

# The RCU API tables

[Posted September 1, 2014 by jake]

These tables are part of Paul McKenney's [2014 RCU API update article](#)

## RCU Per-Flavor API Table

| Attribute                                                                 | RCU                                                       | RCU BH                                             | RCU Sched                                                                                                                                                                                          | SRCU                                                              | Generic                                                                                                                                                                 |
|---------------------------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>                                                            | Wait for RCU read-side critical sections                  | Wait for RCU-bh read-side critical sections & irqs | Wait for RCU-sched read-side critical sections, preempt-disable regions, hardirqs, & NMIs                                                                                                          | Wait for SRCU read-side critical sections, allow sleeping readers | Primitives common to all flavors of RCU                                                                                                                                 |
| <b><u>Initialization</u></b>                                              | N/A                                                       | N/A                                                | N/A                                                                                                                                                                                                | DEFINE_SRCU()<br>DEFINE_STATIC_SRCU()<br>init_srcu_struct()       | RCU_INIT_POINTER()<br>RCU_POINTER_INITIALIZER()                                                                                                                         |
| <b><u>Read-side critical-section markers</u></b>                          | rcu_read_lock()<br>rcu_read_unlock()                      | rcu_read_lock_bh()<br>rcu_read_unlock_bh()         | rcu_read_lock_sched()<br>rcu_read_unlock_sched()<br>rcu_read_lock_sched_notrace()<br>rcu_read_unlock_sched_notrace()<br>preempt_disable()/preempt_enable()<br>local_irq_save()/local_irq_restore() | srcu_read_lock()<br>srcu_read_unlock()                            |                                                                                                                                                                         |
| <b><u>Read-side data access</u></b>                                       | rcu_dereference()<br>rcu_dereference_check()              | rcu_dereference_bh()<br>rcu_dereference_bh_check() | rcu_dereference_sched()<br>rcu_dereference_sched_check()                                                                                                                                           | srcu_dereference()<br>srcu_dereference_check()                    | rcu_access_index()rcu_access_pointer()<br>rcu_dereference_index_check()<br>rcu_dereference_protected()<br>rcu_dereference_raw()<br>rcu_dereference_raw_notrace()        |
| <b><u>Update-side primitives (synchronous)</u></b>                        | synchronize_rcu()<br>synchronize_net()                    | synchronize_rcu_bh()                               | synchronize_sched()                                                                                                                                                                                | synchronize_srcu()                                                | rcu_assign_pointer()                                                                                                                                                    |
| <b><u>Update-side primitives (expedited)</u></b>                          | synchronize_rcu_expedited()                               | synchronize_rcu_bh_expedited()                     | synchronize_sched_expedited()                                                                                                                                                                      | synchronize_srcu_expedited()                                      |                                                                                                                                                                         |
| <b><u>Update-side primitives (asynchronous/callback)</u></b>              | call_rcu()                                                | call_rcu_bh()                                      | call_rcu_sched()                                                                                                                                                                                   | call_srcu()                                                       |                                                                                                                                                                         |
| <b><u>Update-side primitives (wait for callbacks)</u></b>                 | rcu_barrier()                                             | rcu_barrier_bh()                                   | rcu_barrier_sched()                                                                                                                                                                                | srcu_barrier()                                                    |                                                                                                                                                                         |
| <b><u>Update-side primitives (free memory)</u></b>                        | kfree_rcu()                                               |                                                    |                                                                                                                                                                                                    |                                                                   |                                                                                                                                                                         |
| <b><u>Validation</u></b>                                                  | rcu_read_lock_held()                                      | rcu_read_lock_bh_held()                            | rcu_read_lock_sched_held()                                                                                                                                                                         | srcu_read_lock_held()                                             | __rcu<br>init_rcu_head()<br>destroy_rcu_head()<br>init_rcu_head_on_stack()<br>destroy_rcu_head_on_stack()<br>rcu_is_watching()<br>rcu_lockdep_assert()<br>RCU_NONIDLE() |
| <b><u>Memory ordering</u></b>                                             |                                                           |                                                    |                                                                                                                                                                                                    | smp_mb__after_srcu_read_unlock()                                  |                                                                                                                                                                         |
| <b><u>Read side constraints</u></b>                                       | No blocking except preemption and "spinlock" acquisition. | No BH enabling                                     | No blocking                                                                                                                                                                                        | No wait for synchronize_srcu()                                    |                                                                                                                                                                         |
| <b><u>Read side overhead</u></b>                                          | Simple instructions (free on !PREEMPT)                    | BH disable/enable                                  | Preempt disable/enable (free on !PREEMPT)                                                                                                                                                          | Simple instructions, preempt disable/enable                       |                                                                                                                                                                         |
| <b><u>Asynchronous update-side overhead (for example, call_rcu())</u></b> | sub-microsecond                                           | sub-microsecond                                    | sub-microsecond                                                                                                                                                                                    | sub-microsecond                                                   |                                                                                                                                                                         |

|                                          |                     |                     |                     |                                                                                                       |
|------------------------------------------|---------------------|---------------------|---------------------|-------------------------------------------------------------------------------------------------------|
| <u>Grace-period latency</u>              | 10s of milliseconds | 10s of milliseconds | 10s of milliseconds | 10s of microseconds, but increases with number of CPUs (rough rule of thumb: 200 nanoseconds per CPU) |
| <u>PREEMPT RT default implementation</u> | RCU Sched           | RCU BH              | RCU Sched           | SRCU                                                                                                  |
| <u>PREEMPT RT default implementation</u> | Preemptible RCU     | RCU BH              | RCU Sched           | SRCU                                                                                                  |

## RCU List APIs

| Operation                 | list                                                            | hlist                                                                                             | hlist_nulls                                                                       | hlist_bl                                            |
|---------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------|
|                           | Circular doubly linked list                                     | Linear doubly linked list                                                                         | Linear doubly linked list with marked NULL pointer, with up to 31 bits of marking | Linear doubly linked list with bit locking          |
| <u>Initialization</u>     | INIT_LIST_HEAD_RCU()                                            |                                                                                                   |                                                                                   |                                                     |
| <u>Full traversal</u>     | list_for_each_entry_rcu()                                       | hlist_for_each_entry_rcu()<br>hlist_for_each_entry_rcu_bh()<br>hlist_for_each_entry_rcu_notrace() | hlist_nulls_for_each_entry_rcu()                                                  | hlist_bl_for_each_entry_rcu()                       |
| <u>Resume traversal</u>   | list_for_each_entry_continue_rcu()                              | hlist_for_each_entry_continue_rcu()<br>hlist_for_each_entry_continue_rcu_bh()                     |                                                                                   |                                                     |
| <u>Stepwise traversal</u> | list_entry_rcu()<br>list_first_or_null_rcu()<br>list_next_rcu() | hlist_first_rcu()<br>hlist_next_rcu()<br>hlist_pprev_rcu()                                        | hlist_nulls_first_rcu()<br>hlist_nulls_next_rcu()                                 | hlist_bl_first_rcu()                                |
| <u>Add</u>                | list_add_rcu()<br>list_add_tail_rcu()                           | hlist_add_after_rcu()<br>hlist_add_before_rcu()<br>hlist_add_head_rcu()                           | hlist_nulls_add_head_rcu()                                                        | hlist_bl_add_head_rcu()<br>hlist_bl_set_first_rcu() |
| <u>Delete</u>             | list_del_rcu()                                                  | hlist_del_rcu()<br>hlist_del_init_rcu()                                                           | hlist_nulls_del_rcu()<br>hlist_nulls_del_init_rcu()                               | hlist_bl_del_rcu()<br>hlist_bl_del_init_rcu()       |
| <u>Replacement</u>        | list_replace_rcu()                                              | hlist_replace_rcu()                                                                               |                                                                                   |                                                     |
| <u>Splice</u>             | list_splice_init_rcu()                                          |                                                                                                   |                                                                                   |                                                     |

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