Kernel: to be or not to be?

Yiying Zhang

About Me and WukLab

WukLab: Building next-gen datacenter systems

- Fields
  - Operating systems
  - Distributed systems
  - Datacenter networking
  - Computer architecture

"I see myself as a generalist -- I am attracted to the biggest problem I can find, regardless of area"

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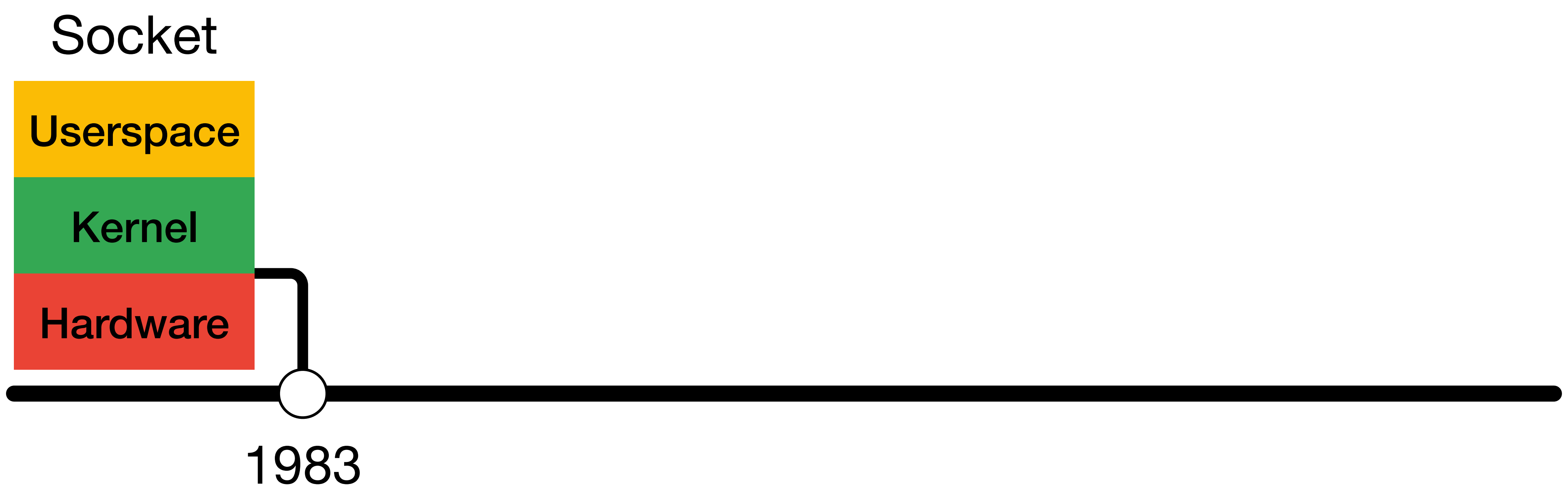
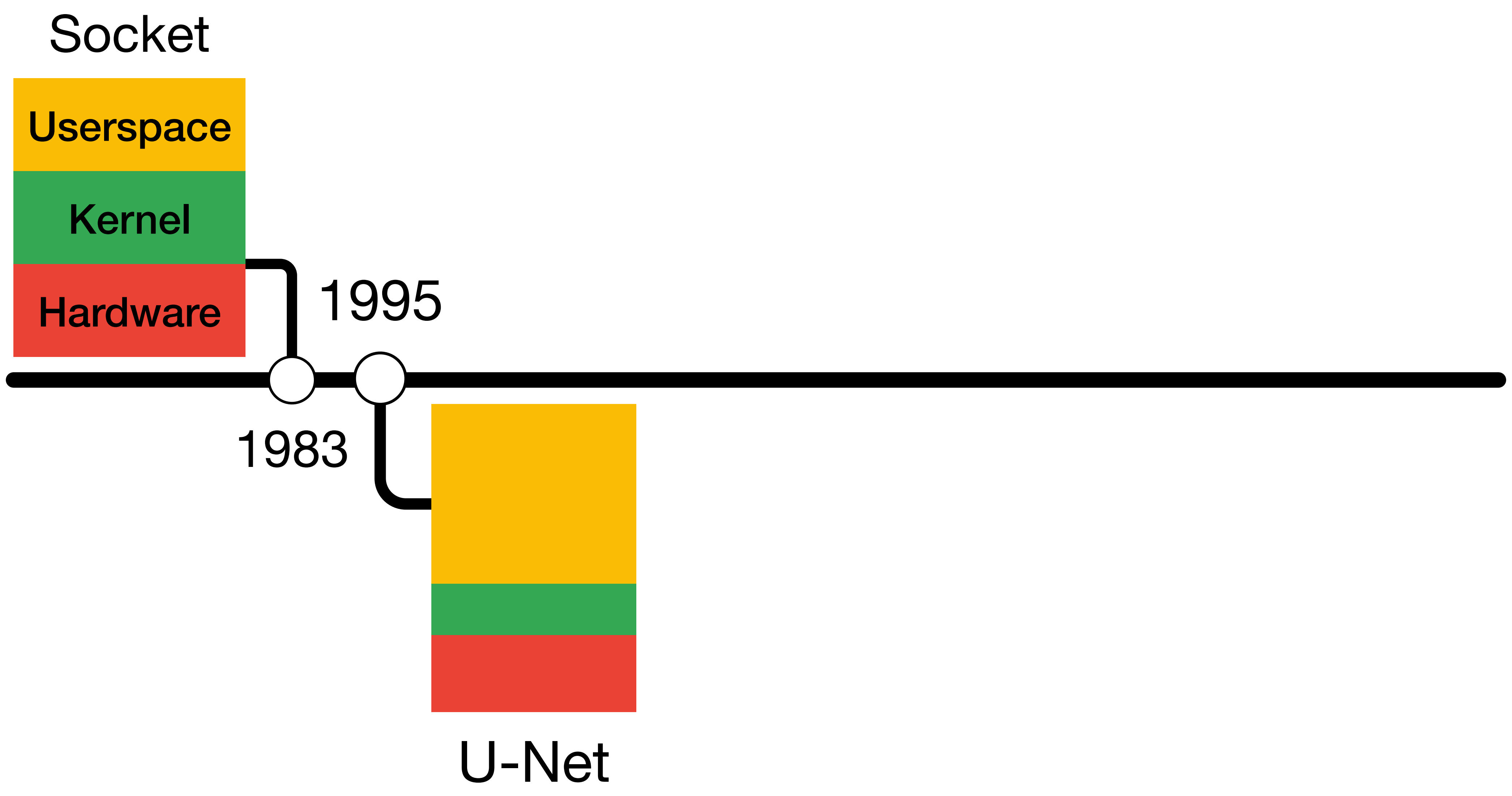
But most of our works are in kernel

What should go into kernel?


Socket
Userspace
Kernel
Hardware
1983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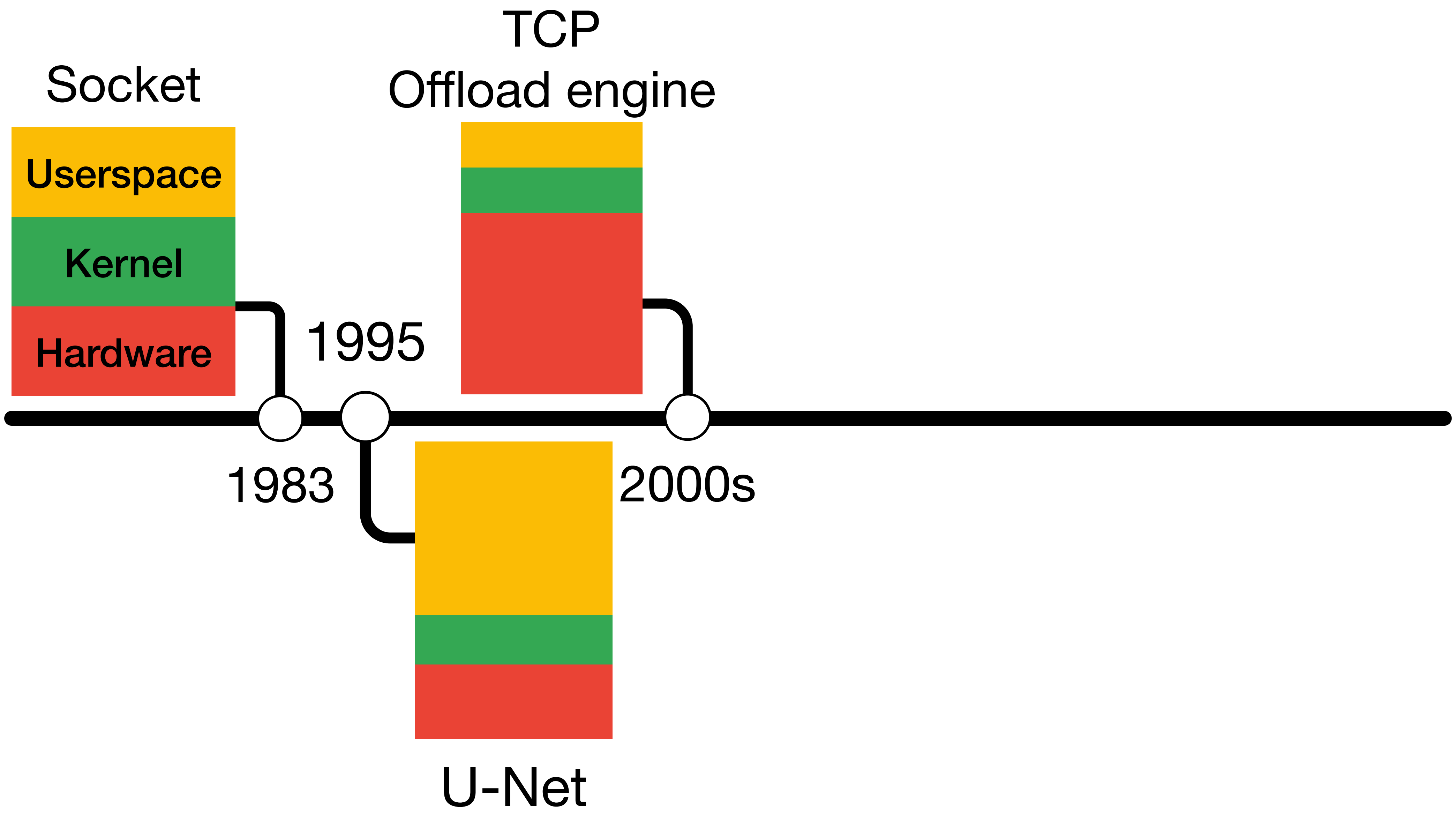
TCP
Offload engine
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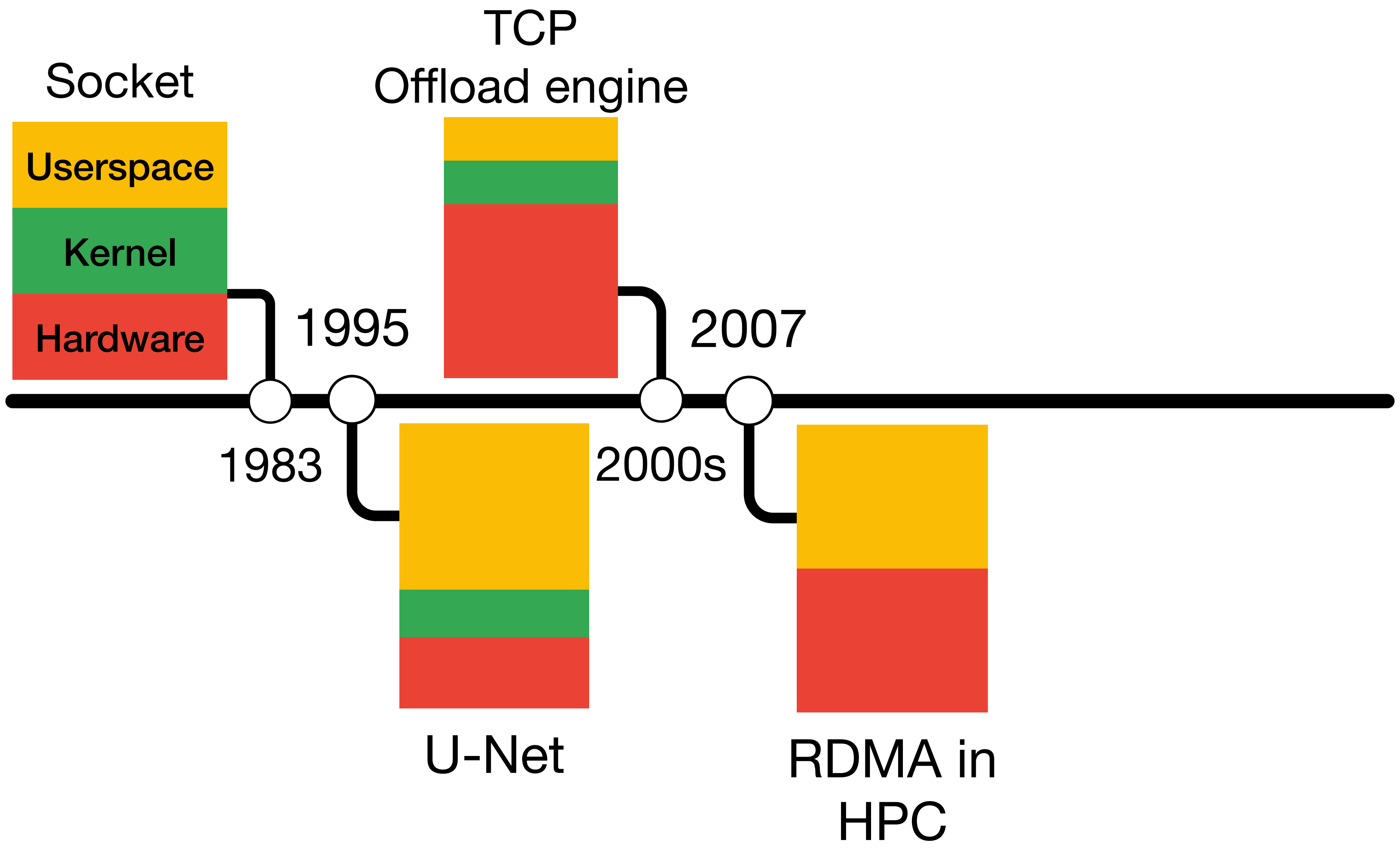
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RDMA in
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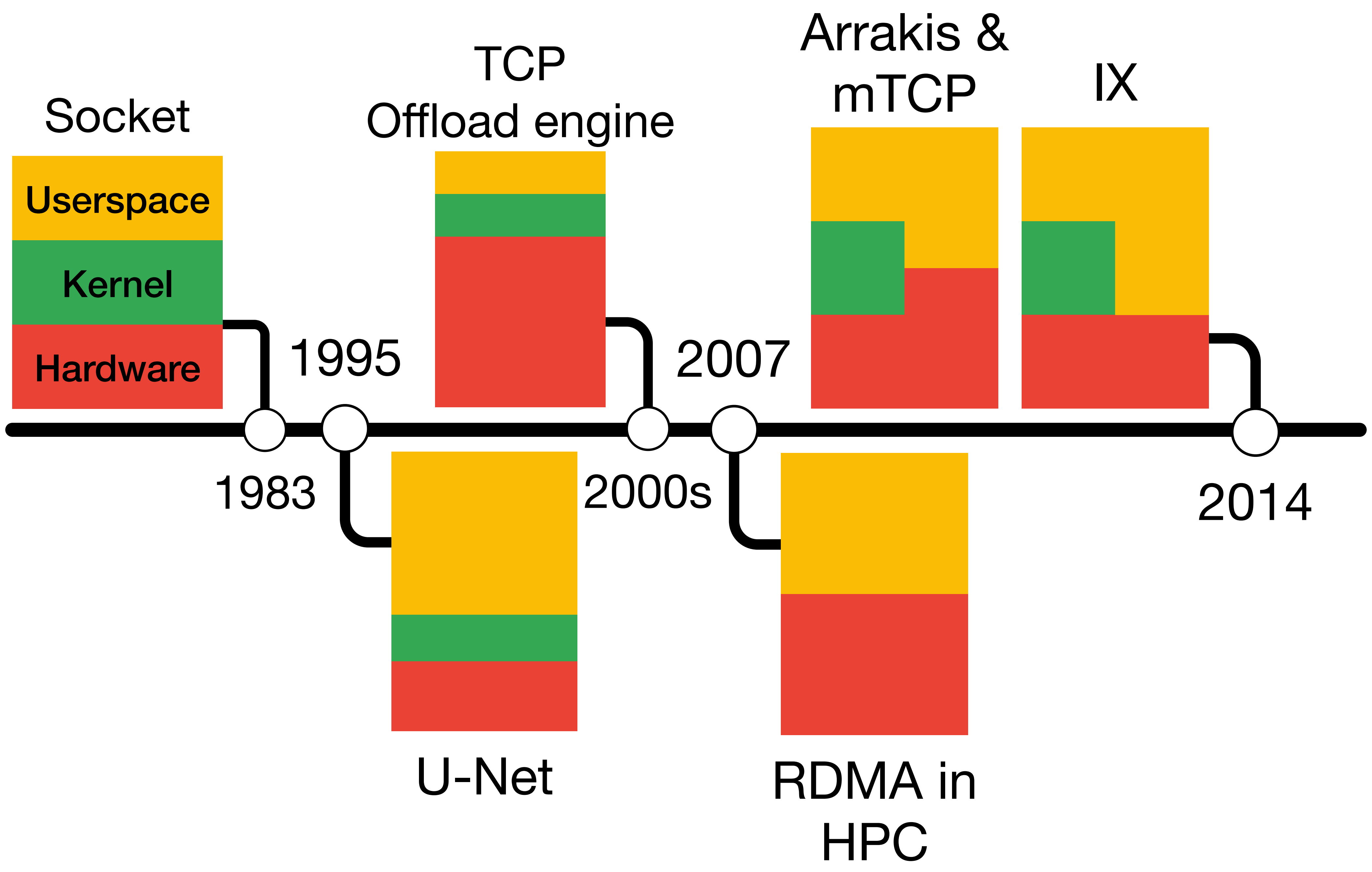
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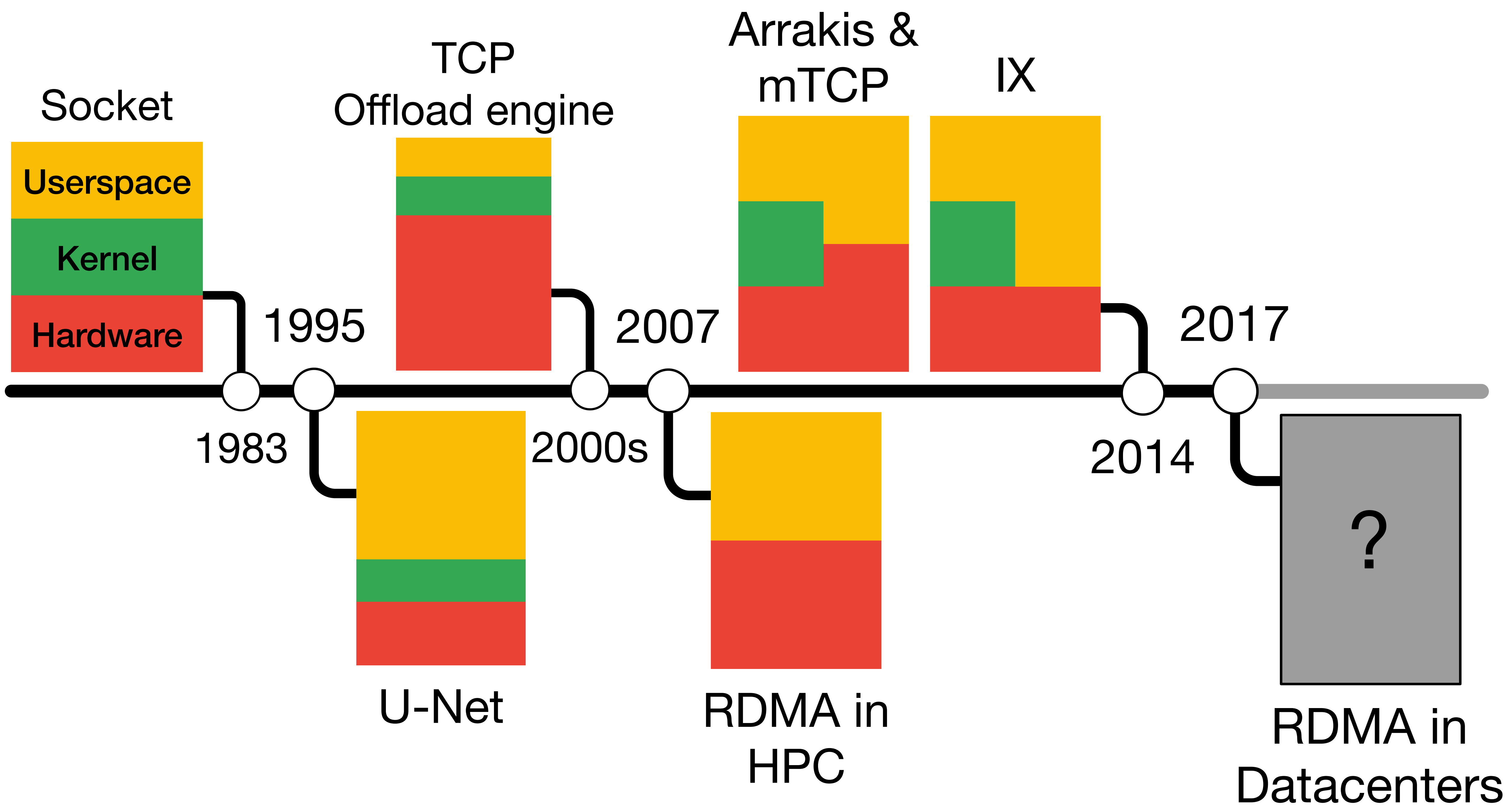
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RDMA in
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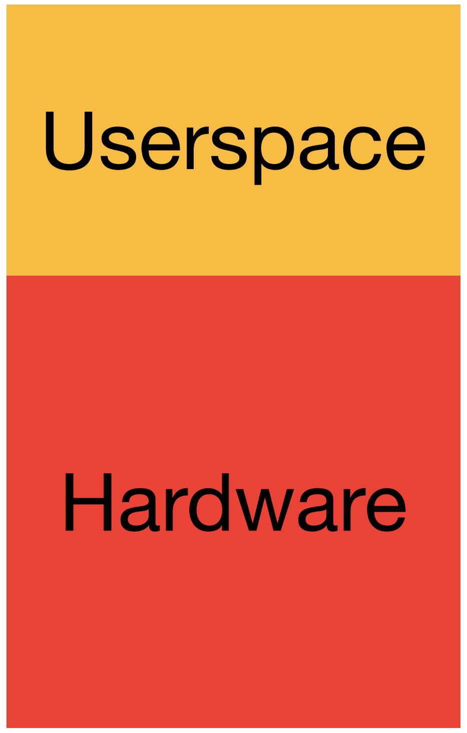
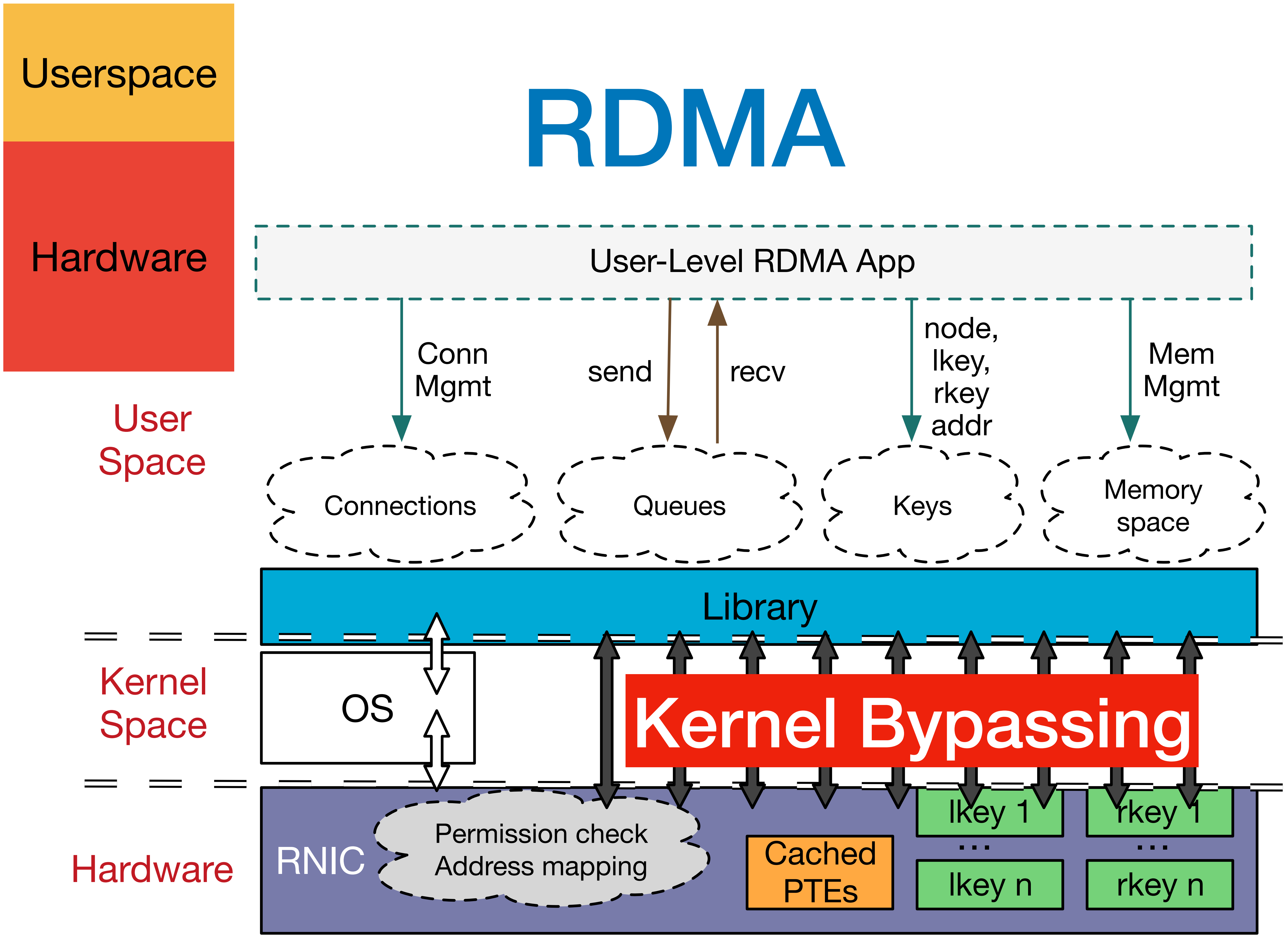


RDMA

RDMA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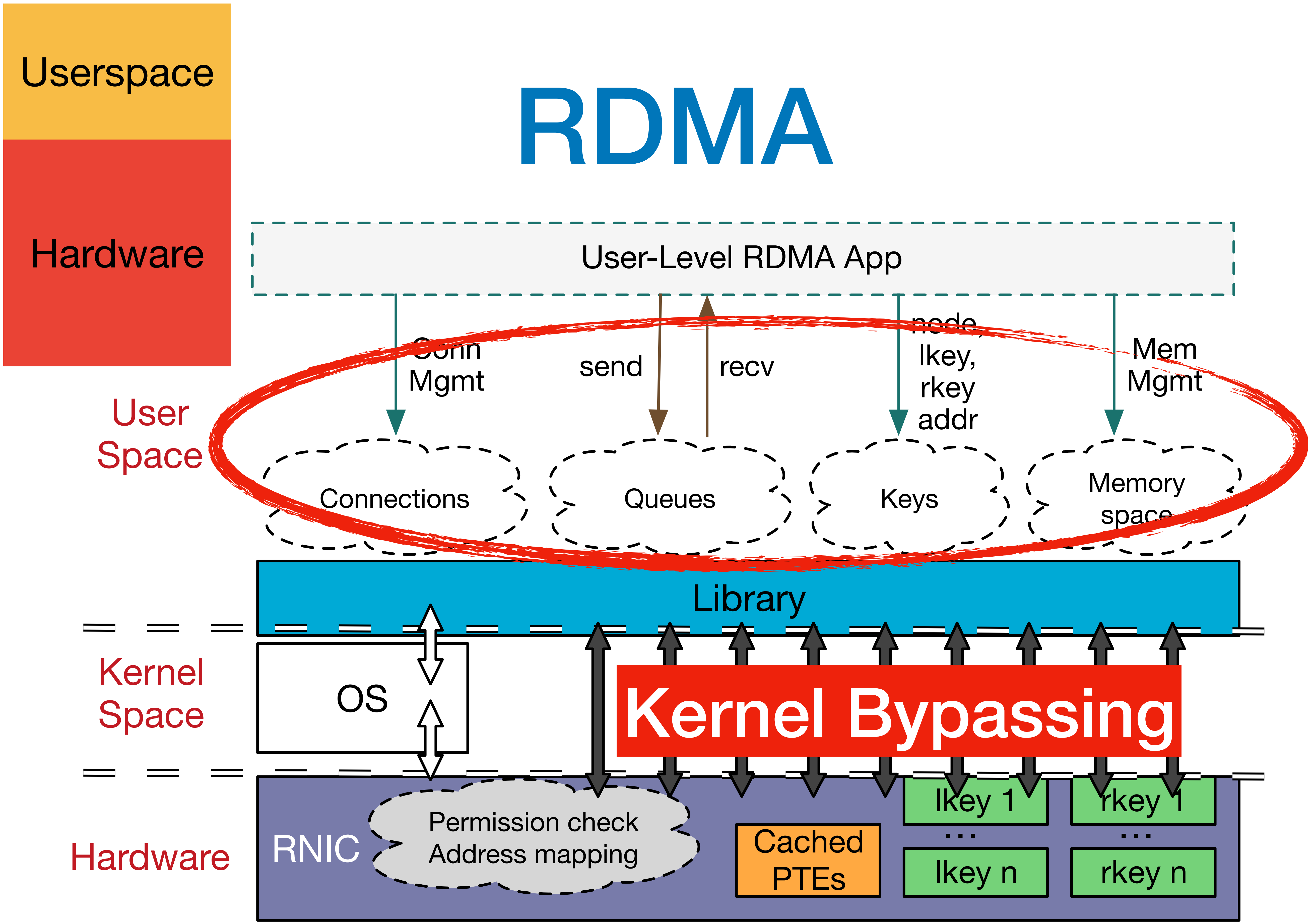
Hardware
User-Level RDMA App
Conn Mgmt
send
recv
node, lkey, rkey addr
Mem Mgmt
User Space
Connections
Queues
Keys
Memory space
Library
Kernel Space
OS
Kernel Bypassing
Hardware
RNIC
Permission check
Address mapping
Cached PTEs
lkey 1
…
lkey n
rkey 1
…
rkey n

RDMA



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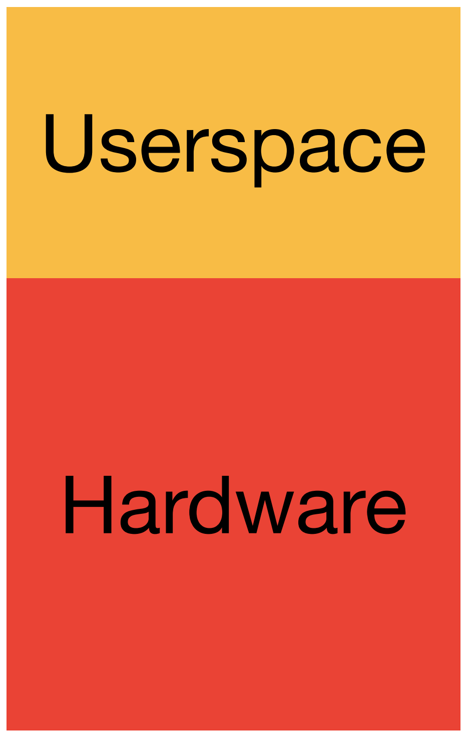
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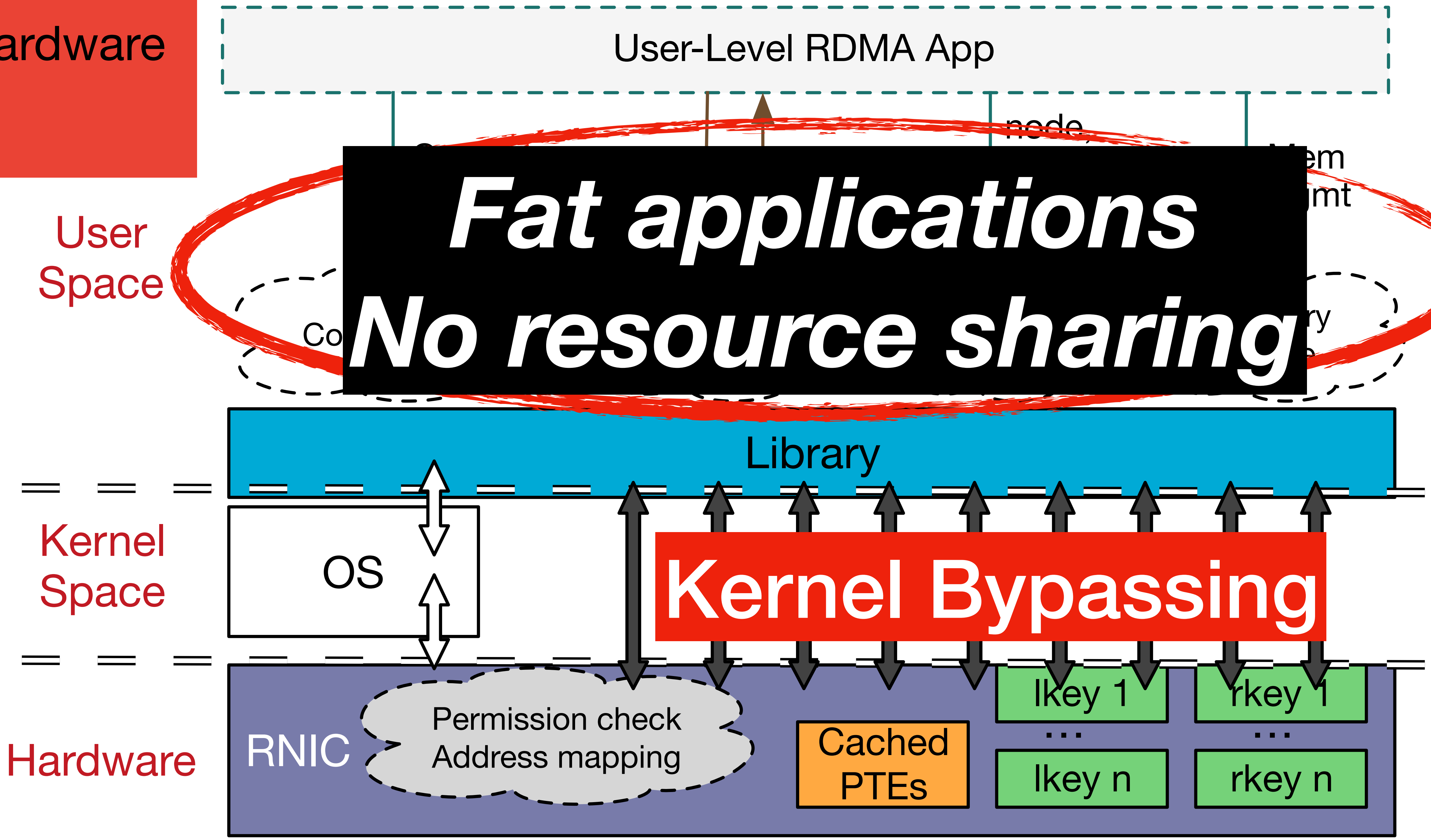
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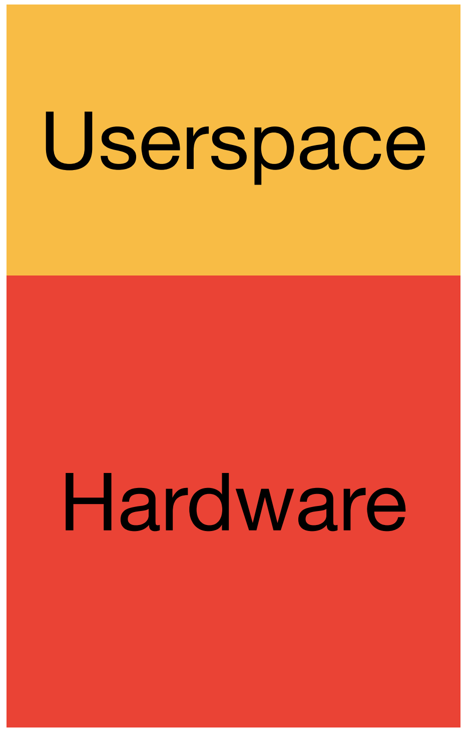
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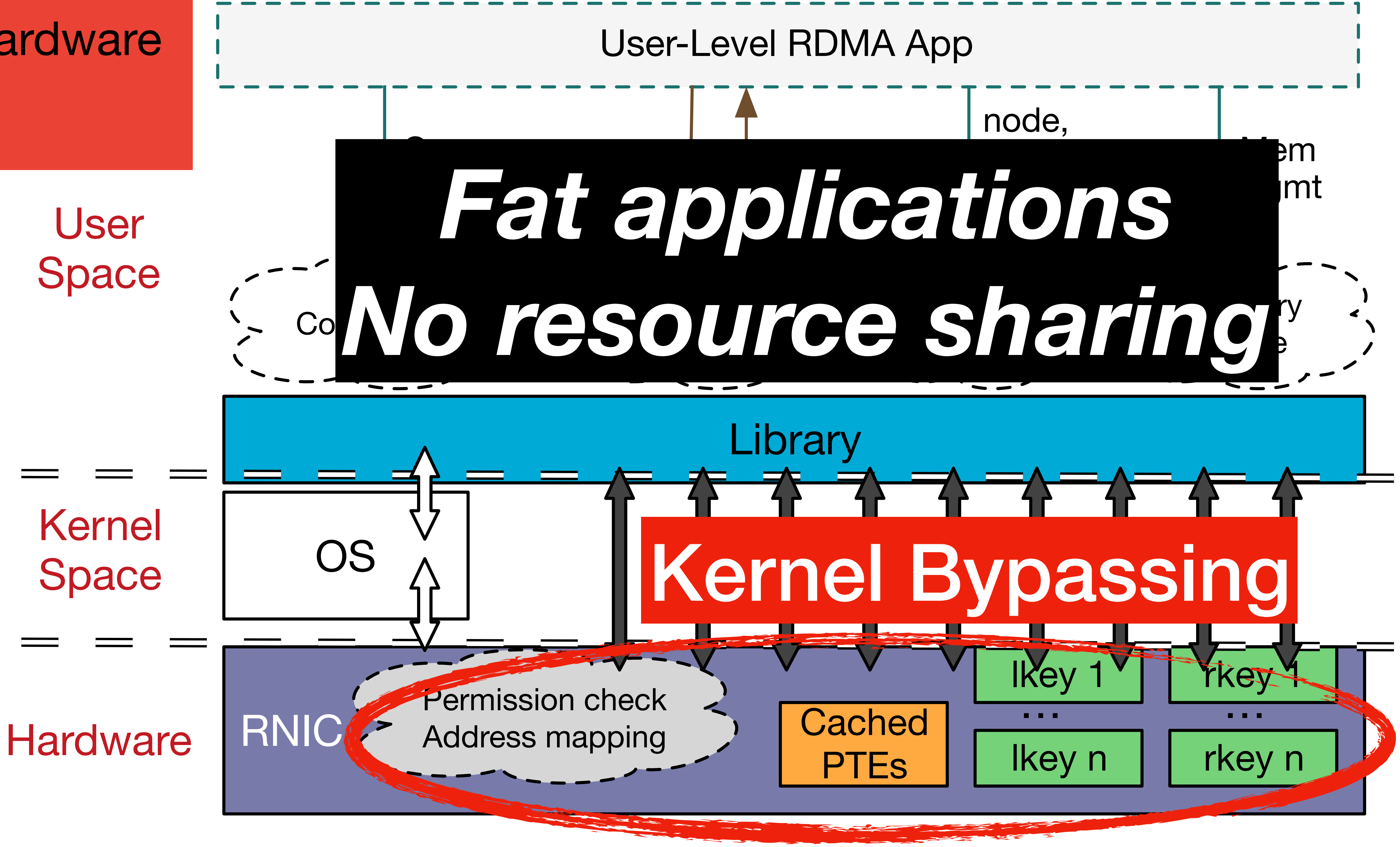
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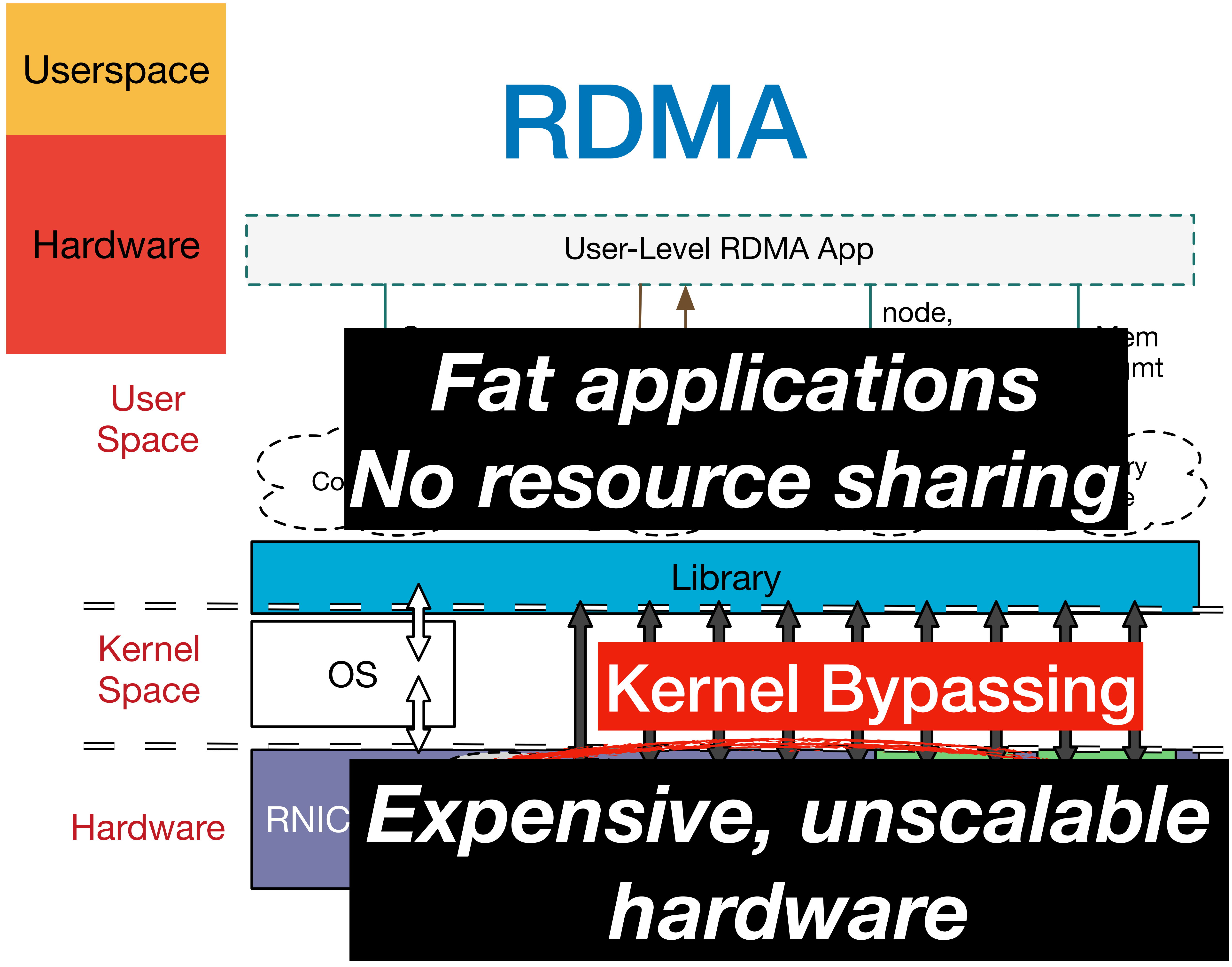

Fat applications

No resource sharing

Kernel Bypassing

Expensive, unscalable hardware

Are we removing too much from kernel?

Without Kernel

High-level abstraction

Resource sharing

Protection

Flexible QoS management

Without Kernel

Resource sharing

Protection

Flexible QoS management

Without Kernel

Resource sharing

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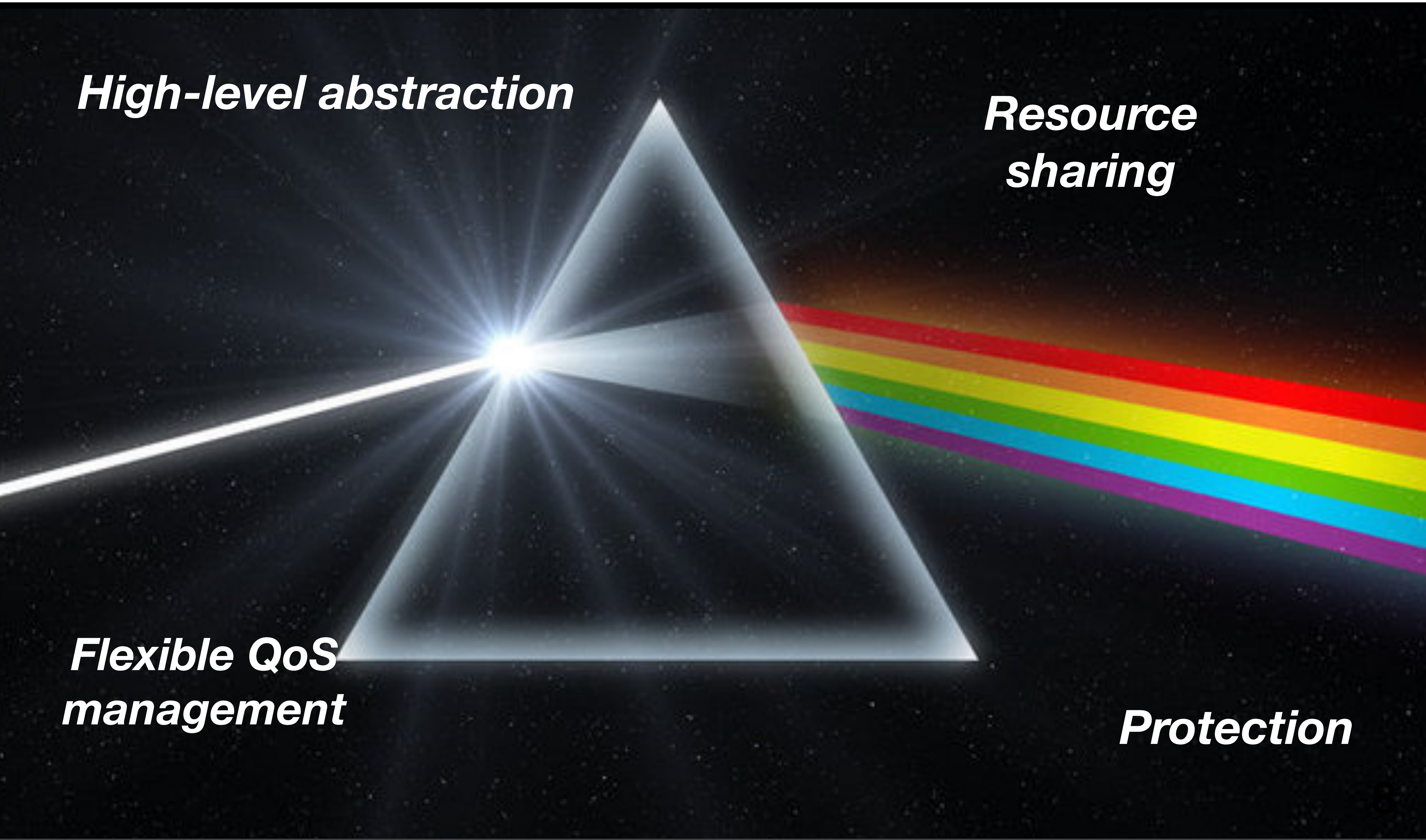
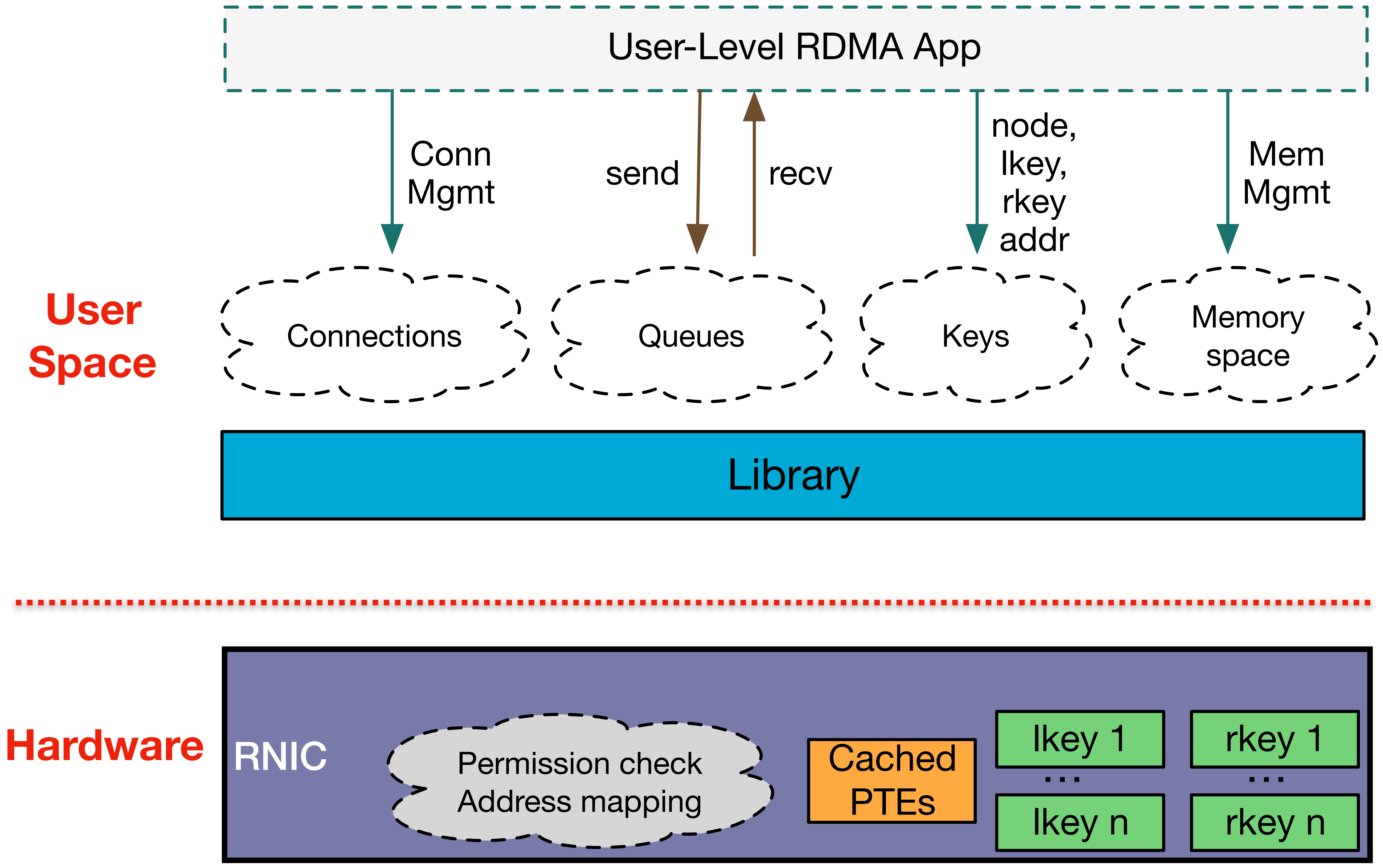
Without Kernel

Flexible QoS management

Without Kernel

LITE - Kernel-Level Indirection for RDMA [SOSP'17]

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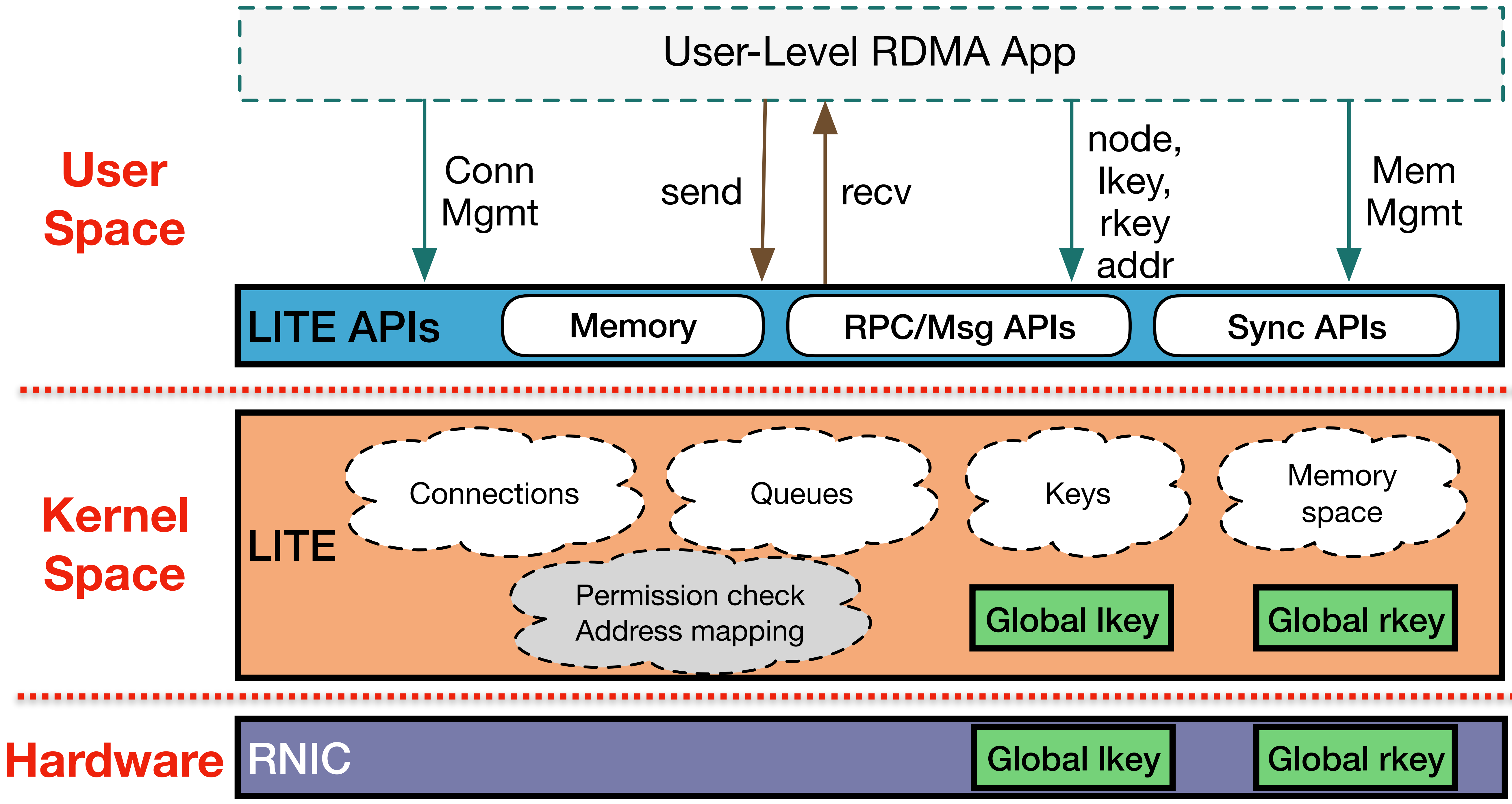
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User Space
Conn Mgmt
send
recv
node, lkey, rkey addr
Mem Mgmt
LITE APIs
Memory
RPC/Msg APIs
Sync APIs
Kernel Space
LITE
Connections
Queues
Keys
Memory space
Permission check Address mapping
Global lkey
Global rkey
Hardware
RNIC
Global lkey
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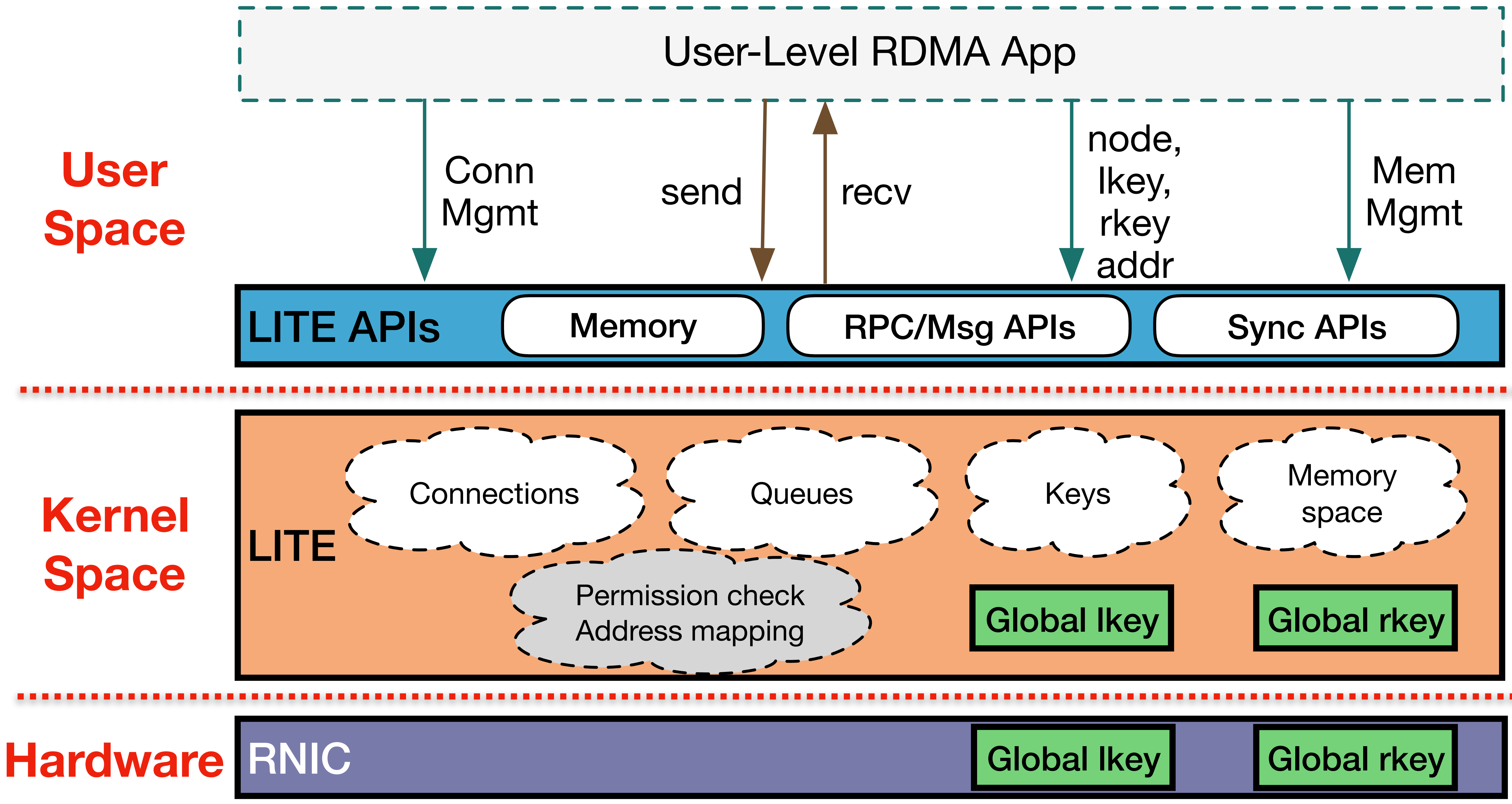
Simpler applications



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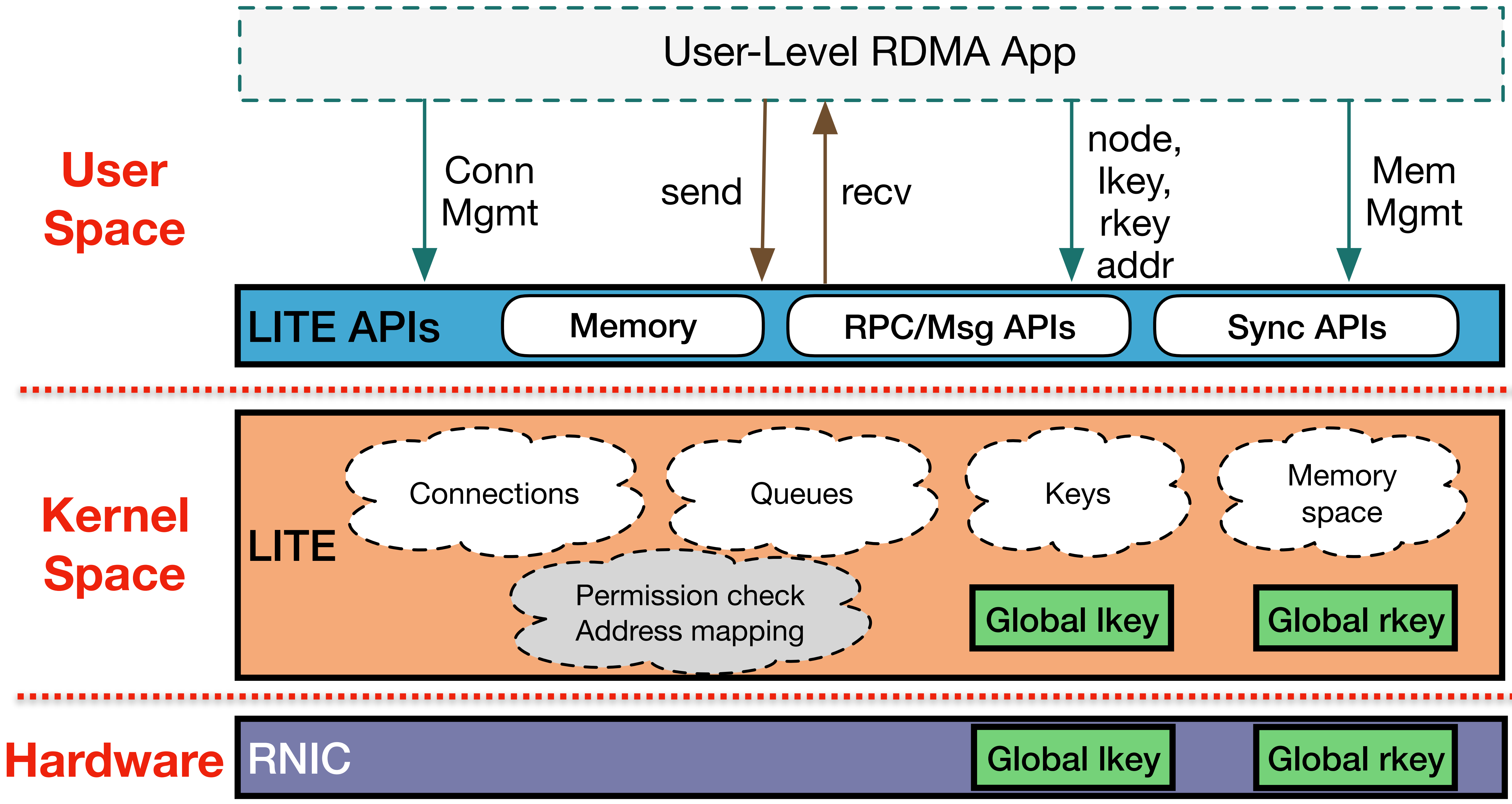
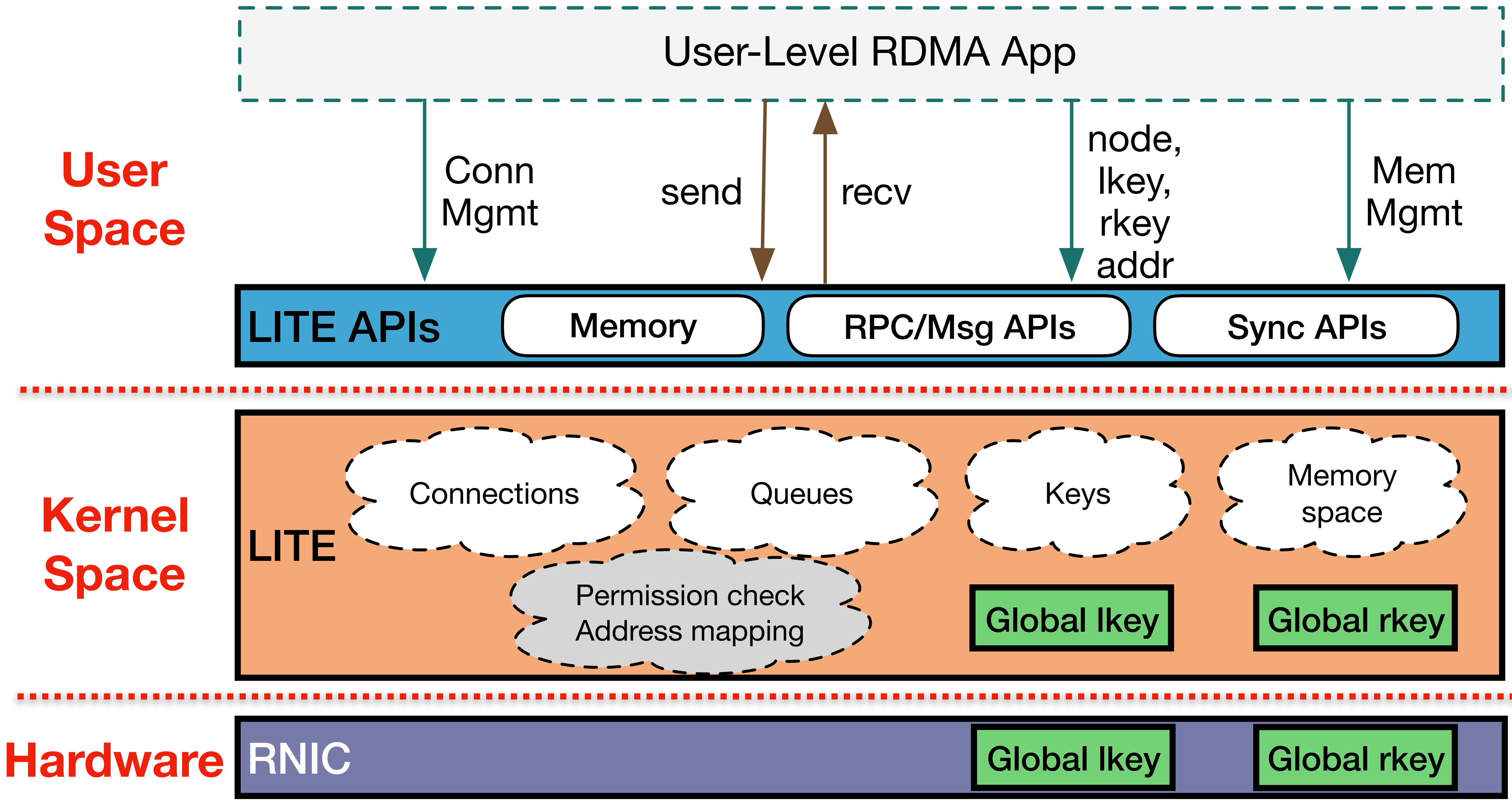


Cheaper hardware

Simpler applications



Cheaper hardware

Great Performance and scalability

My students, **before** going to their first conference:

Kernel programming is fun; we like doing great engineer work

Projects at WukLab

- ***LITE*** [sosp'17]: **15K** LOC, 80% in kernel
- ***Hotpot*** [SoCC'17]: **19K** LOC, all in kernel
- ***Lego*** OS [ongoing]: **170K** LOC already, all in kernel

My students, **after** going to their first conference:

Why are we writing so many kernel code when other students can get a paper with hundreds lines of user-level code?

Thank you
Questions?

Get LITE at: *[github.com/Wuklab/LITE]*

wuklab.io