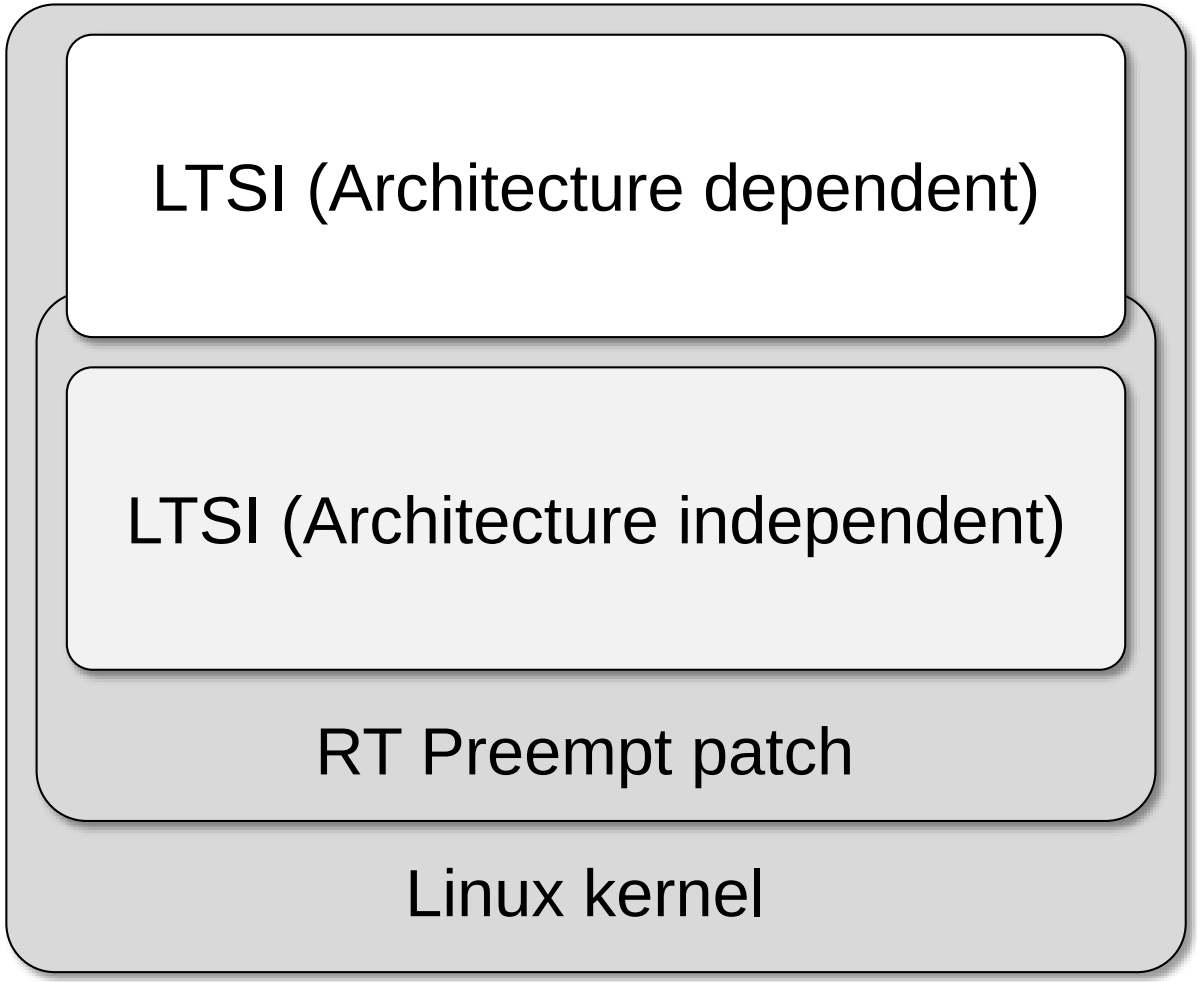
Conflicts for v3.0.39-ltsi-rt development

```
$ git merge v3.0.39-rt59
Renaming drivers/tty/serial/8250.c => drivers/tty/serial/8250/8250.c
CONFLICT (rename/modify): Merge conflict in drivers/tty/serial/8250/8250.c
CONFLICT (content): Merge conflict in arch/arm/common/gic.c
CONFLICT (content): Merge conflict in arch/arm/common/gic.c
CONFLICT (content): Merge conflict in arch/x86/kernel/process_32.c
CONFLICT (content): Merge conflict in include/linux/irq.h
CONFLICT (content): Merge conflict in include/linux/plist.h
CONFLICT (content): Merge conflict in include/linux/rtmutex.h
CONFLICT (content): Merge conflict in kernel/Makefile
CONFLICT (content): Merge conflict in kernel/irq/settings.h
CONFLICT (content): Merge conflict in kernel/rtmutex.c
CONFLICT (content): Merge conflict in mm/page_alloc.c
```

- **Current solution**
  - Simply ignore patches which are related to PLIST

Step 3: Still missing an important thing

- **This modification covers the following grey areas**



Step 4: Test

- **Compilation test**
  - allconfig
  - allmodconfig
  - Customized configuration

- **Kernel configuration file preparation**
  - Configuration
    - ON: CONFIG_PREEMPT_RT_FULL , High resolution timer
    - OFF: Power management, Debug
  - Tutorials
    - https://rt.wiki.kernel.org/index.php/RT_PREEMPT_HOWTO

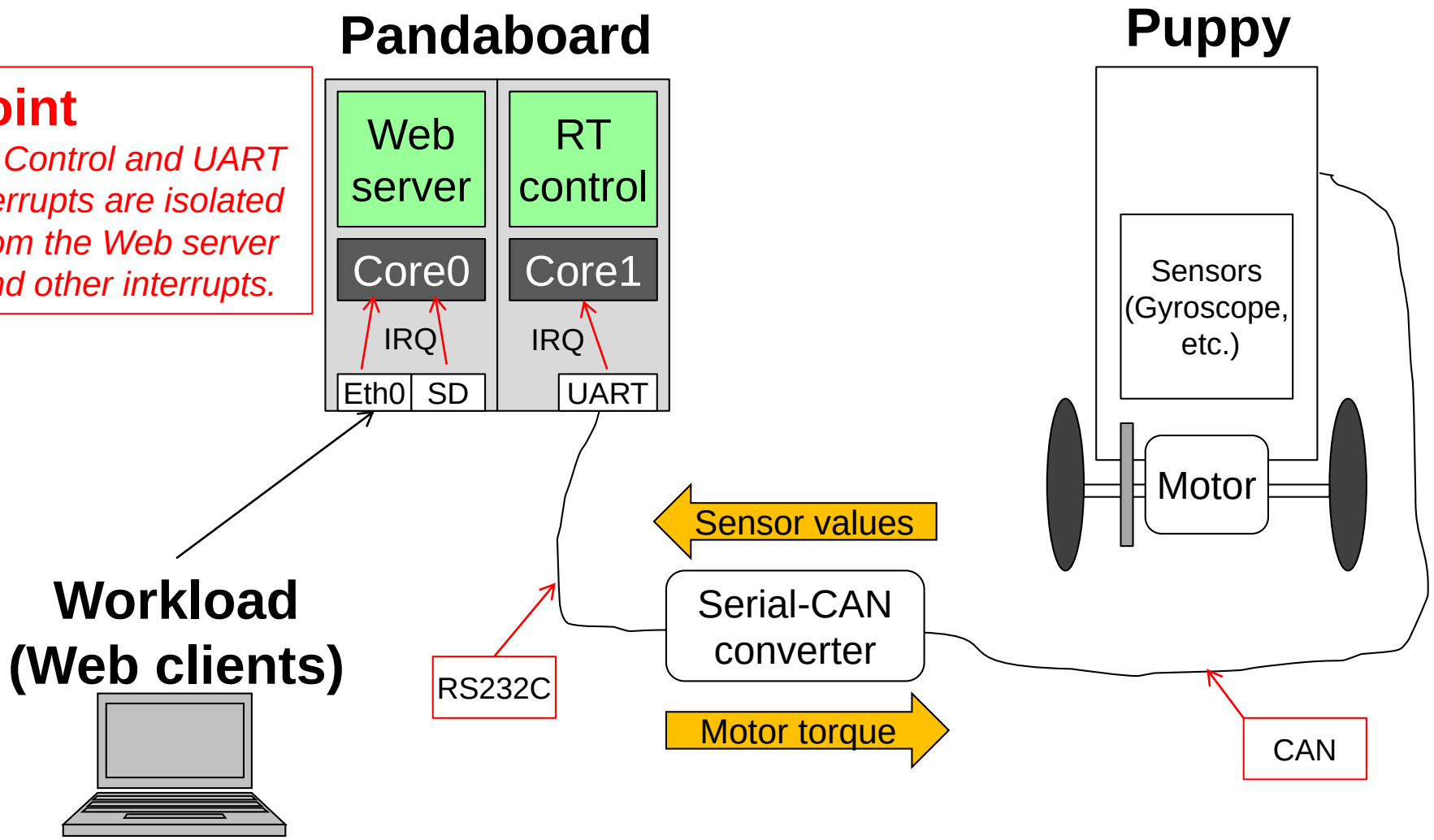
Step 4: Test

- **LTP**
  - Compare results between original RT kernel and LTSI-RT
- **Performance test**
  - Latency
    - Cyclictest
  - Network
    - Netperf
  - I/O
    - dd
- **Stress test**
  - CPU stress
  - Data reliability
  - Power ON/OFF
- **Customized test**
  - Hardware resource isolation

An example for isolation demo

Point

RT Control and UART interrupts are isolated from the Web server and other interrupts.



Reference (original idea): https://www.toppers.jp/safeg.html

DEMO

When a system has some latency issue..

- **Find latency bottleneckes**
  - Profilers
  - Tracers
- **Fix it**

Conclusion

- **This presentation shows how to create LTSI-RT**
- **Source code is available at the following URL:**
  - https://github.com/ystk/linux-ltsi
- **LTSI-3.10-RT will be available soon**

Questions?

The latest slide is available at the following URL:
http://elinux.org/ELC_2014_Presentations