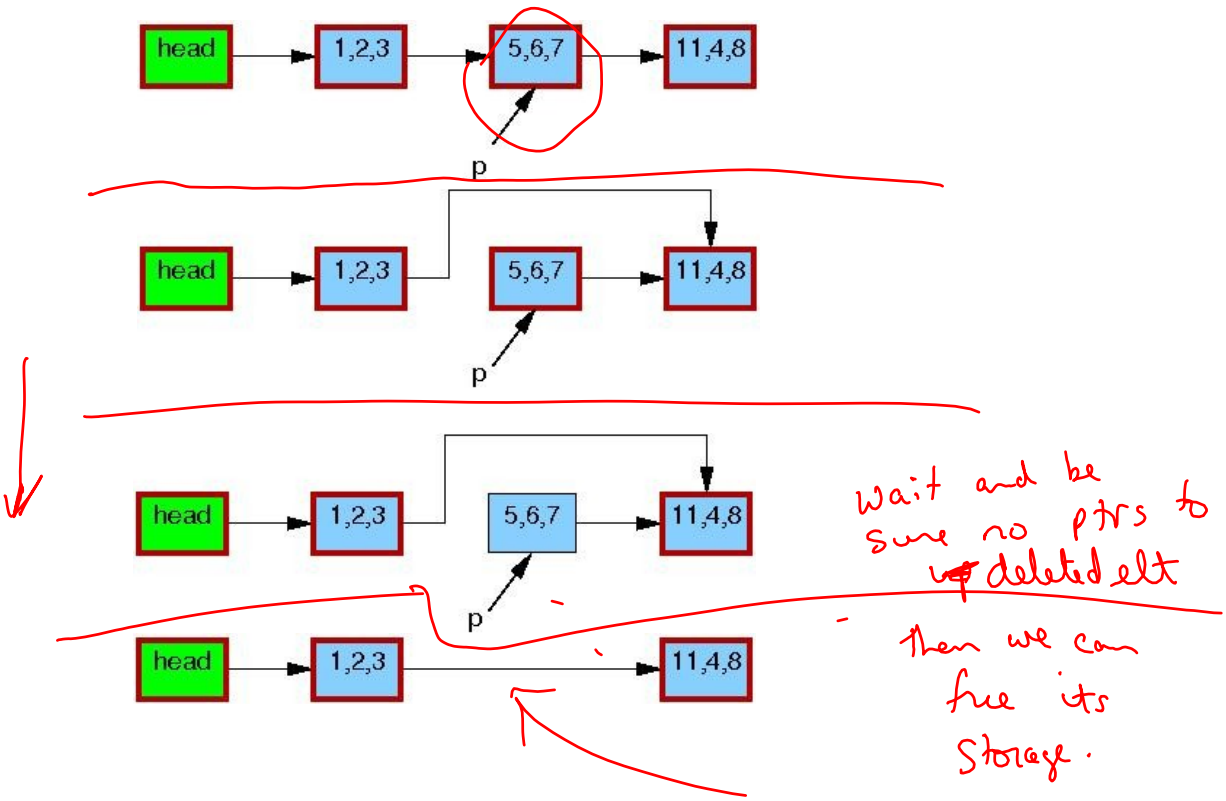
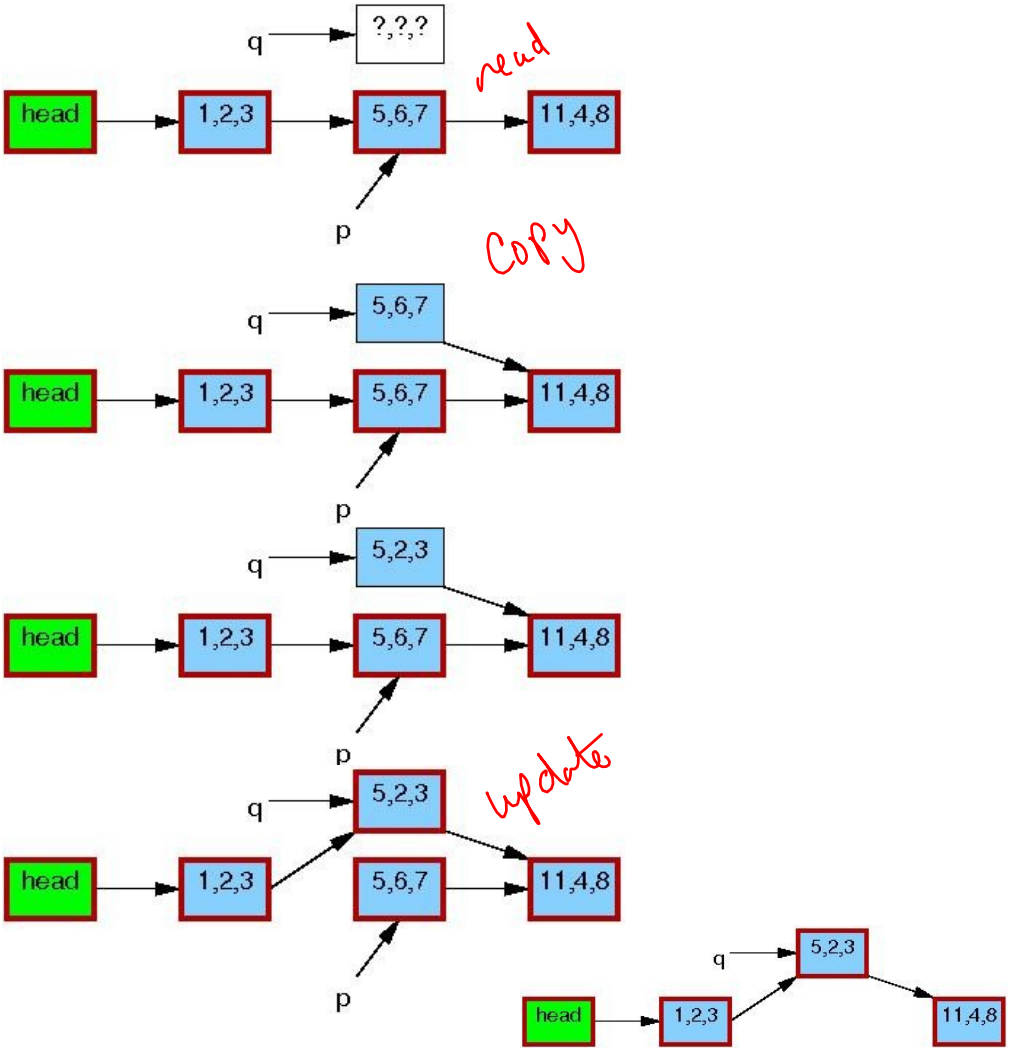
Read-Copy-Update (RCU)

CptS 483/580
April 21, 2010

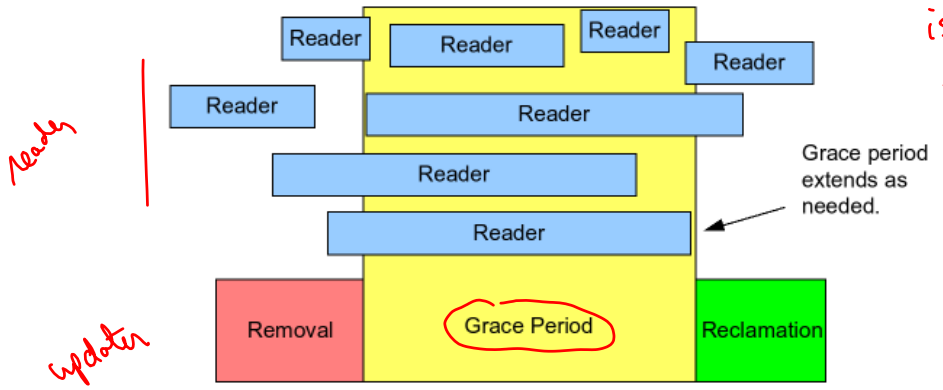


Deleting a List Element

List element update



Read-copy-update: high-performance synchronization for read-mostly workloads.
Paul McKenney
Linux Weekly News (3 articles from late 2007-2008)
See http://www.rdrop.com/users/paulmck/RCU/
Figures here are from those three articles.



any reader that started before the grace period is finished by the end of the grace period.
At end of GP, it is safe to reclaim storage of the removed element

synchronize_rcu
when does GP end?

Note: update visibility is an issue that the Linux RCU interface also addresses with higher-level pointer read/update instructions that incorporate memory barriers

Primitives for RCU

```
rcu_read_lock();  /* read -side */
rcu_read_unlock();
synchronize_rcu(); /* write side */
```

synchronize_rcu() - implements the grace period after which removed elements may be freed.

Another approach is with a **call-back** procedure call_rcu(f,p) which calls f(p) when system determines that the grace period has expired.

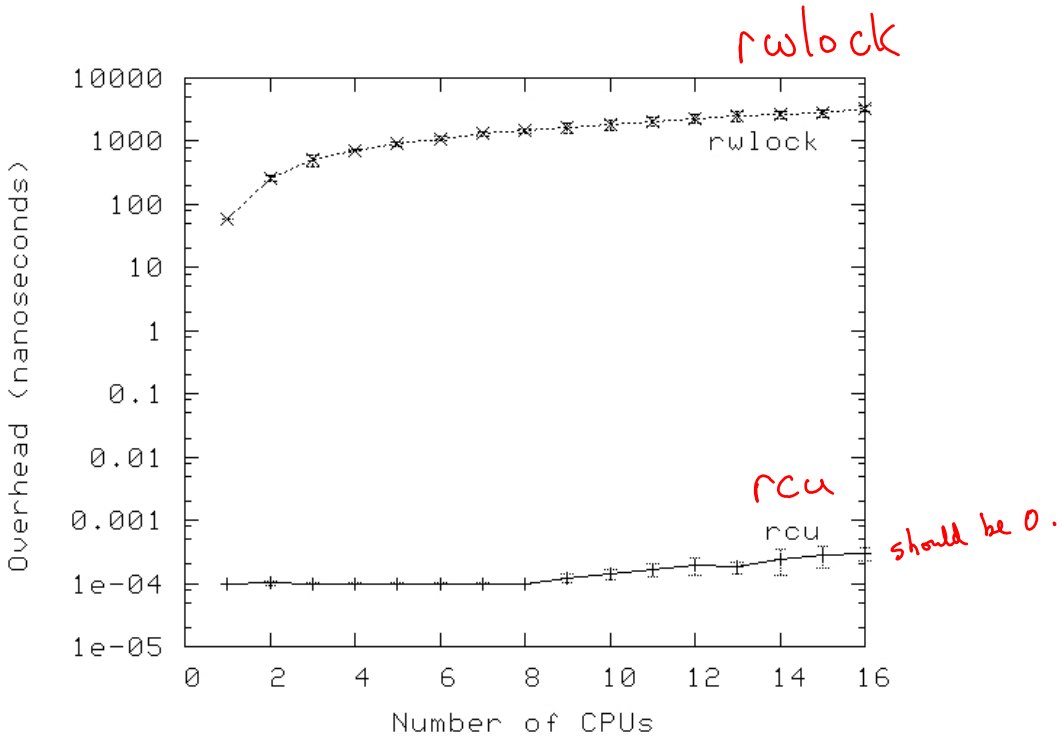
Implementing synchronize_rcu() – various mechanisms: if pre-emption is disallowed in lock...unlock sections sufficient to detect that all contexts have run once.

With garbage-collection: these techniques are (nearly) free – have to worry about update visibility.

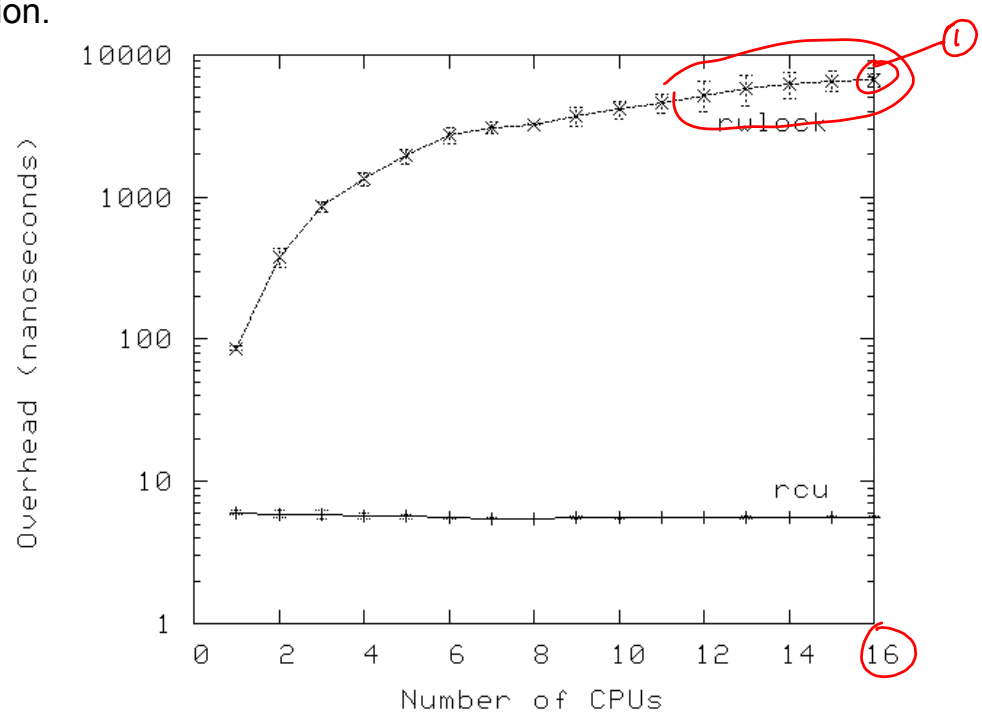
Note: locks (or TM, or …) are still needed to protect against concurrent updates!

Micro-benchmarks

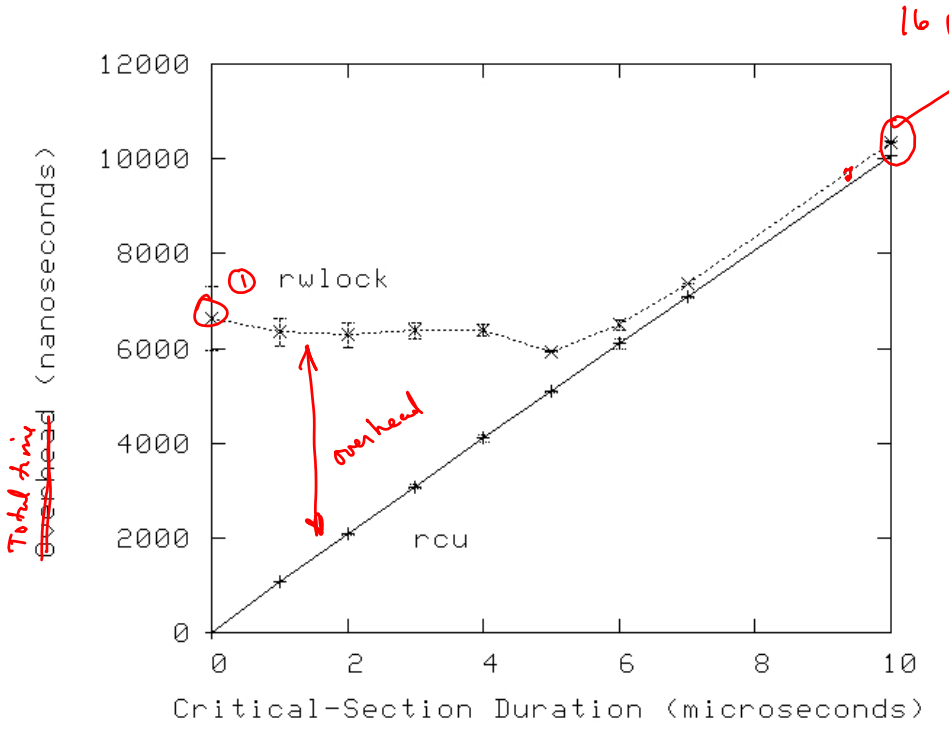
Overhead – non-preemptive kernel: 0



Overhead – preemptive kernel: non-zero cost because read_lock_rcu() has to turn off pre-emption.



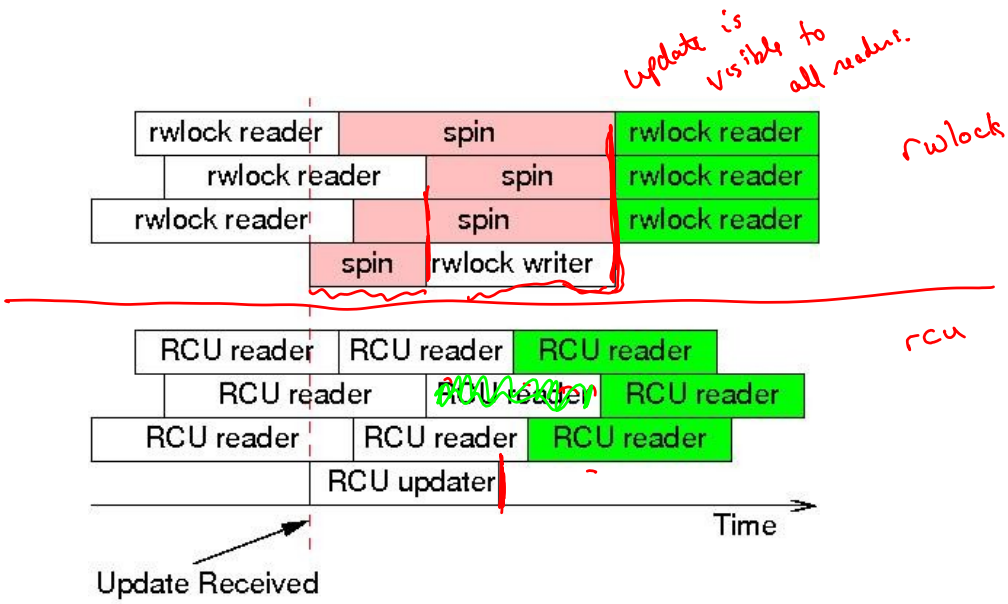
Overhead: Pre-emptive kernel – 16 CPUs, increasing CS size

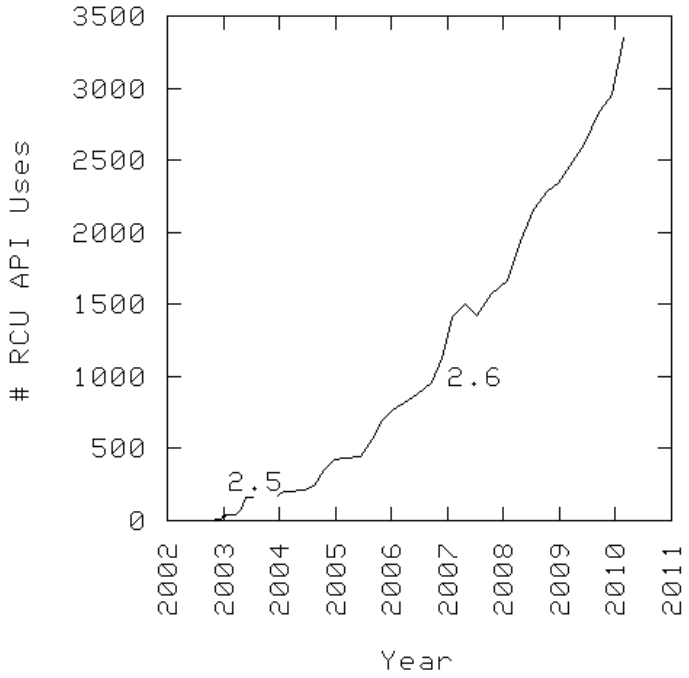


Why does the overhead and variability of rwlock decrease with increasing CS duration?

Macro-effect

RW-lock vs RCU

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RCU API Uses
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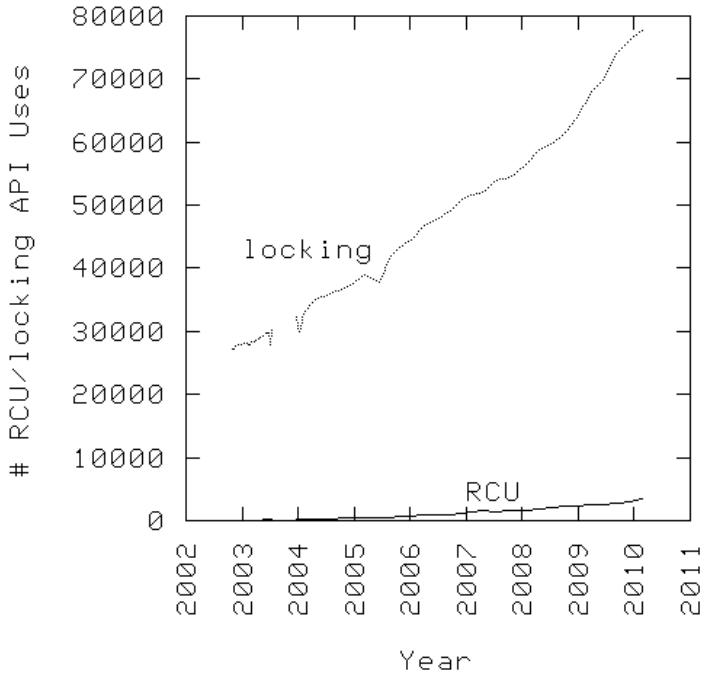
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RCU/locking API Uses
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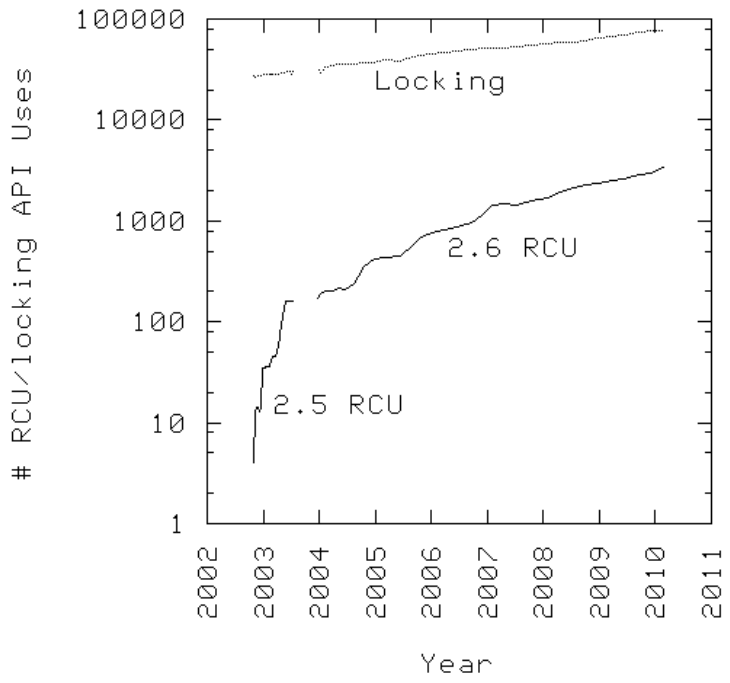
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RCU/locking API Uses
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2.5 RCU
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