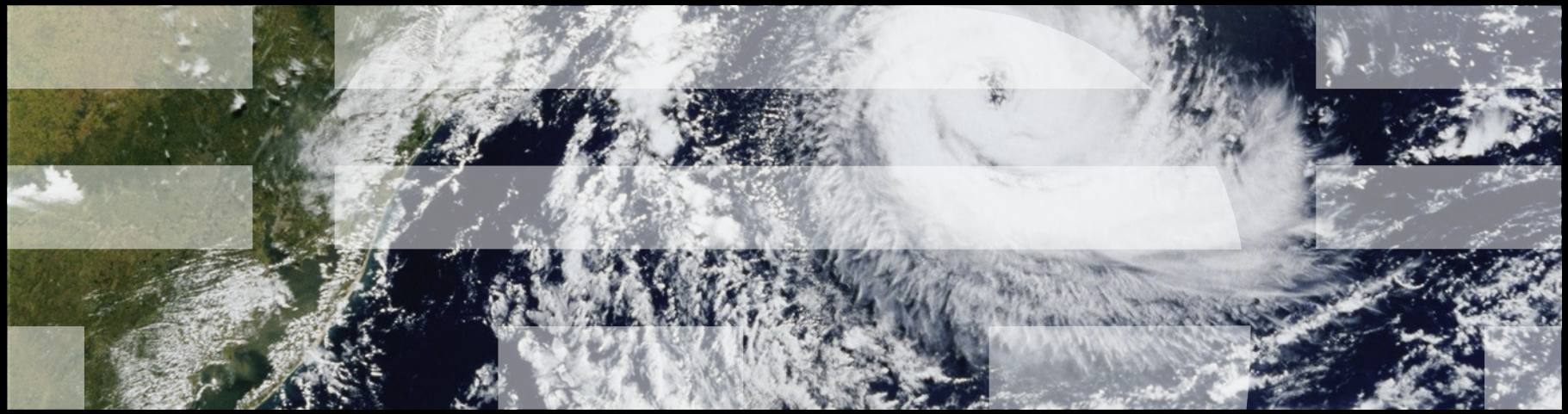
Paul E. McKenney – Distinguished Engineer, Linux Technology Center. Linaro Technical Steering Committee Member

27 Jan 2011

Whacking Droids: *

How to Extract Requirements from Flame Wars

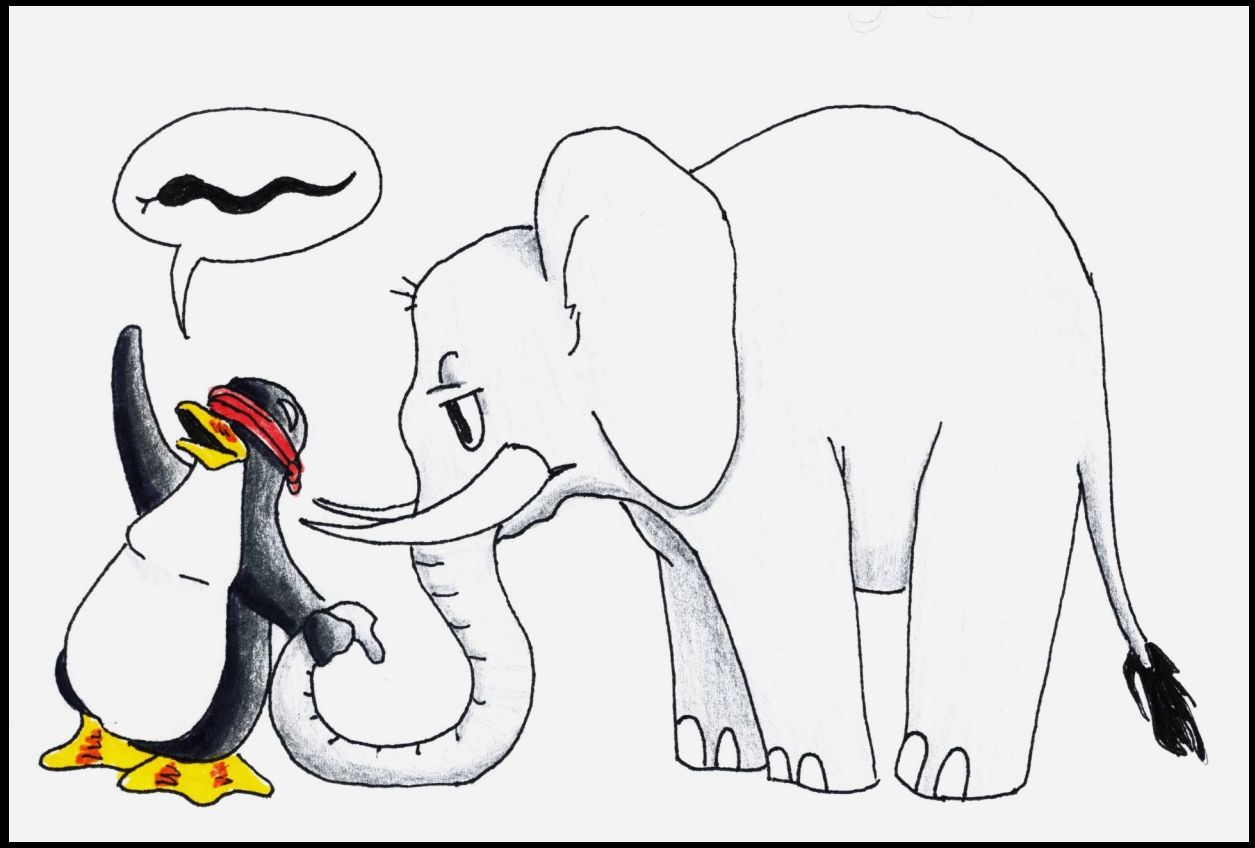


* With apologies to Jon Corbet.

Such A Small Thing To Cause So Much Trouble!!!

The Parable of the Six Blind Penguins and the Elephant

Proprietary Programming: Requirements

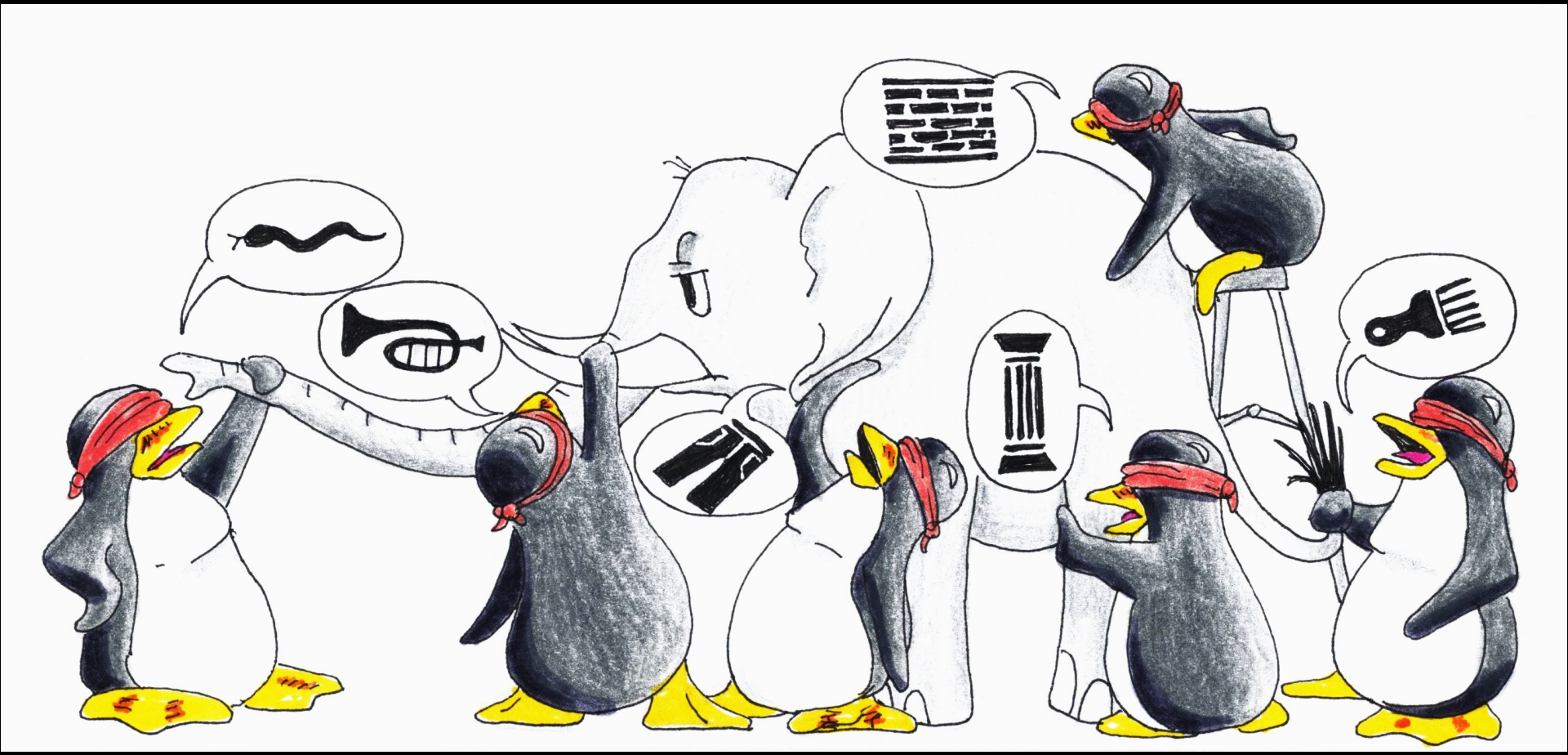


Proprietary Programming: “Solution”

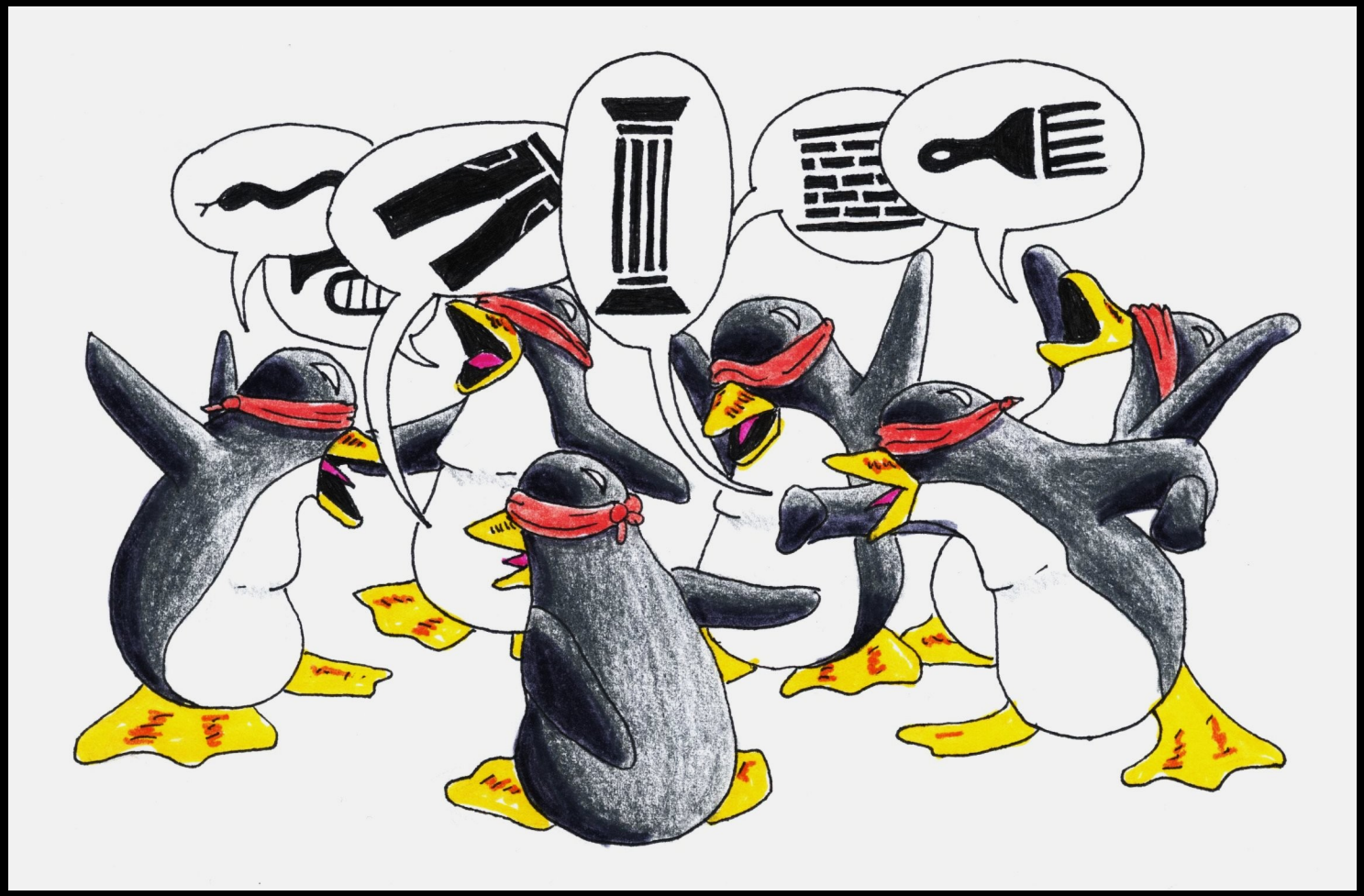
But sooner or later...

The Rest of the Elephant Will Make Itself Known...

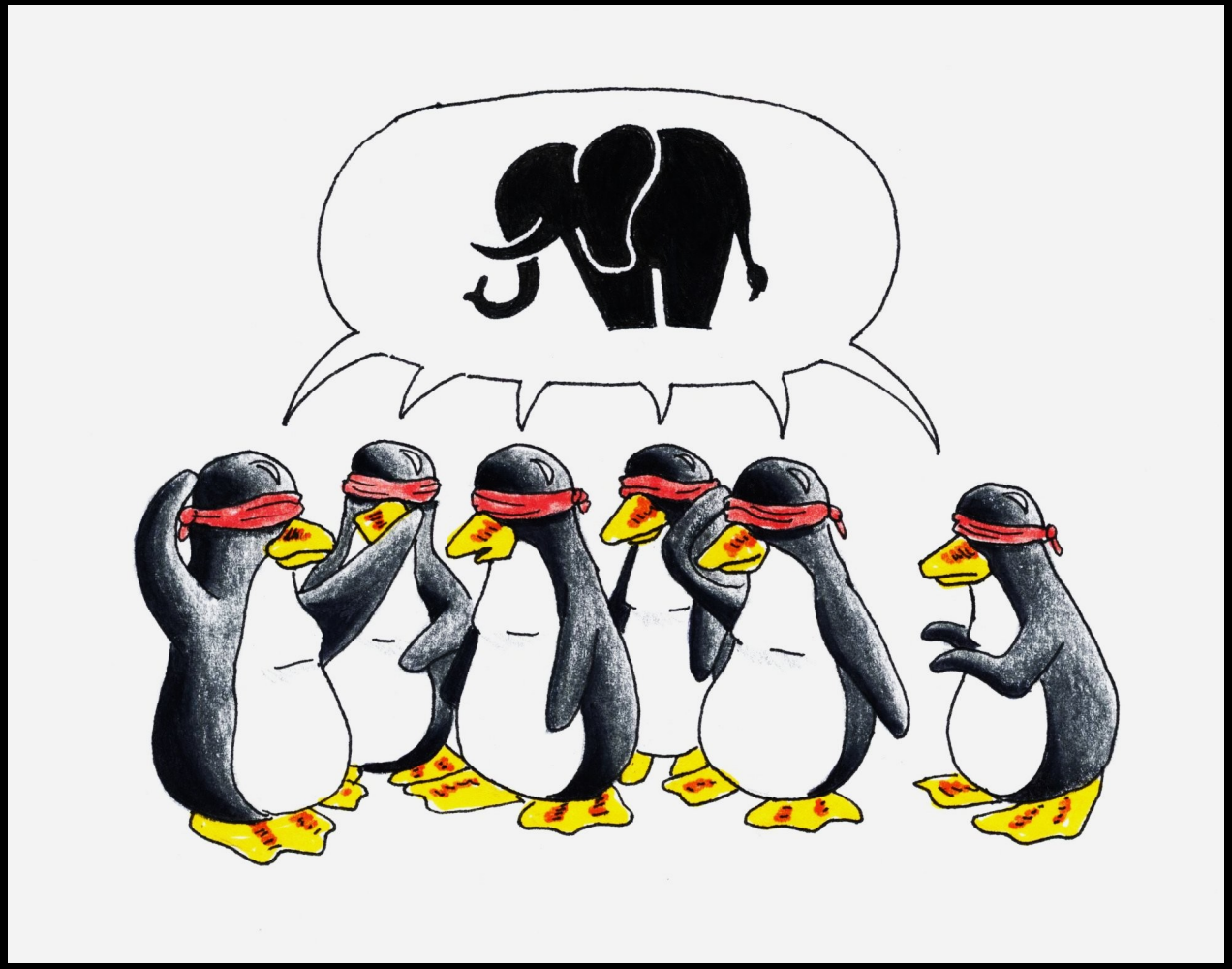
FOSS Programming: Requirements



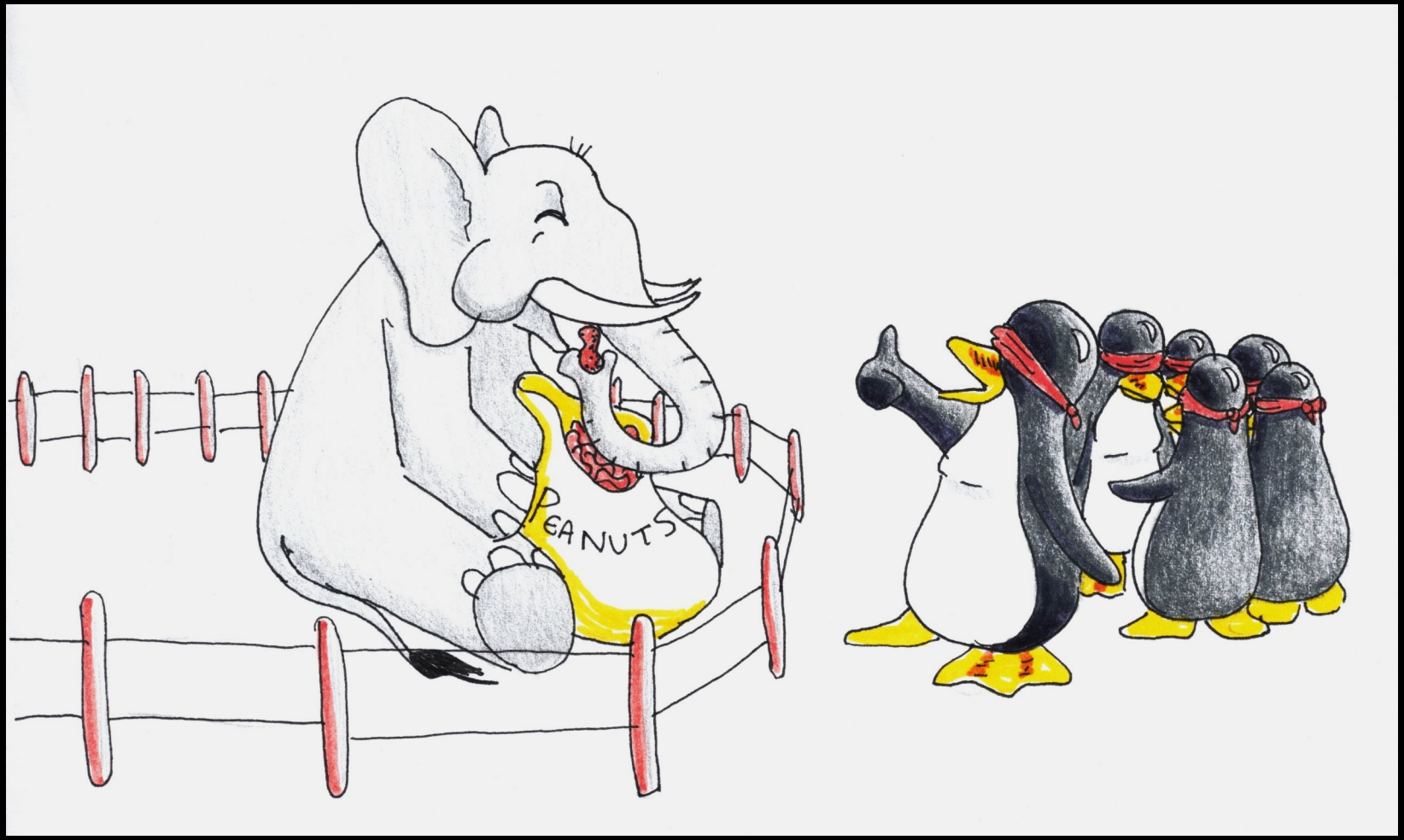
Just Another Day on LKML...



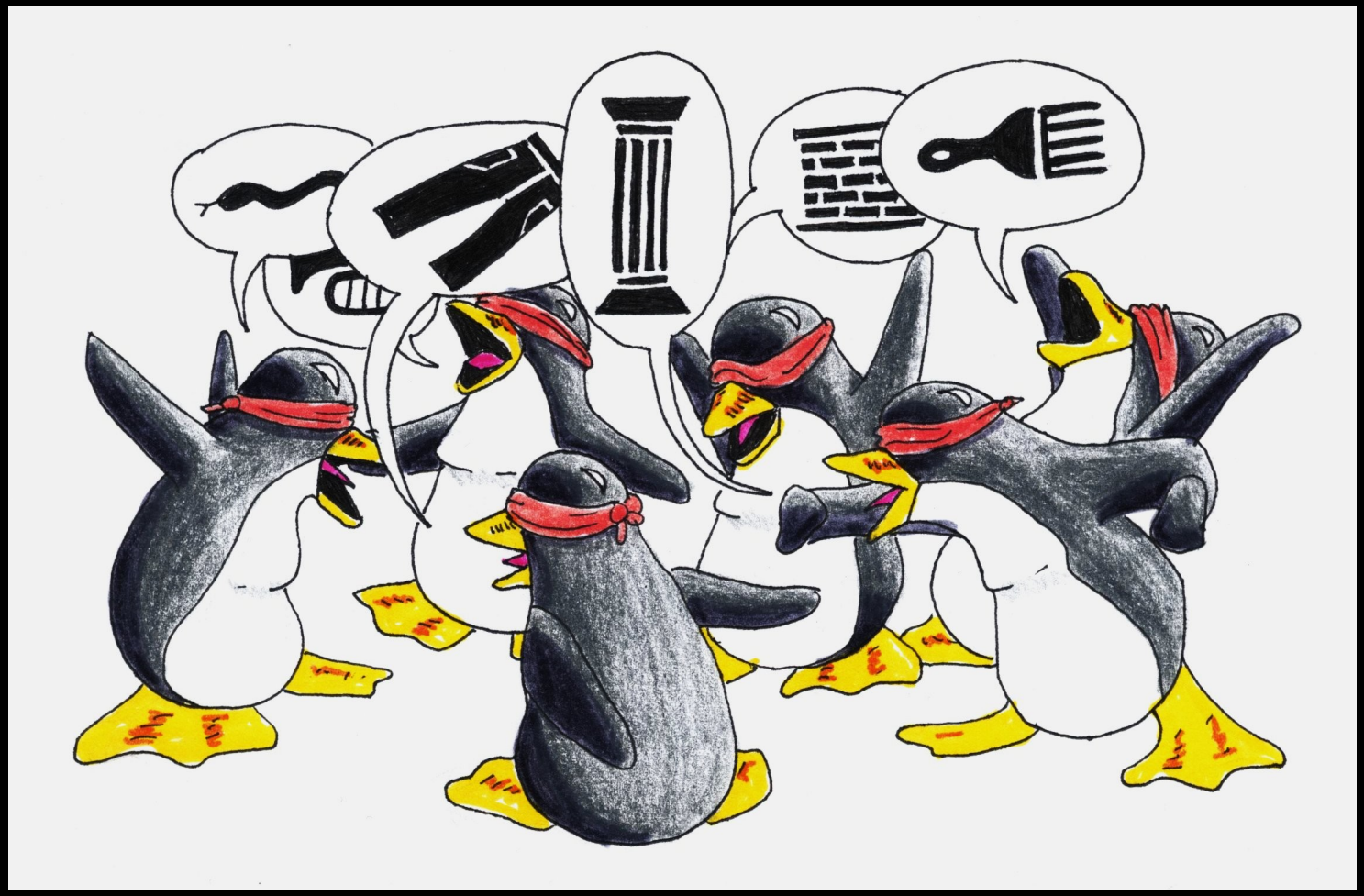
But Sometimes Consensus is Achieved



And an Appropriate Solution Produced Thereby



But Most of the Android Discussions Seem to Have Gotten Stuck Right Here:



And Hence This Talk!

Table of contents

A Question To Get Started:

Why Do People Flame?

Choose Your Flamewar

Flamewar Tradeoffs

- Shorter flamewars require more expertise on your part
  - The shorter the flamewar, the less time you have to study the topic
  - In contrast, you might calm a years-long flamewar simply by writing the combatants' positions in a neutral tone
  - The Android suspend-blocker flamewar was almost 2 years old
    - My several weeks of study were negligible by comparison
- The more people talk past each other, the more help needed
  - But don't expect them to welcome such help
  - Or to thank you for it

    “People really need help but may attack you if you do help them.”

    “Help people anyway.”
  - A thick skin: Don't leave home without it!

http://www.paradoxicalcommandments.com/

Know Your Goals

Why Would You Need A Goal Beyond Having Fun?

- If all you are doing is having fun, you will be just another flamer

Why Would You Need A Goal Beyond Having Fun?

- If all you are doing is having fun, you will be just another flamer
- Which might be OK, but not the topic for this talk

What Goals Might You Have?

- Learn more about the inflamed topic
- Understand the positions of the various flamers
- Present a neutral view of one of the positions
- Advocate for one of the positions
- Present a neutral view of all of the positions
- Present a neutral view of all of the positions along with a critique of each
- Propose a solution designed to meet all participants' needs

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Do Your Homework

Types Of Homework

- Review textbooks (if any)
- Read datasheets and relevant technical web sites
  - It is amazing how many flamewars are missing a few hard facts
  - And be aware of any axe-grinding that might be taking place
- Read the flamewar messages
  - You will need ~10x the writing time!
    - Extracting technical content from screaming and shouting is not always easy...
  - Keep track of unstated assumptions and consequences
  - Keep a written log of technical content, including URLs if possible
  - Avoid taking sides
    - This is harder than it looks

“Whacking Droids” Homework

- Review textbooks (if any)
  - I couldn't find any, but several of the Linaro folks gave me a tutorial
- Read datasheets and relevant technical web sites
  - The LWN writeups were extremely helpful (see next slide)
- Read the flamewar messages
  - Accumulated almost 1,600 lines of commentary
  - Not counting the actual requirements themselves

“Whacking Droids” Homework: LWN Articles &c

- Android Wakelock Java-Level Documentation
  - http://developer.android.com/reference/android/os/PowerManager.WakeLock.html
- Wakelocks and the embedded problem (LWN)
  - February 10, 2009: http://lwn.net/Articles/318611/
- From wakelocks to a real solution (LWN)
  - February 18, 2009: http://lwn.net/Articles/319860/
- Suspend block (LWN)
  - April 28, 2010: http://lwn.net/Articles/385103/
- Blocking suspend blockers (LWN)
  - May 18, 2010: http://lwn.net/Articles/388131/
- Suspend blocker suspense (LWN)
  - May 26, 2010: http://lwn.net/Articles/389407/
- What comes after suspend blockers (LWN)
  - June 1, 2010: http://lwn.net/Articles/390369/
- A suspend blockers post-mortem (LWN)
  - June 2, 2010: http://lwn.net/Articles/390392/

“Whacking Droids” Homework: Relevant Experience RCU and Energy Efficiency

- State in 2003: RCU wakes up each CPU at least once per grace period to check for quiescent states
- Wastes power, so dyntick-idle API was added
- This proved buggy (failed to spot RCU read-side critical sections in interrupts from dyntick idle)
  - Buggy, but extremely reliable...
  - No one noticed for 5 years...
- Reliable dyntick idle in preemptible RCU in 2007
  - Appeared in TREE_RCU in 2008
- At this point, RCU leaves sleeping CPUs lie

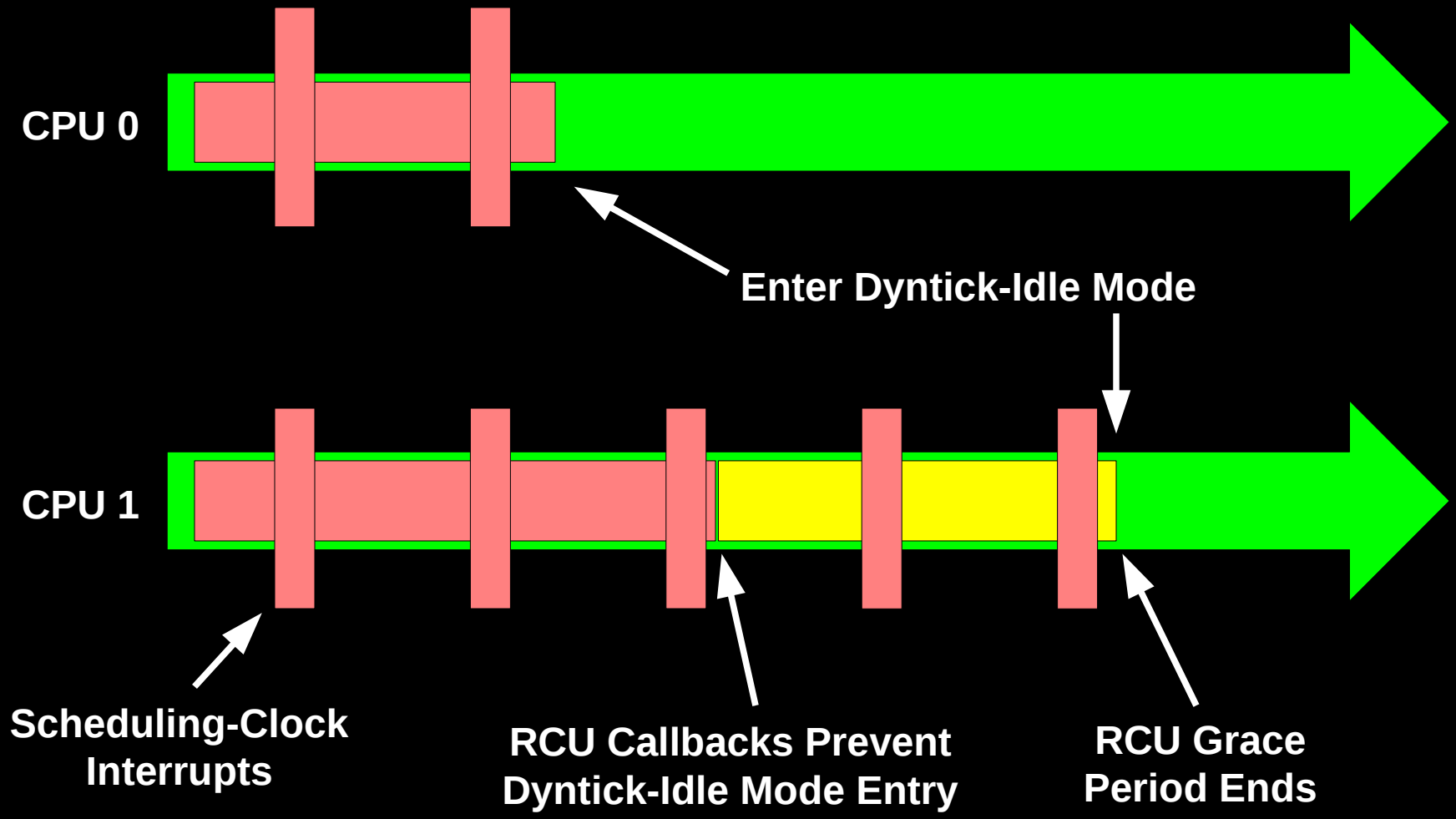
- So RCU is perfectly energy efficient, right?

"Whacking Droids" Homework: Relevant Experience RCU and Energy Efficiency

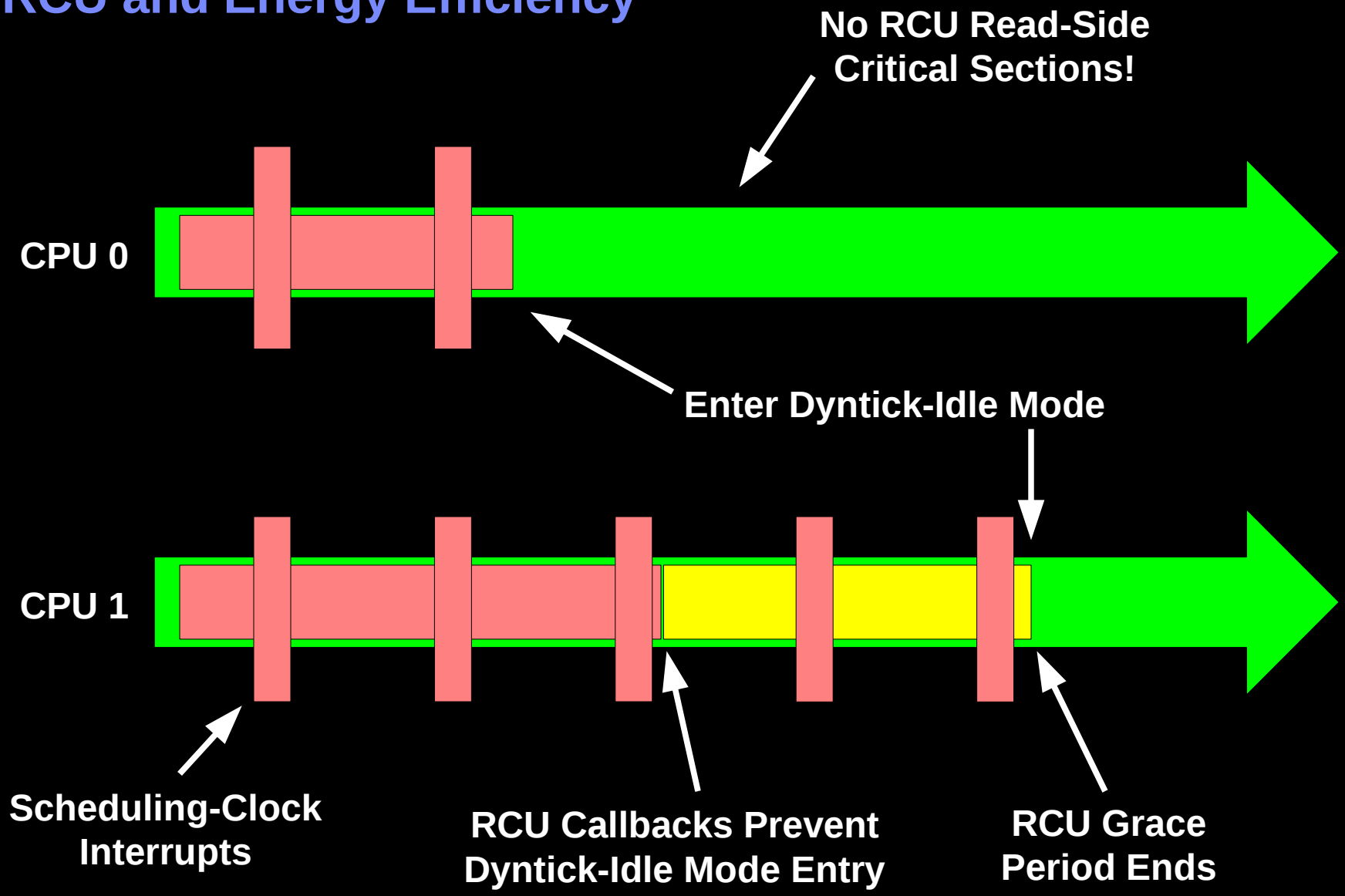
- Well, I thought that RCU was energy efficient
- Then I got a call from someone with a battery-powered multicore system
- And he was ***very*** upset with RCU

- Why?

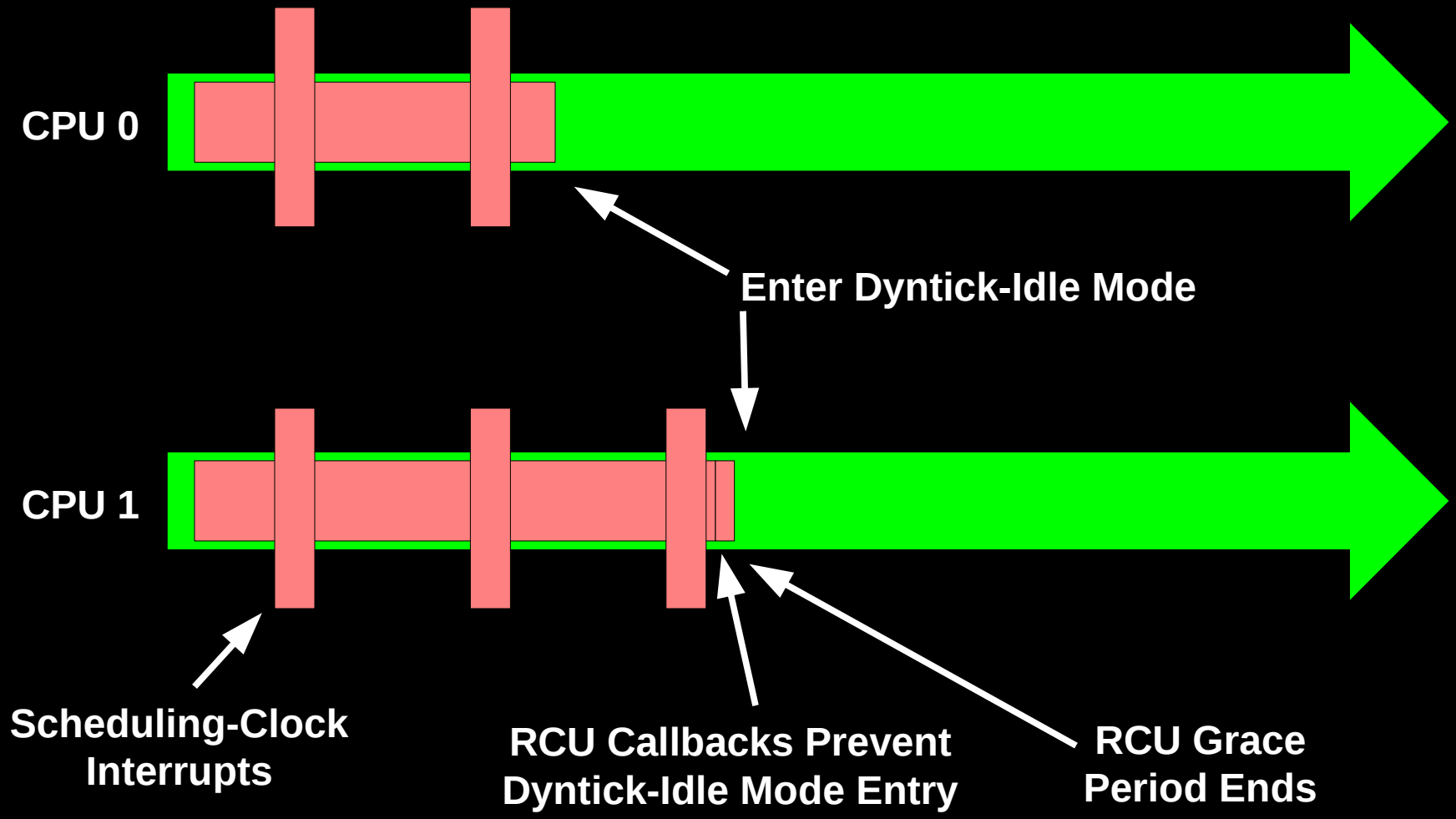
RCU and Energy Efficiency



RCU and Energy Efficiency



RCU and Energy Efficiency: Desired State: CONFIG_RCU_FAST_NO_HZ



RCU and Energy Efficiency: Servers vs. Embedded

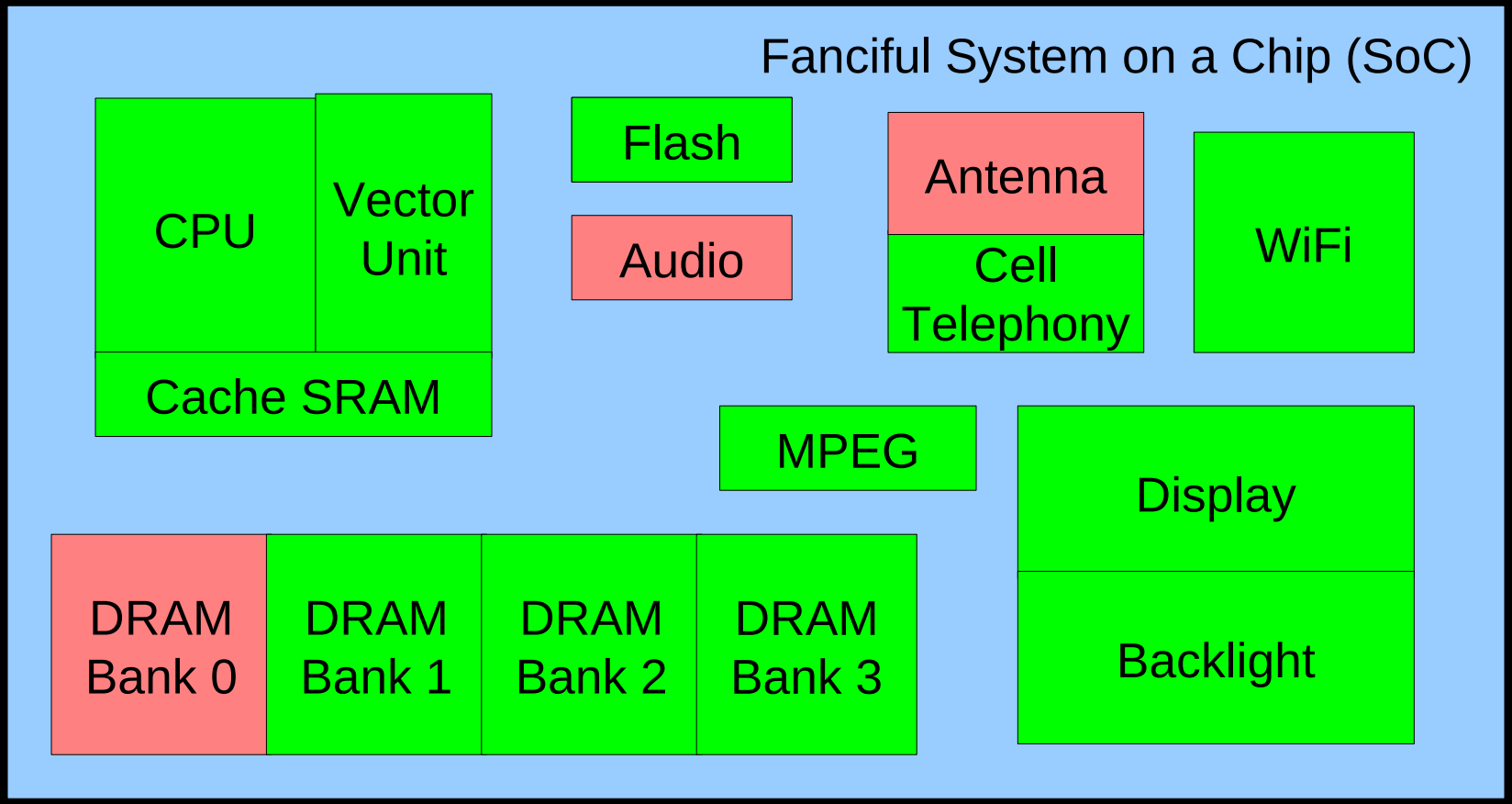
Servers might have energy efficiency as a hard requirement, but...

"Whacking Droids" Homework: Datasheets

- Server power consumption: 100 watts/socket
- Low-power server: 10 watts/socket
- Extreme low-power server: 2 watts/socket
- High-power embedded: 500 milliwatts
- Ditto in low-power mode: 20 milliwatts
- Battery-life power limit: 500 microwatts

How can this *possibly* work???

"Whacking Droids" Homework: Datasheets
Audio Playback Application

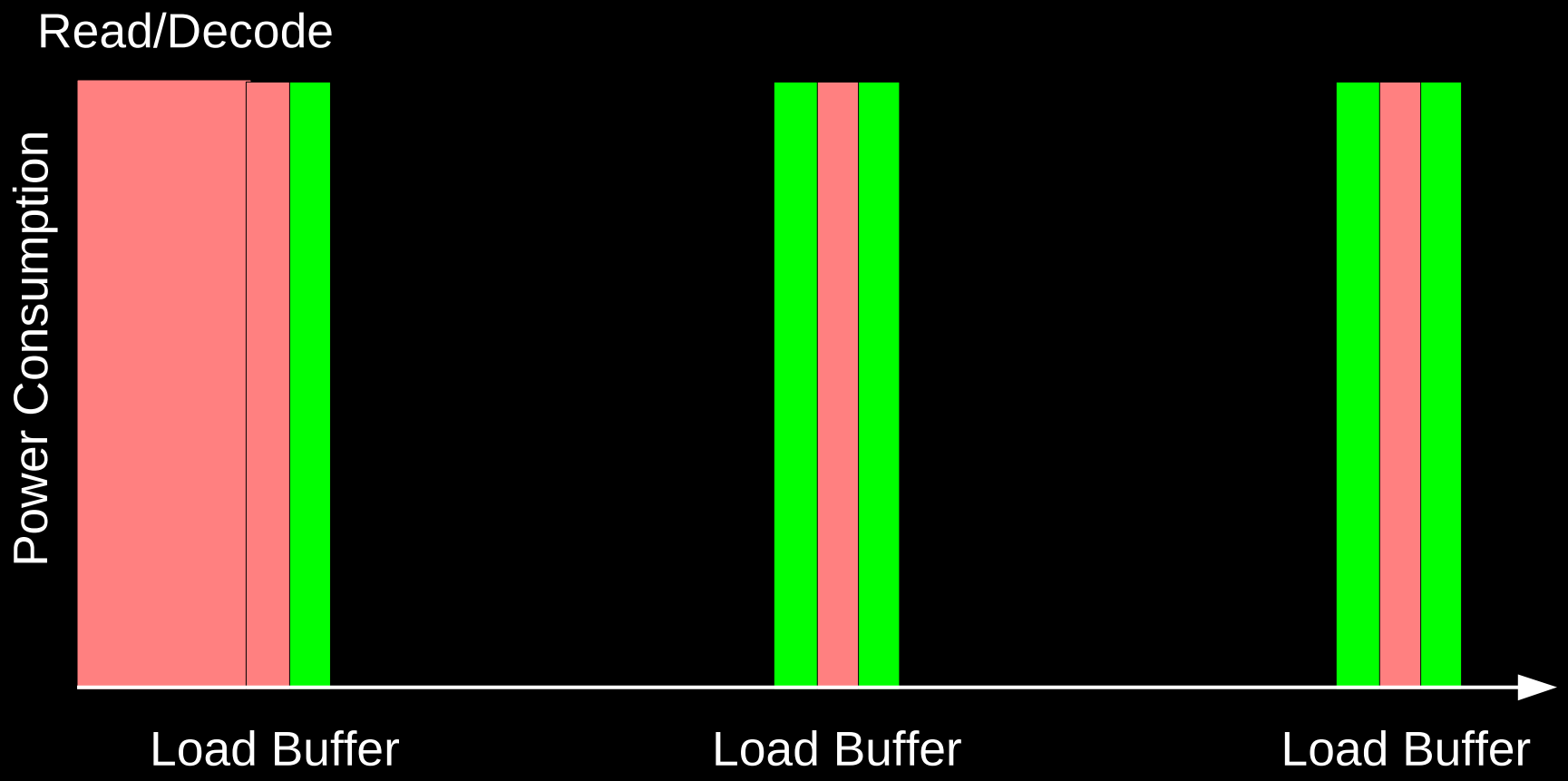


Much of the time, most of the chip powered down.
Must periodically power up CPU and flash to decode more sound.

“Whacking Droids” Homework: Datasheets
Data Flow For Audio Playback Application

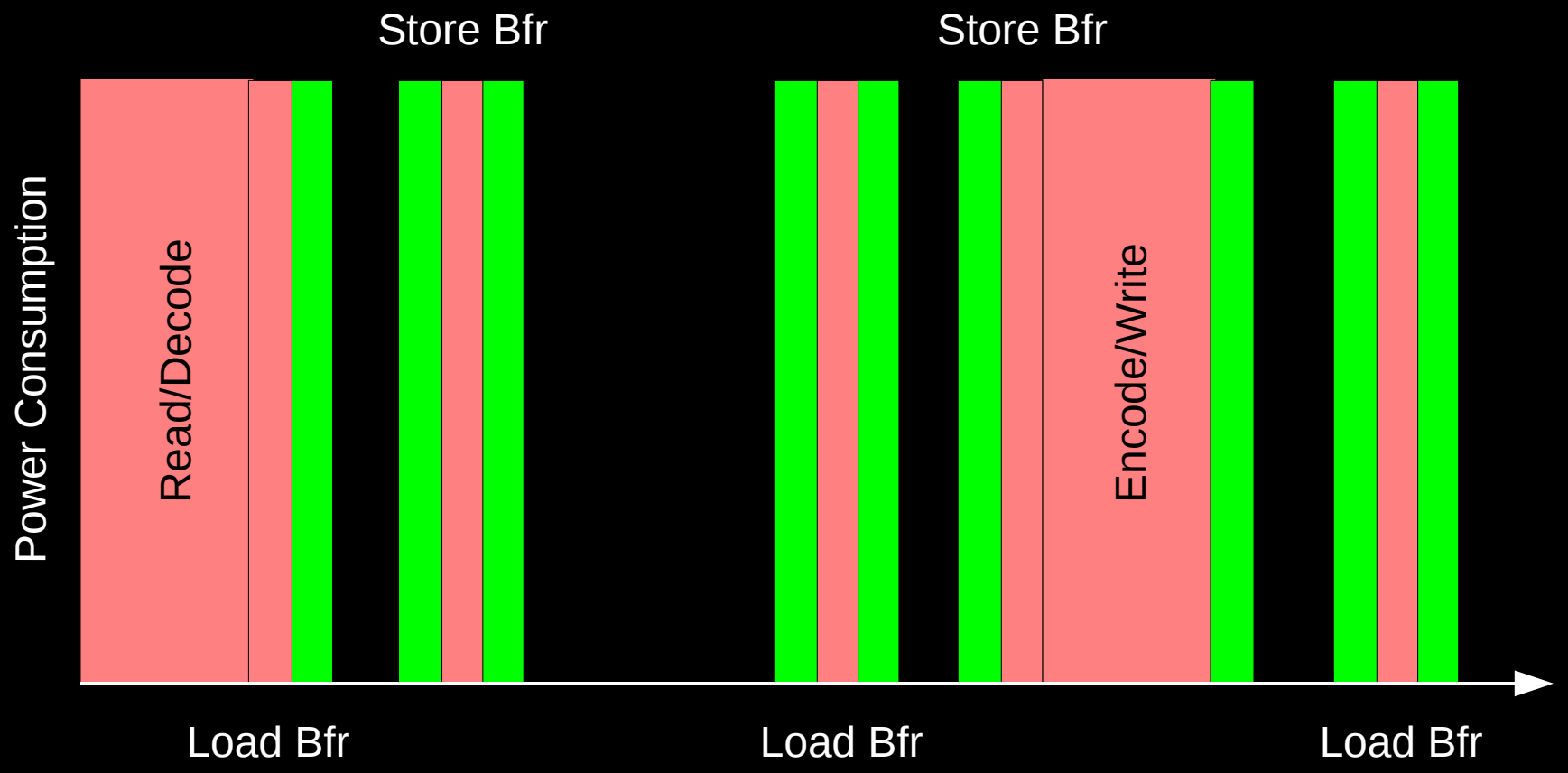
Audio output interrupts CPU when buffer nearly empty.
CPU decodes more MP3 from flash when DRAM nearly empty.
Given MP3 decode HW, CPU can remain powered off for *minutes.*

“Whacking Droids” Homework: Datasheets
Audio Playback Application: Power Consumption Profile



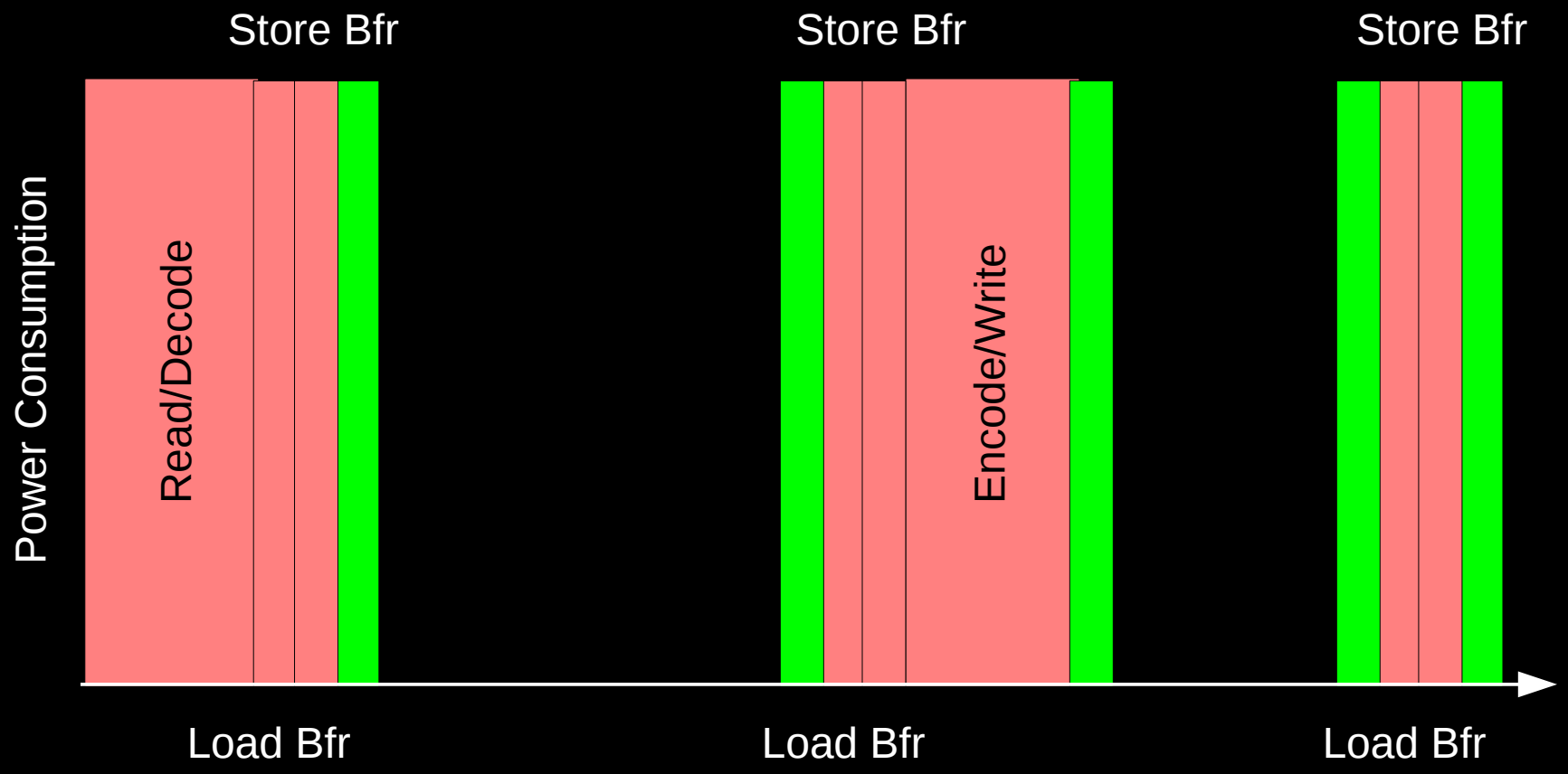
Backlight and display assumed to be powered off.
What do the green bars signify?

"Whacking Droids" Homework: Datasheets
Audio Playback Plus Recording: Power Consumption Profile



Combining Two Power-Efficiency Applications Results in Power Inefficiency!!!

“Whacking Droids” Homework: Datasheets Audio Playback Plus Recording: Energy-Efficient Operation



Power efficiency is a system attribute, not just an application attribute

"Whacking Droids" Homework: Summary

- In some ways, power efficiency is more challenging than is concurrency
  - Power efficiency is a system attribute
  - Power efficiency thus less amenable to localized approaches
- I learned a huge amount while doing the homework
  - And I suspect that many other server-centric hackers also have much to learn as well

- But this does not necessarily prove the Android guys correct

Analyze The Flamewar

Example Flames For Your Analysis

I don't think x86 is relevant anyway, it doesn't suspend/resume anywhere near fast enough for this to be usable.

My laptop still takes several seconds to suspend (Lenovo T500), and resume (aside from some userspace bustage) takes the same amount of time. That is quick enough for manual suspend, but I'd hate it to try and auto-suspend.

Example Flames For Your Analysis

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My laptop still takes several seconds to suspend (Lenovo T500), and resume (aside from some userspace bustage) takes the same amount of time. That is quick enough for manual suspend, but I'd hate it to try and auto-suspend.

Hidden assumption: opportunistic suspend is to have same function on laptops, desktops and servers as on Android smartphones.

Example Flames For Your Analysis

There is no other solution (beisdes suspend blockers).

Example Flames For Your Analysis

```
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blockers).
```

Hidden assumption: “I have not thought of anything else besides suspend blockers, so there must not be anything else.”

Example Flames For Your Analysis

Solutions to the problem already exist.

Example Flames For Your Analysis

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```

Hidden assumption: the guy posting this believes he understands the problem that the Android guys are trying to solve. Maybe he does, maybe he doesn't.

Example Flames For Your Analysis

I still don't see how blocking applications will cause missed wakeups in anything but a buggy application at worst, and even those will eventually get the event when they unblock.

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```

Hidden assumptions: (1) the poster's idea of “buggy” coincides with that of the Android community and (2) it is OK for the event to be delayed until the application finally unblocks.

Example Flames For Your Analysis

The whole concept sucks, as it does not solve anything. Burning power now or in 100ms is the same thing power consumption wise.

Example Flames For Your Analysis

The whole concept sucks, as it does not solve anything. Burning power now or in 100ms is the same thing power consumption wise.

Hidden assumption: (1) An AC power adapter won't enter the picture in the next 100ms. (2) Power cannot be deferred for seconds, minutes, hours, or days – only for about 100ms.

Example Flames For Your Analysis

```
> On some platforms (like those with ACPI), deeper
> power-savings are available by using forced
> suspend than by using idle.

Sounds like something that's fixable, doesn't it?
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```

Hidden assumptions: (1) if a hardware platform can achieve lower power dissipation in suspend than in idle, this constitutes a hardware bug (2) apps should be totally responsible for their energy efficiency.

Example Flames For Your Analysis

> How long do you wait for applications to respond
> that they've stopped drawing? What if the
> application is heavily in swap at the time?

Very realistic scenario on a mobile phone.

Example Flames For Your Analysis

```
> How long do you wait for applications to respond
> that they've stopped drawing? What if the
> application is heavily in swap at the time?

Very realistic scenario on a mobile phone.
```

Hidden assumption: opportunistic suspend is useful only on Android smartphones.

Example Flames For Your Analysis

> So either we get the packet before suspend, and we
> cancel the suspend, or we get it after and we wake
> up. What's the problem, and how does that need
> suspend blockers?

In order to cancel the suspend we need to keep track of whether userspace has consumed the event and reacted appropriately. Since we can't do this with the process scheduler, we end up with something that looks like suspend blockers.

Example Flames For Your Analysis

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whether userspace has consumed the event and reacted
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```

Hidden assumption: all the non-Android people understood the interaction between suspend blockers and I/O. (I certainly did not!)

Example Flames For Your Analysis

Nobody besides Android needs suspend blockers.

Example Flames For Your Analysis

```
Nobody besides Android needs suspend blockers.
```

An earlier hidden assumption is finally made explicit. And ifsuspend blockers can help non-Android platforms, this guy posting won't be the one to figure it out, now will he?

Lessons Learned

General Lessons Learned

- It is not enough to listen to what people say
  - You must strive to understand what they are thinking
  - So you must understand all aspects of the technology in play
- If understanding all aspects was easy...
  - There probably wouldn't be any flaming to begin with
- Those strongly opposed to something won't think about it
  - And therefore are unlikely to come up with a use case
  - And furthermore might not be happy with use cases from others
- Those wedded to a solution won't think about other solutions
  - And therefore are unlikely to come up with alternative solutions
  - And furthermmore might not be happy with solutions from others

Android Lessons Learned

- Reasonable Android wakelock requirements exist
  - https://wiki.linaro.org/WorkingGroup/KernelConsolidation/Projects/AndroidSuspendBlockers
  - This lists 18 requirements, 2 nice-to-haves, and 3 non-requirements
- Wakelocks are likely to have server/desktop uses
  - But programmable interface to RTC required
  - More information on this is likely to be forthcoming
  - Of course, it remains to be seen whether this use case is compelling to the Linux kernel community at large
  - Or whether solutions developed along these lines address all 18 of the above requirements
- Some pm_qos functionality is under development
  - Might not meet all requirements, but should allow merging drivers

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QUESTIONS?