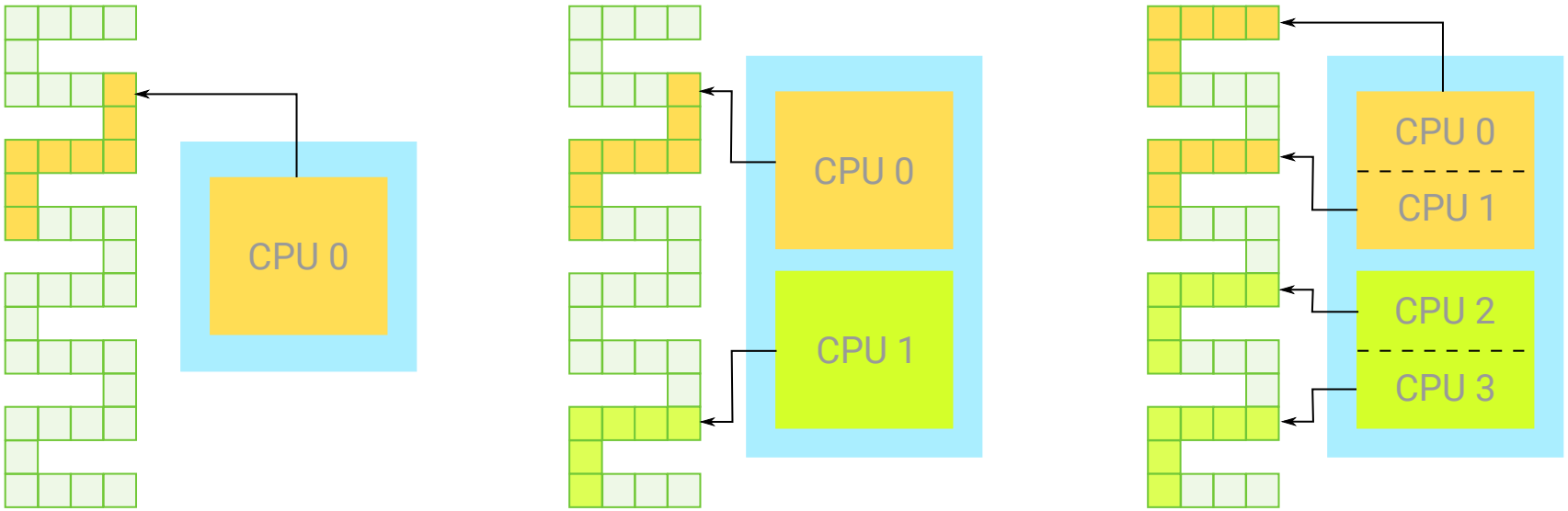
Advances in CPU Idle Time Management

Rafael J. Wysocki

Intel Open Source Technology Center

November 2, 2018

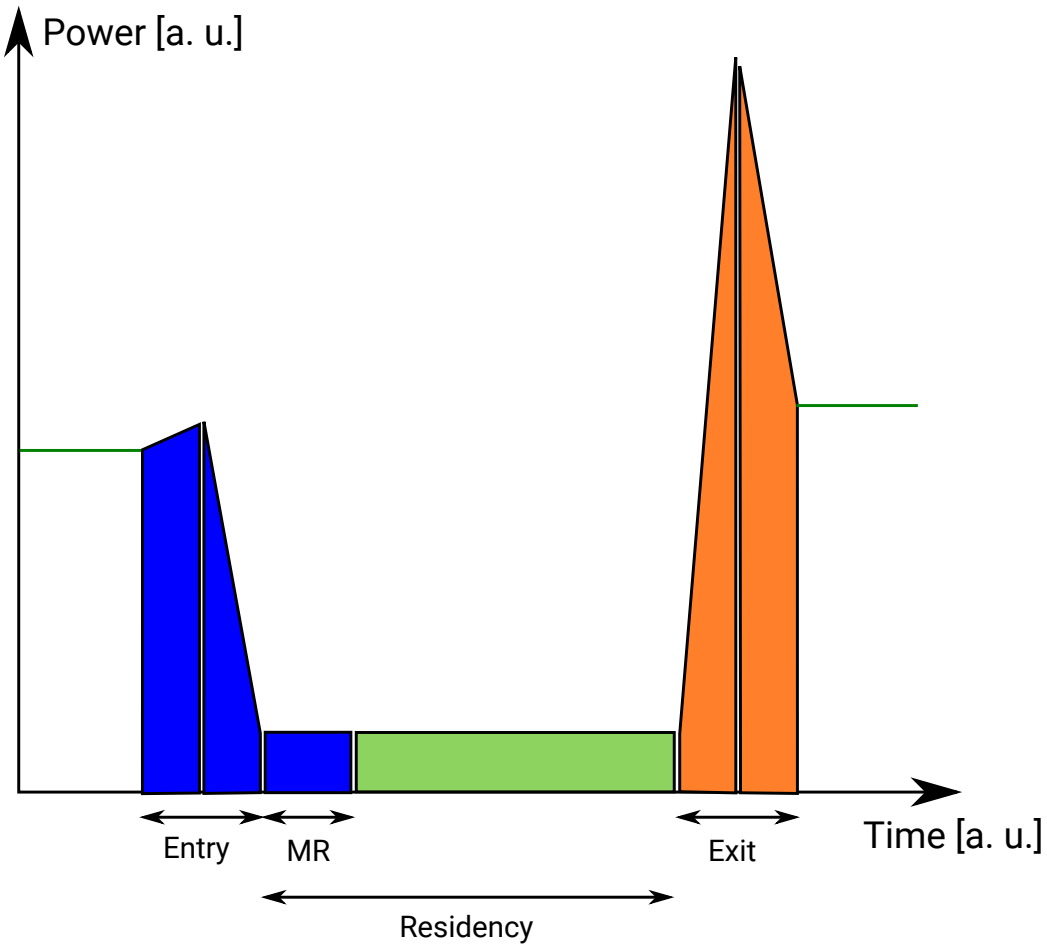
Terminology: CPUs = Logical CPUs



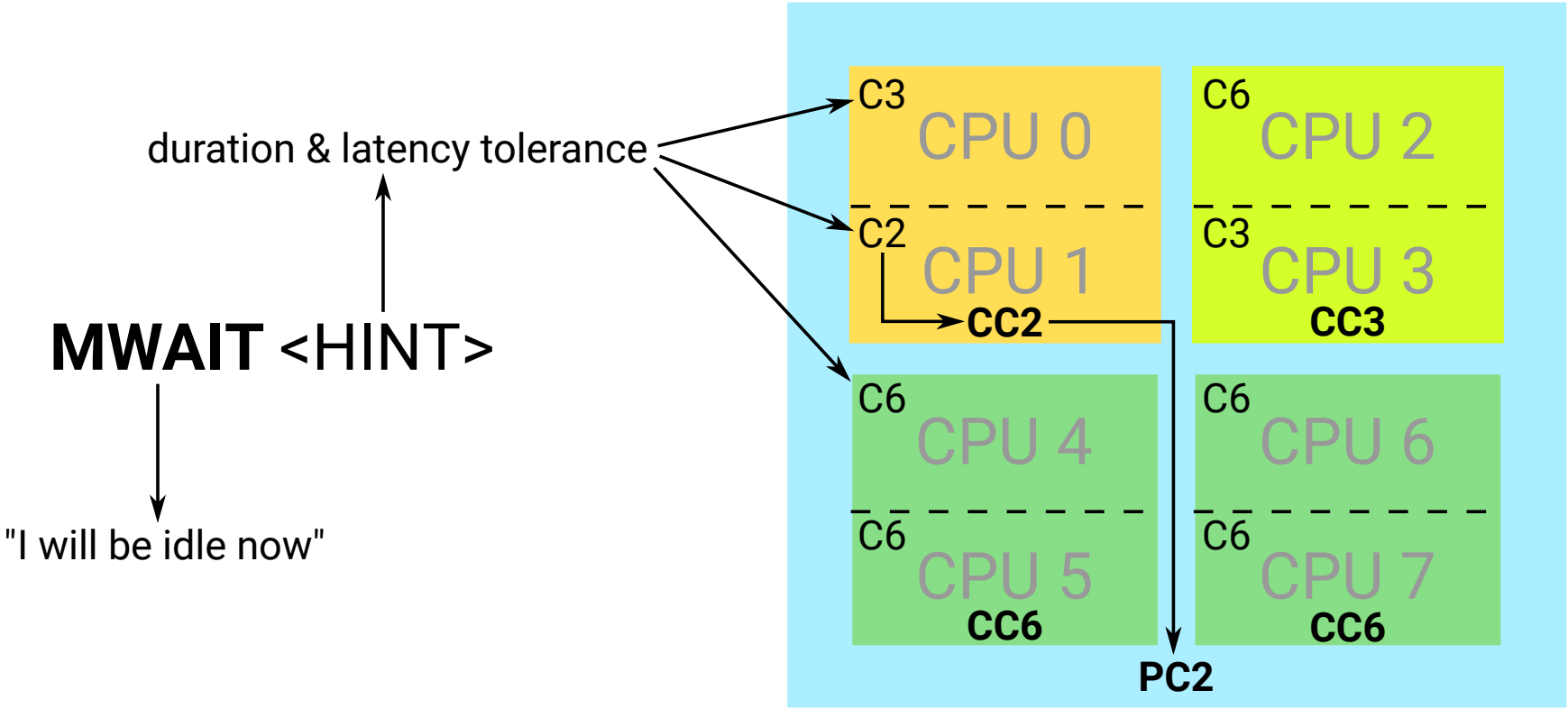
CPUs: Busy Vs Idle

Intel OpenSource TECHNOLOGY CENTER

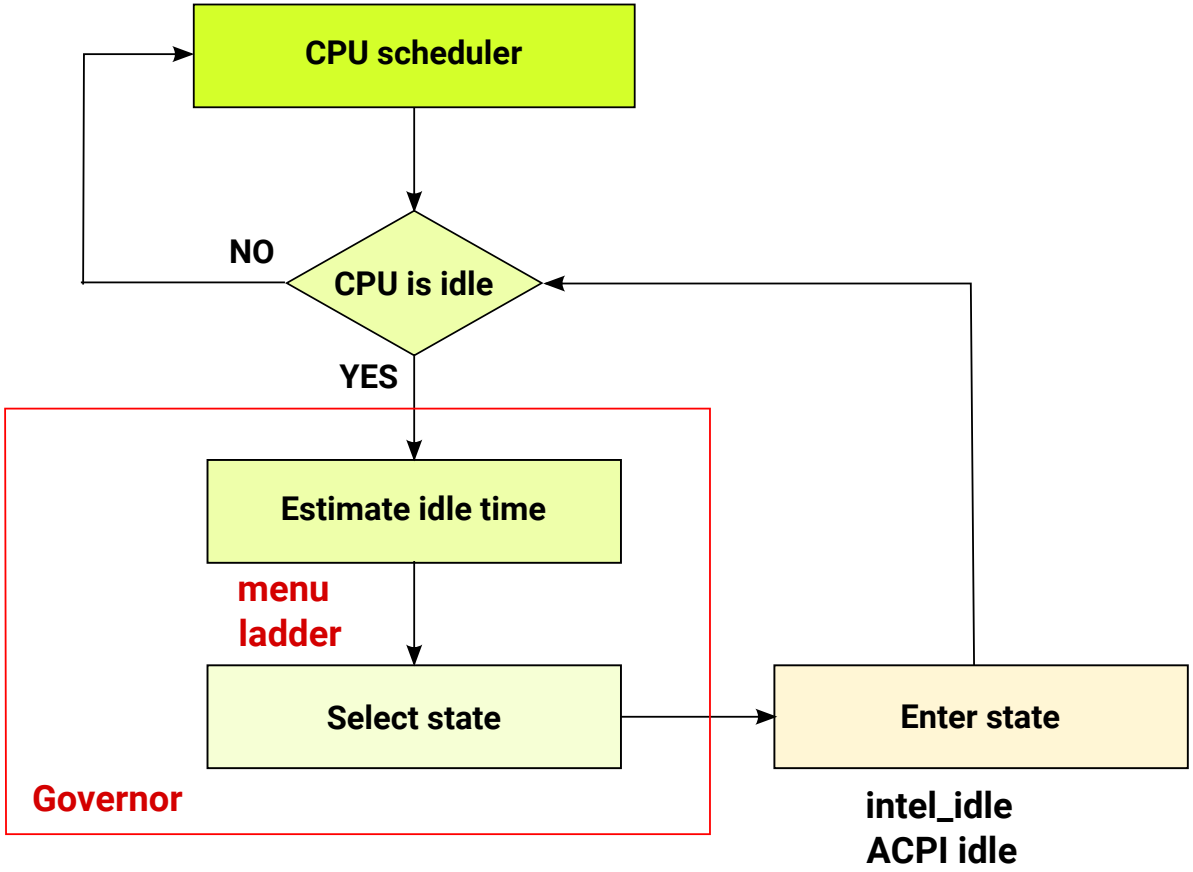
CPU Idle States Properties



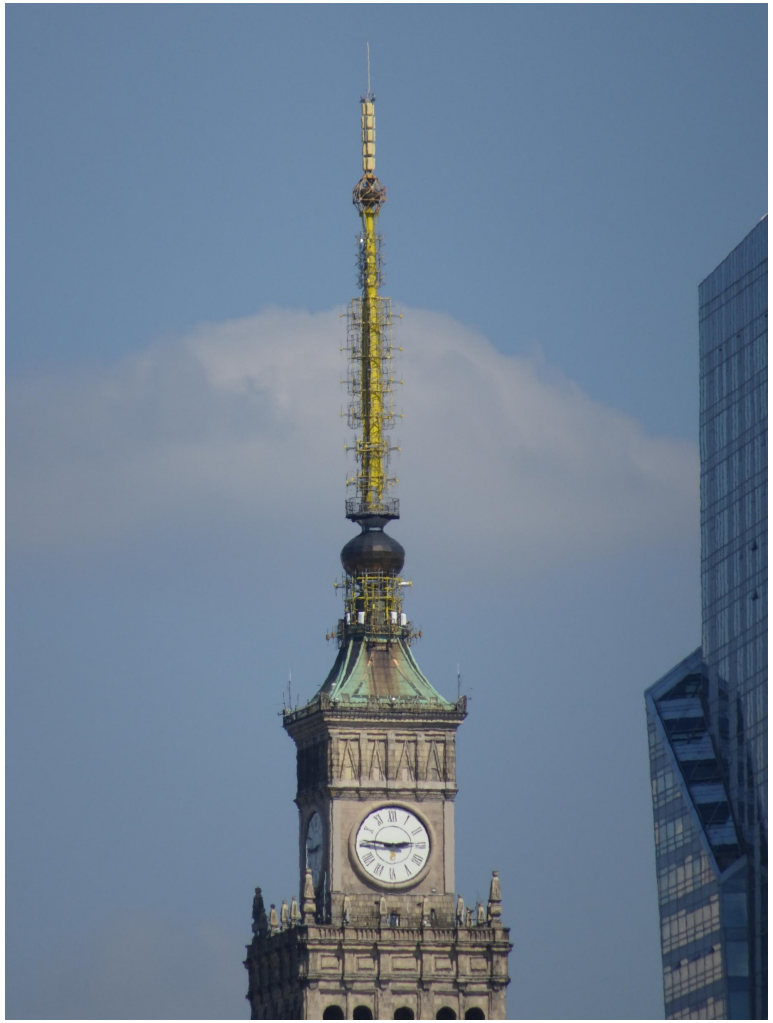
CPU Idle States Example: C-states On Intel Hardware



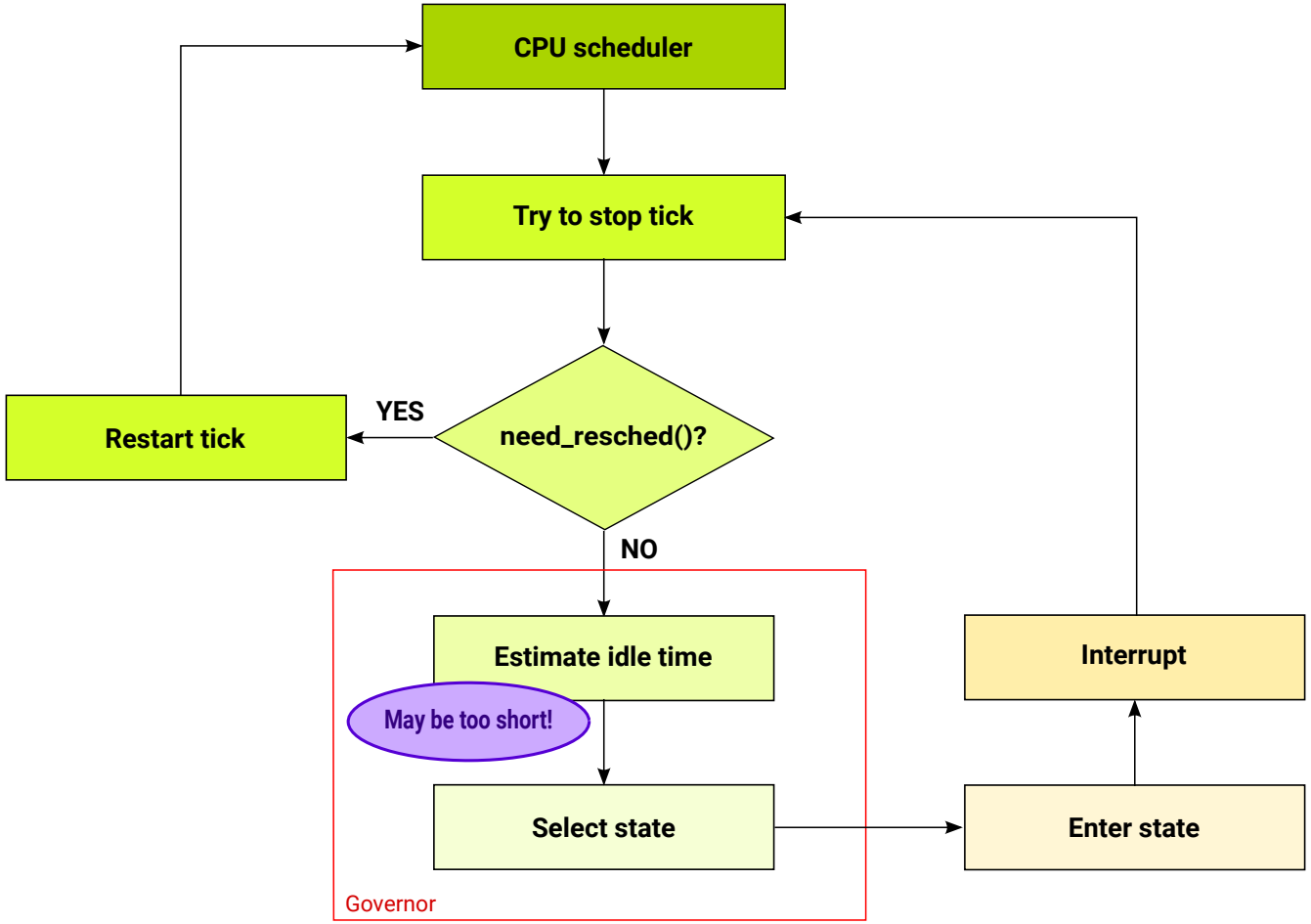
High-level CPU Idle Time Management Control Flow



Complication: CPU Scheduler Tick Timer



Original Idle Loop Design Issue



Short Idle Duration Prediction Problem

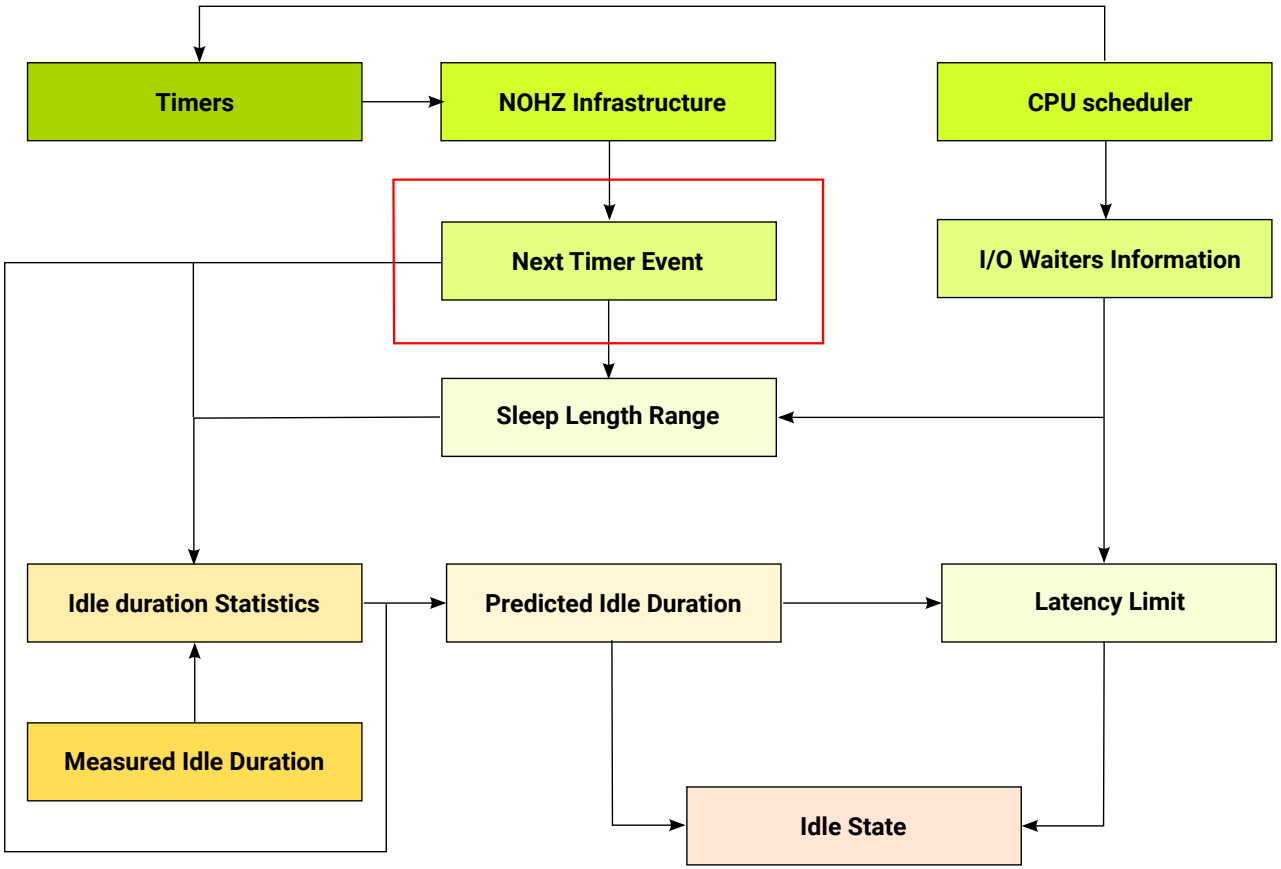
Predicted \ Actual	Long Idle	Short Idle
Long Idle	**WIN**	**LOSS**
Short Idle	**LOSS**	**LOSS**

Intel OpenSource TECHNOLOGY CENTER

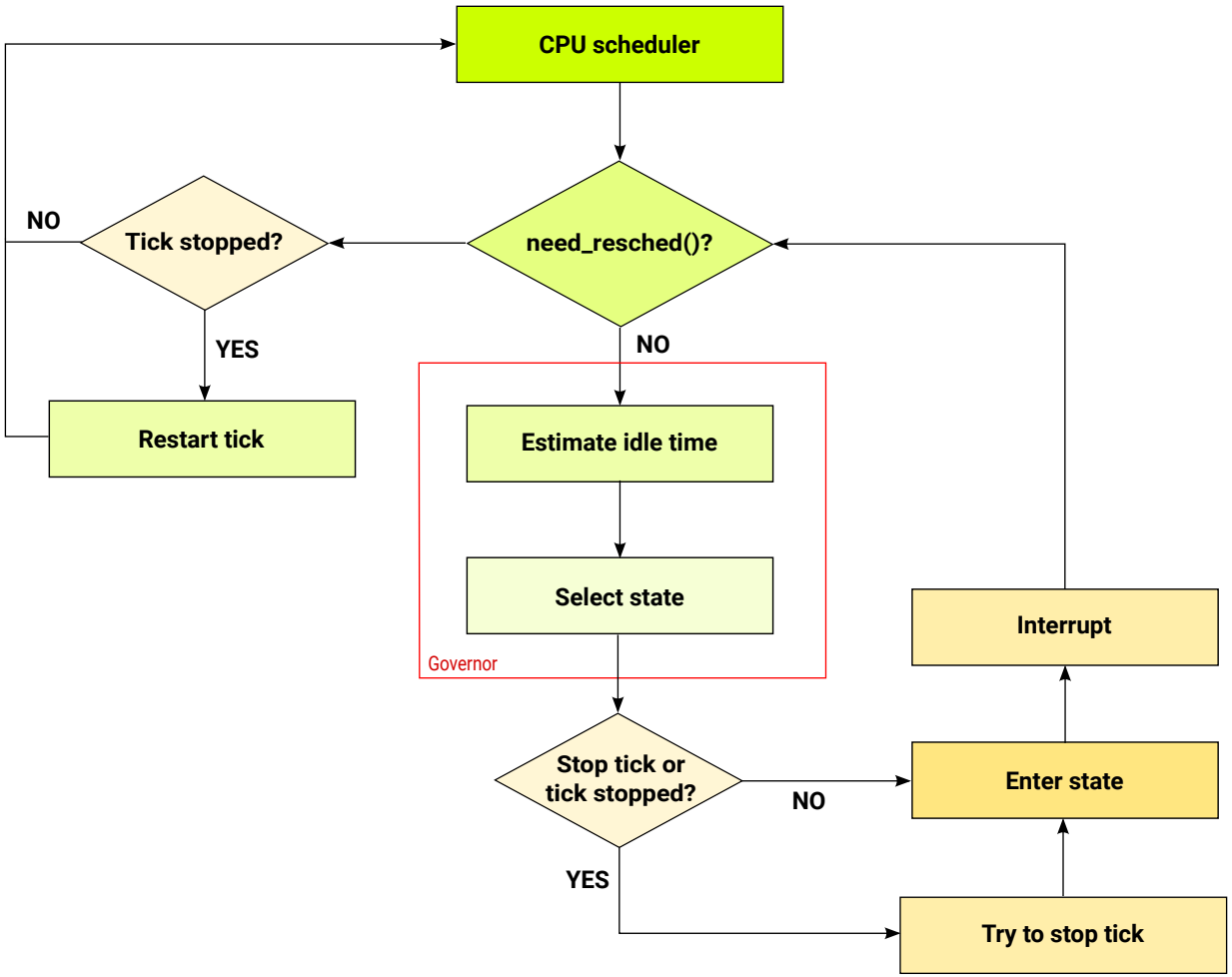
Idle Governor Problem: Two Categories Of Information

Intel OpenSource TECHNOLOGY CENTER

The menu Idle Governor



Redesigned Idle Loop (Linux* 4.17 And Later)



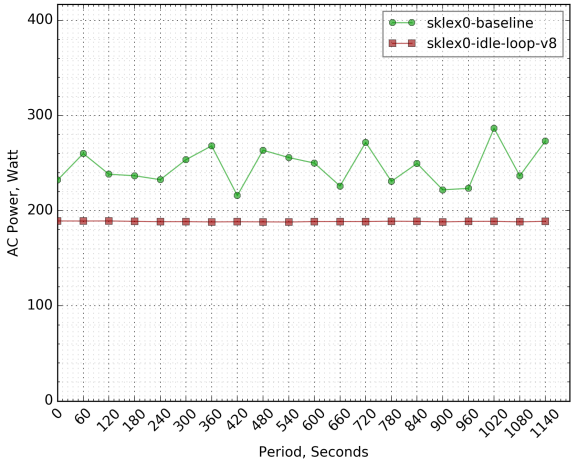
* Other names and brands may be claimed as the property of others

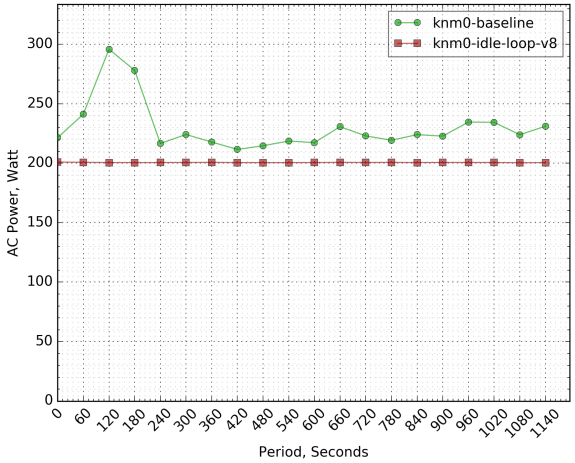
Short Idle Duration Prediction Problem Mitigated

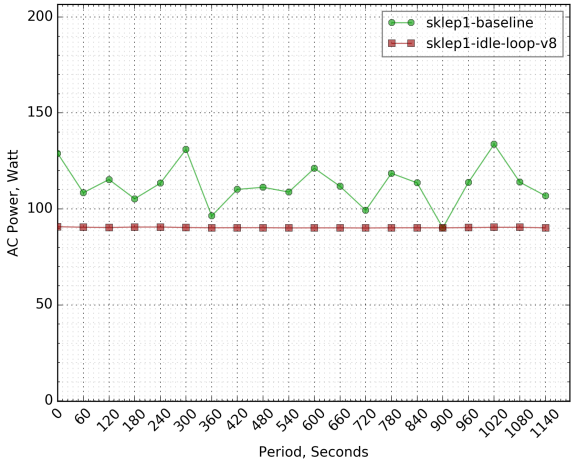
Predicted \ Actual	Long Idle	Short Idle
Long Idle	**WIN**	**LOSS**
Short Idle	**Neutral**	**WIN**

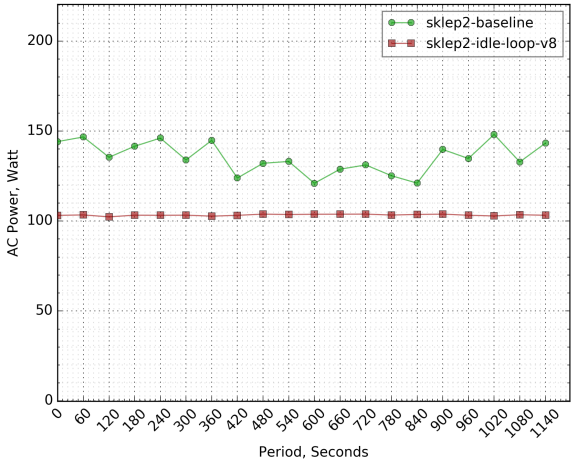
Intel OpenSource TECHNOLOGY CENTER

Idle Power (Intel OTC Server Power Lab)



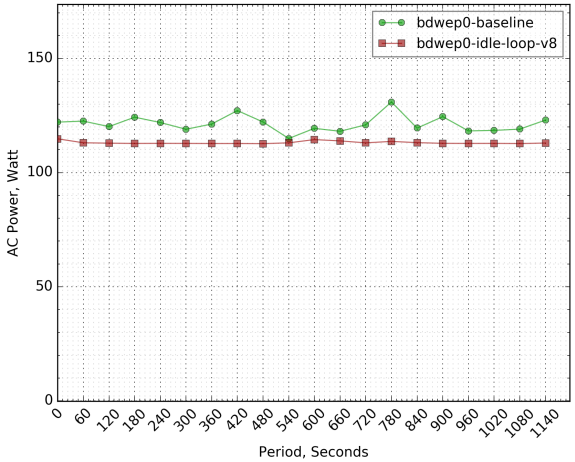


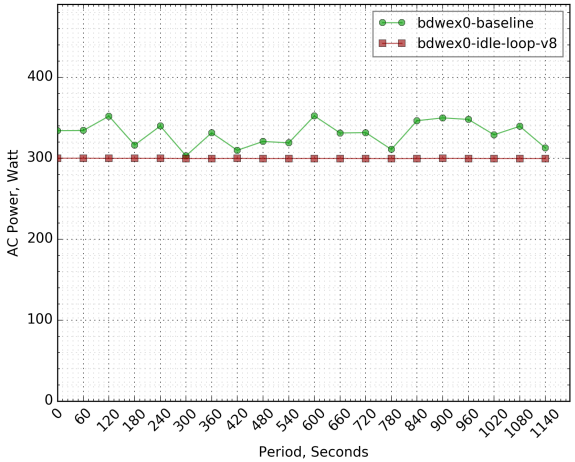


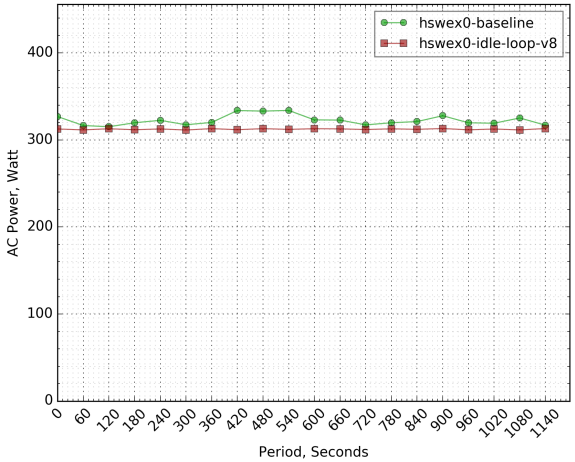


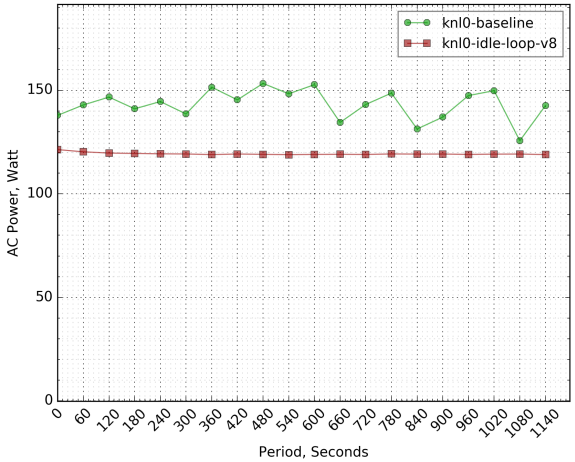
Intel OpenSource TECHNOLOGY CENTER

Idle Power (Intel OTC Server Power Lab) Continued



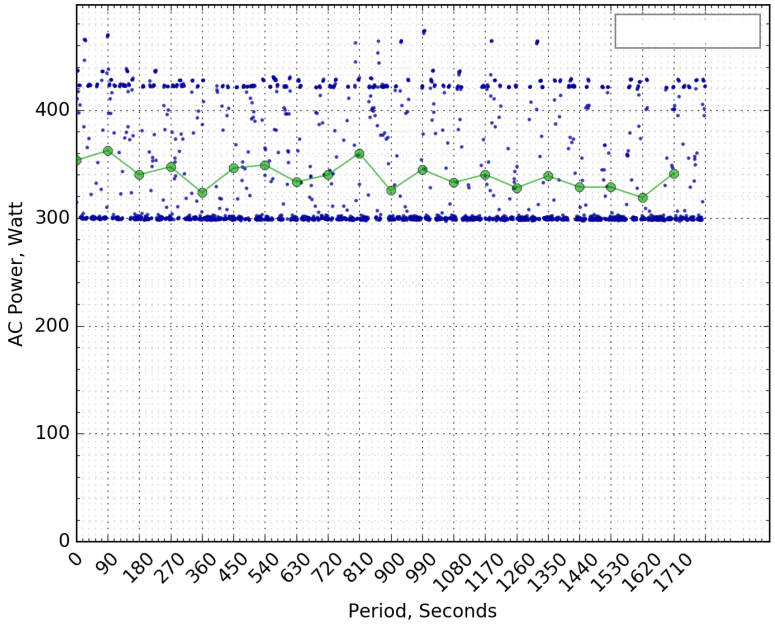




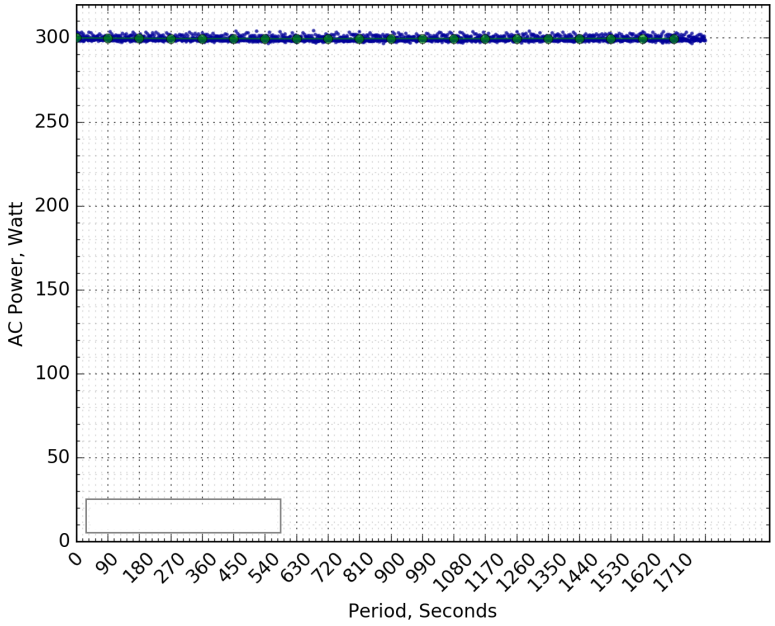


Intel OpenSource TECHNOLOGY CENTER

Idle Power (Intel OTC Server Power Lab) Continued



Before



After (different scale)

Changes Under Development

Intel OpenSource TECHNOLOGY CENTER

Questions?

Intel OpenSource TECHNOLOGY CENTER

References

- Linux Kernel Bug 199227, *Idle loop ordering issue* (https://bugzilla.kernel.org/show_bug.cgi?id=199227).
- T. Ilsche, M. Hähnel, R. Schöhne, M. Bielert, D. Hackenberg, *Powernightmares: The Challenge of Efficiently Using Sleep States on Multi-Core Systems* (https://tu-dresden.de/zih/forschung/ressourcen/dateien/projekte/haec/powernightmares.pdf?lang=en).
- R. J. Wysocki, *Power Management Challenges in Linux* (https://www.linuxplumbersconf.org/2017/ocw//system/presentations/4652/original/linux_pm_challenges.pdf).
- R. J. Wysocki, *PM Infrastructure in the Linux Kernel – Current Status and Future* (https://events.linuxfoundation.org/sites/events/files/slides/kernel_PM_infra_0.pdf).
- J. Corbet, *The cpuidle subsystem* (http://lwn.net/Articles/384146/).

Disclaimer

Intel technologies' features and benefits depend on system configuration and may require enabled hardware, software or service activation. Performance varies depending on system configuration. No computer system can be absolutely secure. Check with your system manufacturer or retailer or learn more at `www.intel.com`.

Intel and the Intel logo are trademarks of Intel Corporation in the U.S. and/or other countries. *Other names and brands may be claimed as the property of others.

© Intel Corporation

Intel OpenSource TECHNOLOGY CENTER