



The Kernel

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Scheduler: Round-Robin, Priority Queues, Tree Flavours

Scheduler Actors: Features, Timers, Async I/O

Streams Backends: Zero-copy, Message Passing

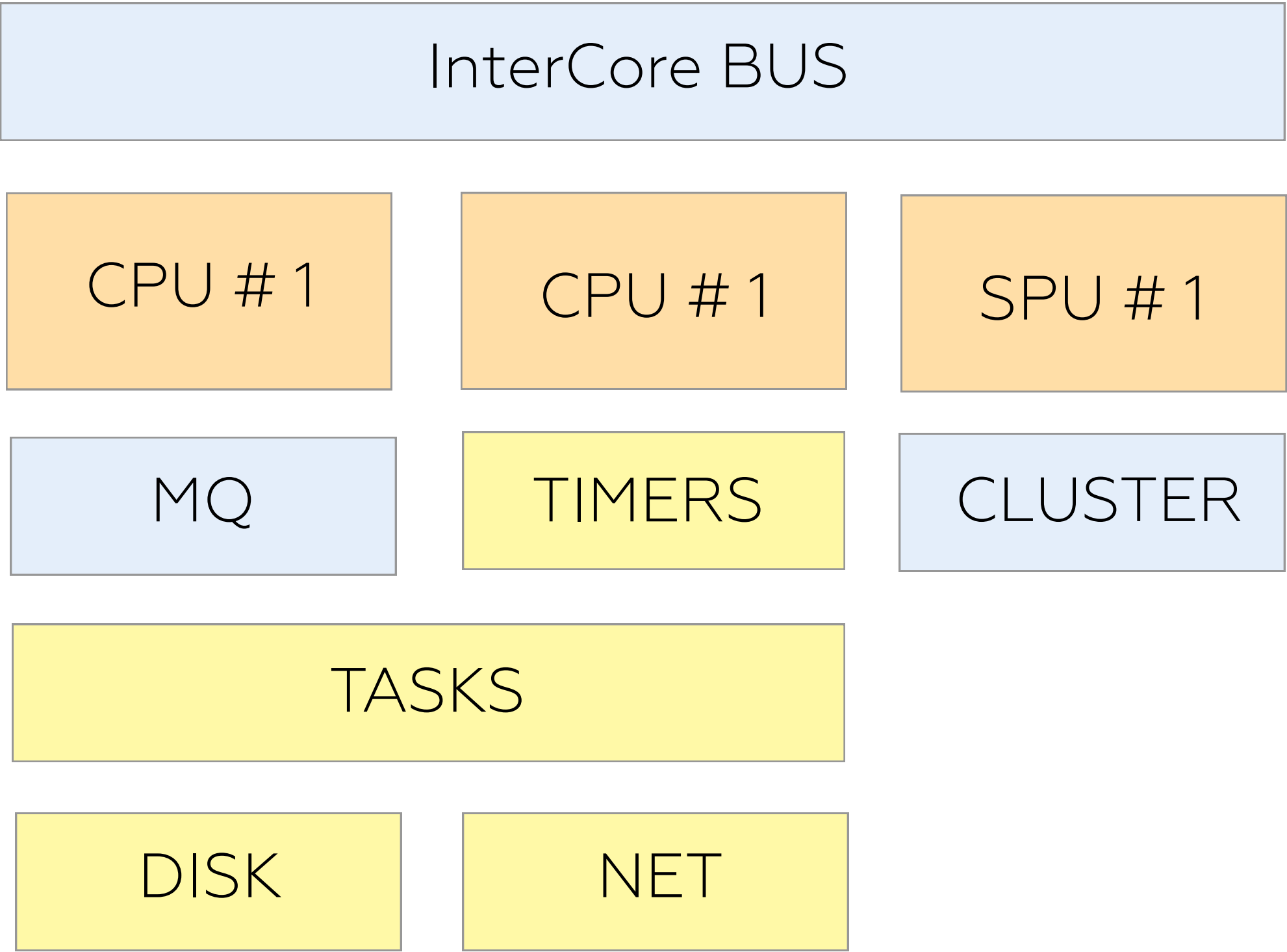
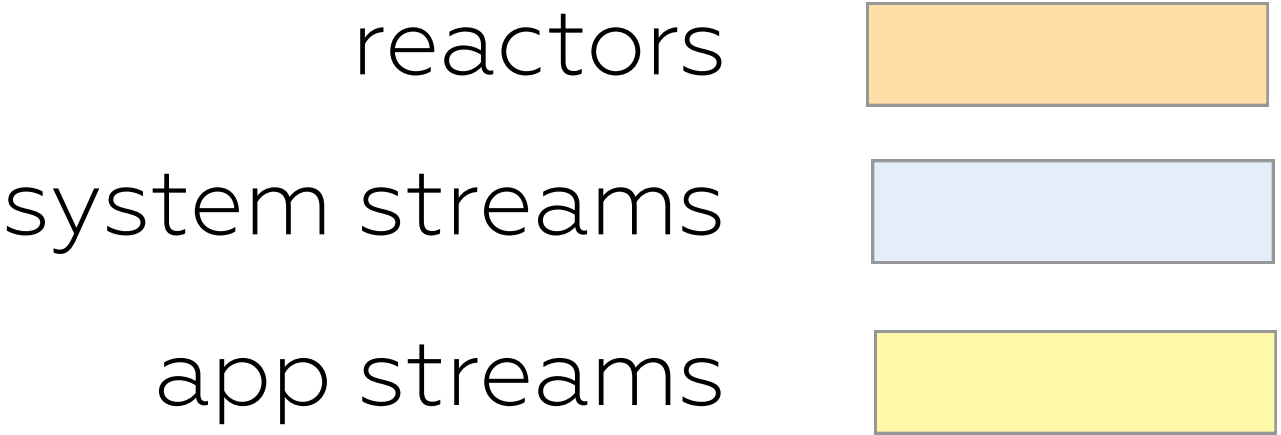
Linear Backends: Async I/O Disk Streams, Network Streams

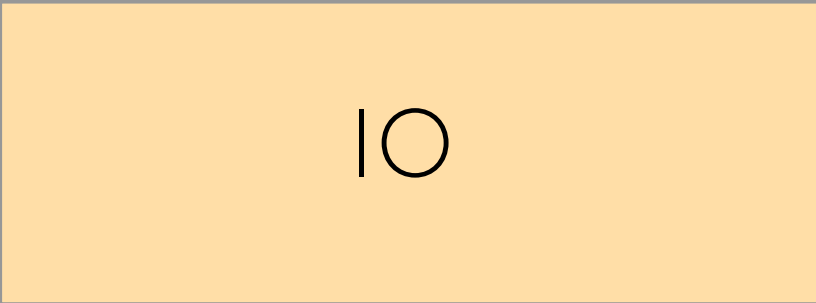
Indexed Backends: Timers, Actors

Backpressured Message Bus/Buffers: Arc/Vec prealloc

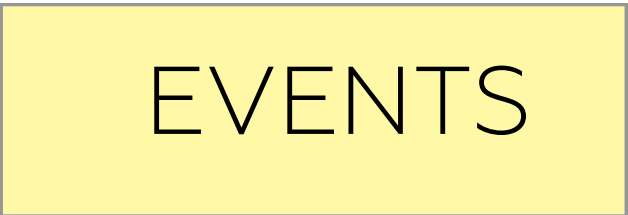
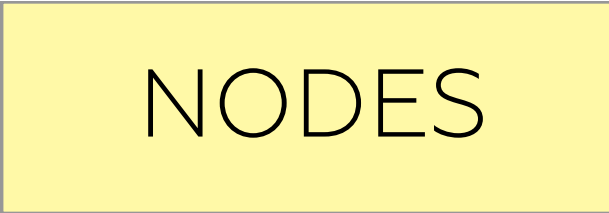
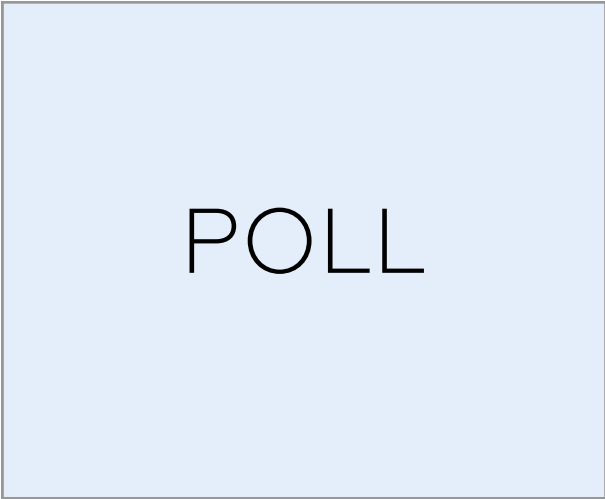
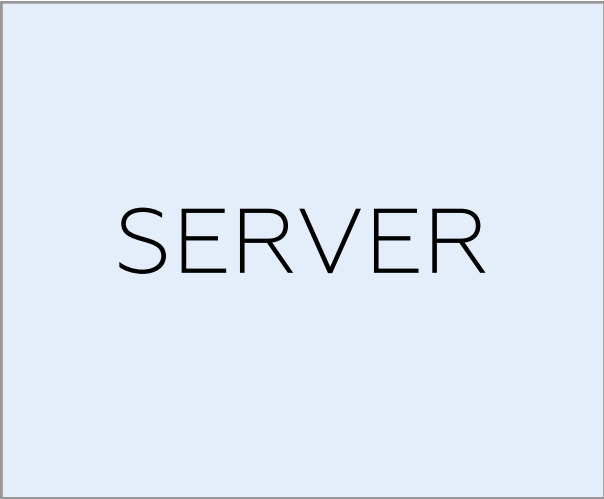
Class: Low Latency, Real Time

Linear: MQ, EXT, DISK, NET
Trees: TIMERS
Priority Queues: TASKS, IRQ





MIO compatible polling loop based on Readiness Queue



OS: EPOLL WAIT

MQ

Queue Types

SPSC/LINK

4-10ns Lowest Latency Possible

MPSC/SUB

10-40ns Reducer or Subscribe Polling

SPMC/PUB

10-40ns Publisher Multicursor

FAST DELIVERY CASE

Single Threaded Task Configuration
to be compared as reference

I/O TASK



CPU TASK



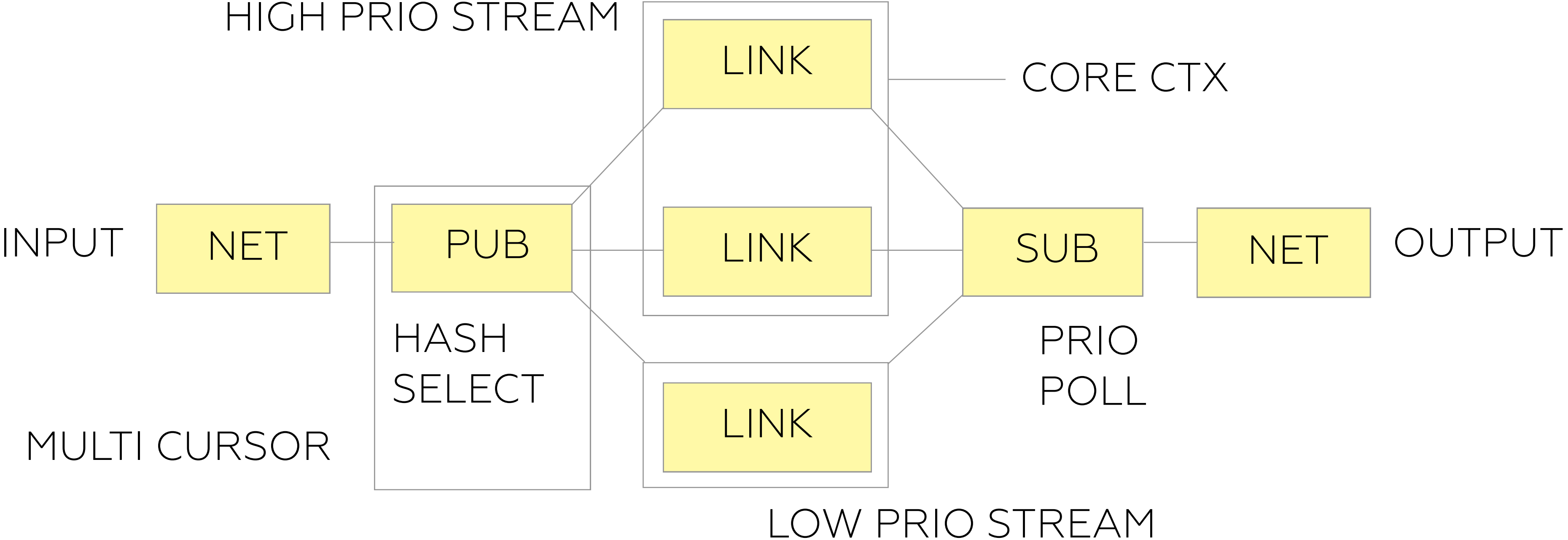
I/O TASK



You can use inplace message modifying and reduce copies to unpack and pack.

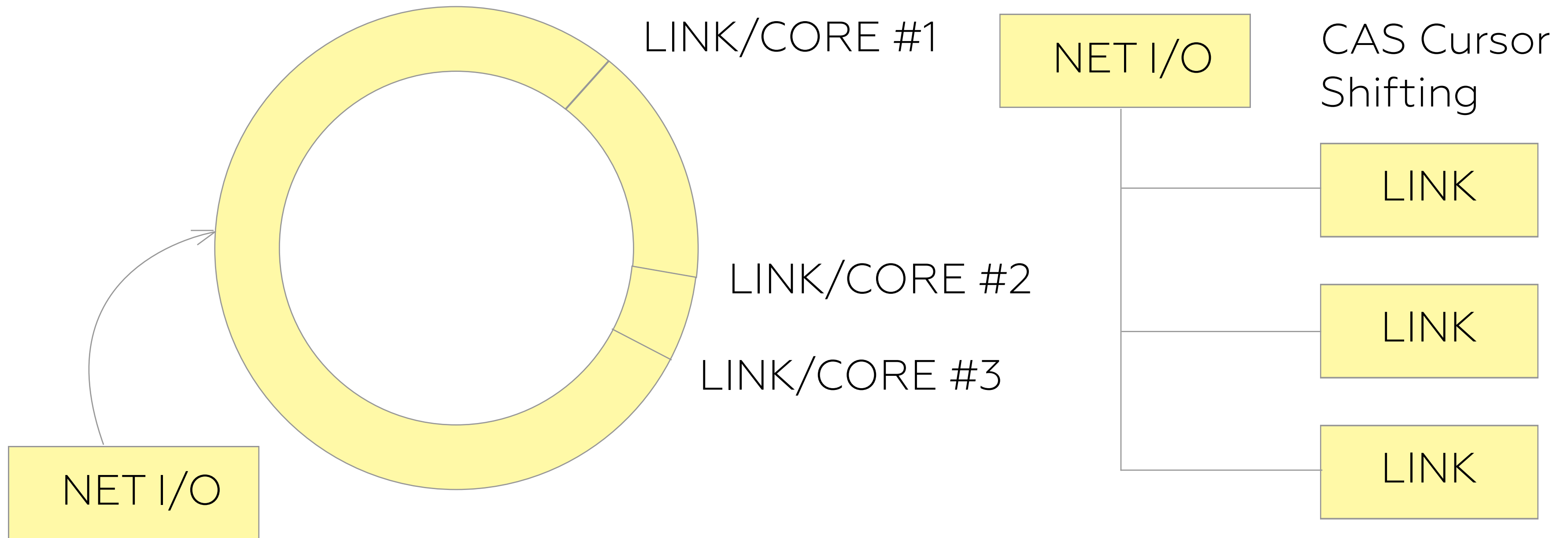
LOAD BALANCING CASE

Load Balancing
of Priority Streams per Core
Buckets



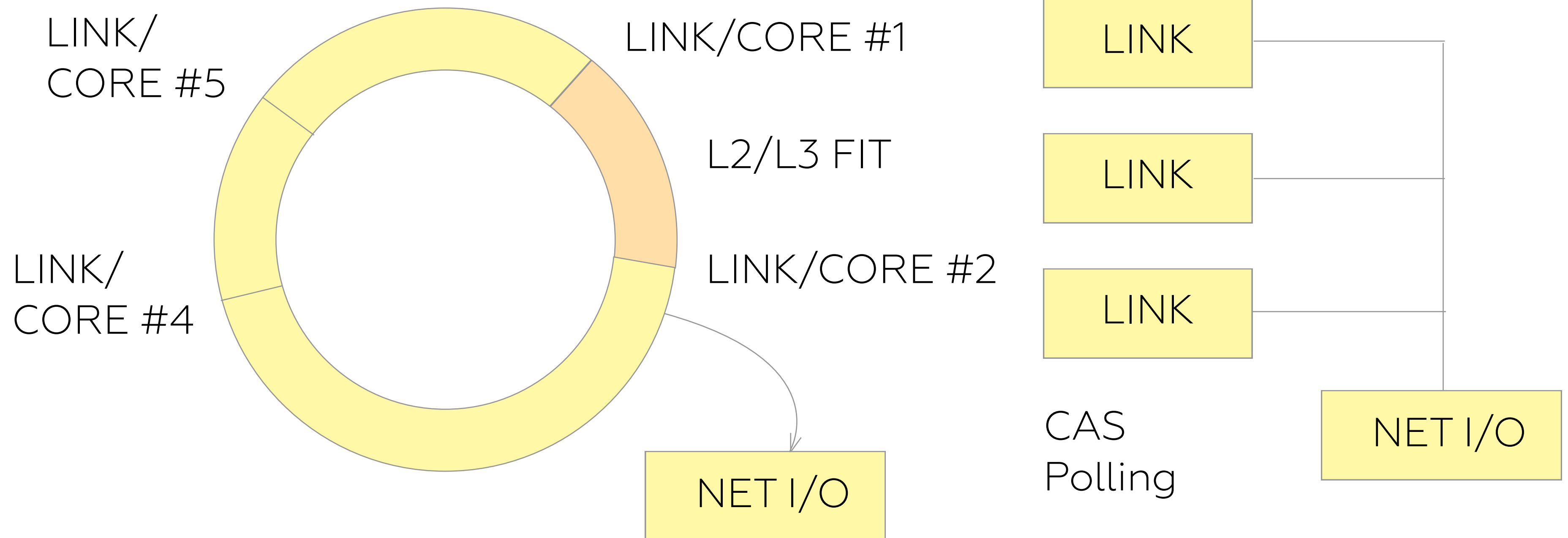
PUBLISHER CASE

PUB Implementation for Zero-Copy
Multiple Consumer Publishing (SPMC)



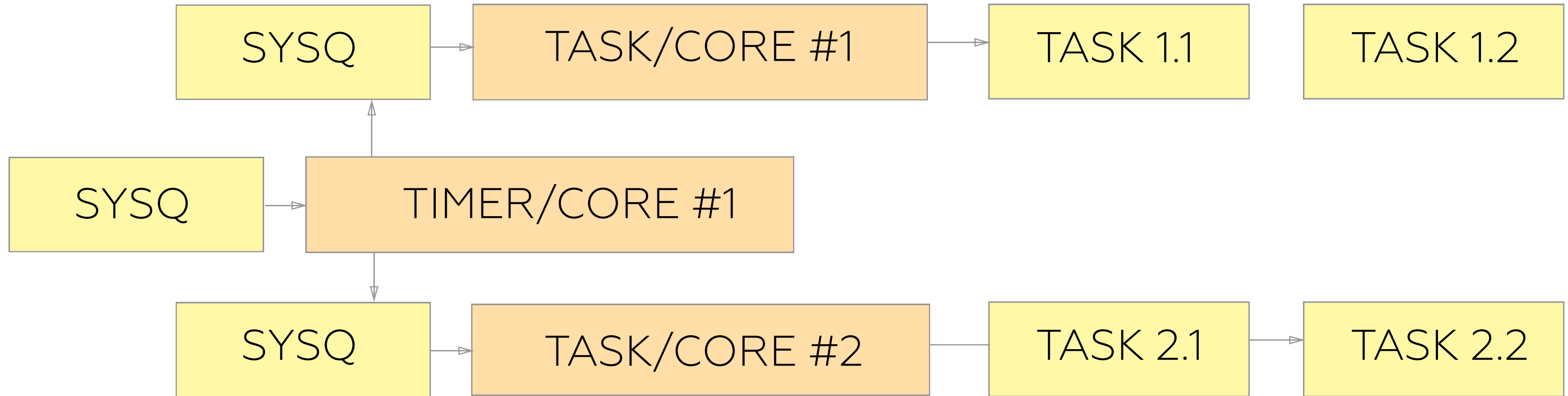
SUBSCRIBER CASE

Multicursor Implementation of SUB (MPSC)
for InterCore Queue Migrations and Cache
Locality



TIMERS

Scheduler Reactors can communicate through InterCore transport for Timers.



Timer uses Linear Firing Round Robin.

Tasks

Cursors/Counters

TASK

STATE VEC

FSM

DATA

CODE

CUR #1 R/W

CUR #2 R

CUR #3 W

CNT #1

0—0xFFFF

0xFFFF—0xFFFF0000

0xFFFF0000—0xFFFFFFFF

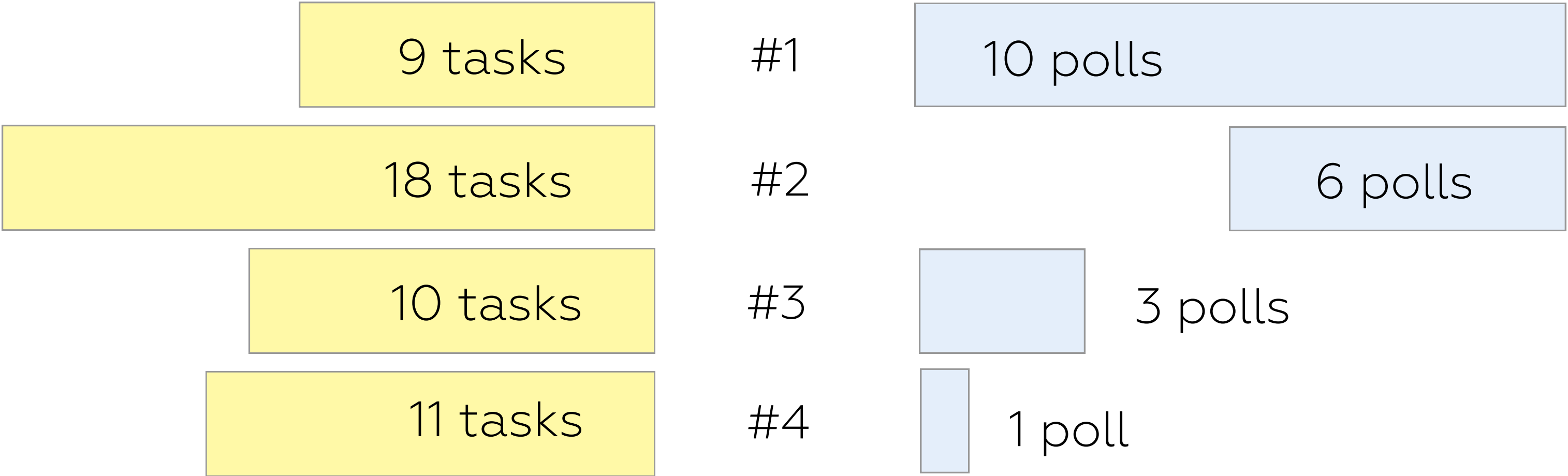
00120090912090

Capacity: 239
Workload: 48

Time: 20
Total: 400

Avg Task Consumption
Accumulated in the Task Stream

$\Sigma \text{Tasks} * \text{Polls} * \text{AvgTime} = \text{Capacity}$



prios: [10,6,3,1]

ITERATORS

```
+/{x*y}[(1;3;4;5;6);  
        (2;6;2;1;3)]
```

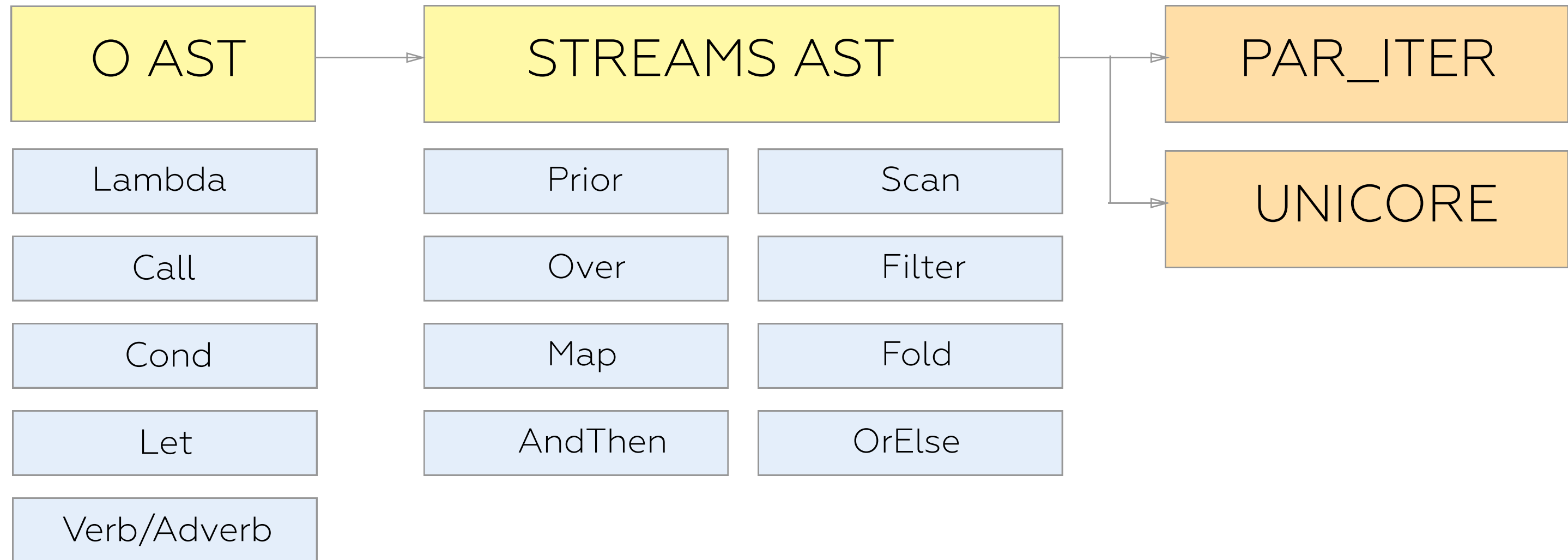
```
+/{x*y}[vec1;vec2]
```

```
vec1.iter().zip(vec2  
  .iter()).map(|(i, j)|  
  i * j).sum()
```

```
movdqu    16(%rdx,%rax,4), %xmm2  
movdqu    16(%rdi,%rax,4), %xmm3  
pshufd    $245, %xmm2, %xmm4  
pmuludq   %xmm3, %xmm2  
pshufd    $232, %xmm2, %xmm2  
pshufd    $245, %xmm3, %xmm3  
pmuludq   %xmm4, %xmm3  
pshufd    $232, %xmm3, %xmm3  
punpckldq %xmm3, %xmm2  
padd      %xmm2, %xmm1  
movdqu    (%rdx, %rax,4), %xmm2  
movdqu    (%rdi, %rax,4), %xmm3  
pshufd    $245, %xmm2, %xmm4  
pmuludq   %xmm3, %xmm2  
pshufd    $232, %xmm2, %xmm2  
pshufd    $245, %xmm3, %xmm3  
pmuludq   %xmm4, %xmm3  
pshufd    $232, %xmm3, %xmm3  
punpckldq %xmm3, %xmm2  
padd      %xmm2, %xmm0
```

INTERPRETER

Unified Pipeline of Language and Streams
Interpretation for Unicore and Multicore

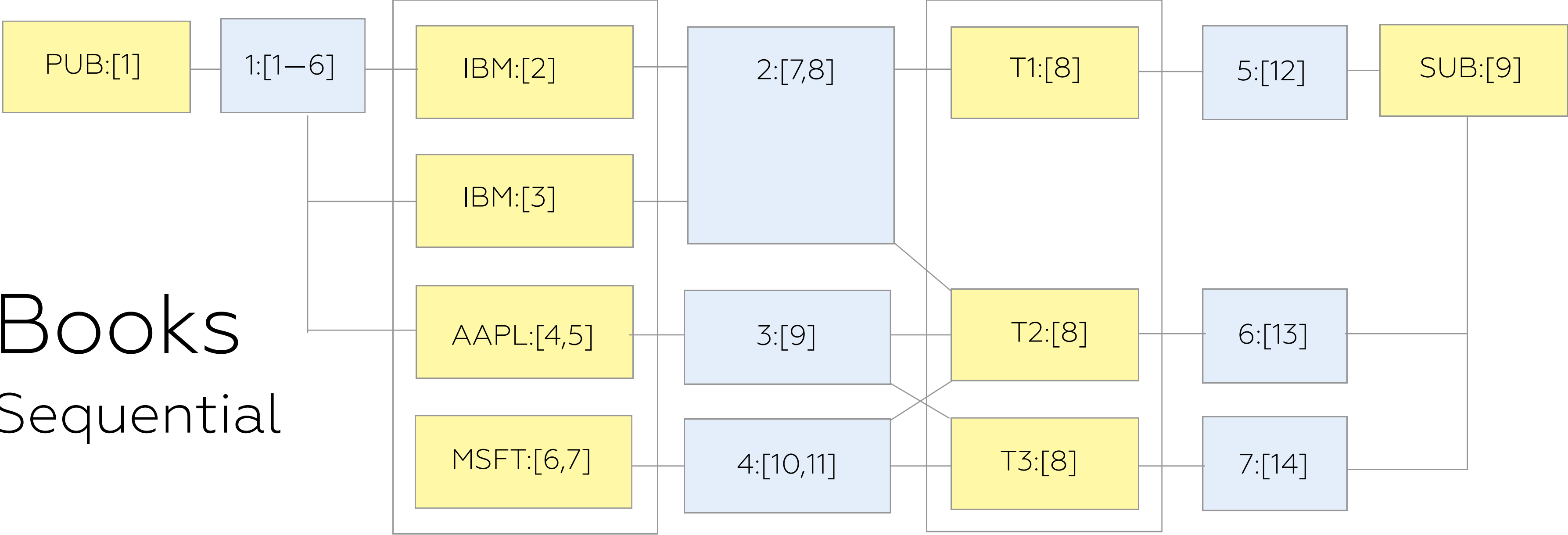


The motivation is to keep LLVM vectorizer continuous happy

```
Console is listening...
>
ring[reader;mem[0;16]];
ring[writer;mem[0;16]];
cursor[1;writer;1];
split[1;2;50];
split[2;3;50];
split[1;4;50];
cursor[5;reader;1];
split[5;6;50];
split[5;7;overlapped];
reactor[aux;0;mod[console;network]];
reactor[timercore;1;mod[timer]];
reactor[core1;2;mod[task]];
reactor[core2;3;mod[task]];
spawn[1;80;AAPL;trader1;core1];
spawn[2;80;EEM-SPY-GDX;trader1;core1];
spawn[3;20;AMI;trader1;core1];
spawn[5;80;GOOG;trader2;core2];
spawn[4;80;FB-NFLX-AMZN;trader2;core2];
timer[timer1;core1;SPY;rule1;t1;notify];
list[reactors];
list[rings];
list[cursors;writer];
list[core1];
list[timercore];
send[1;message1];
send[1;message2];
dump[1;mem[0;100]];
show[recv;1];
```

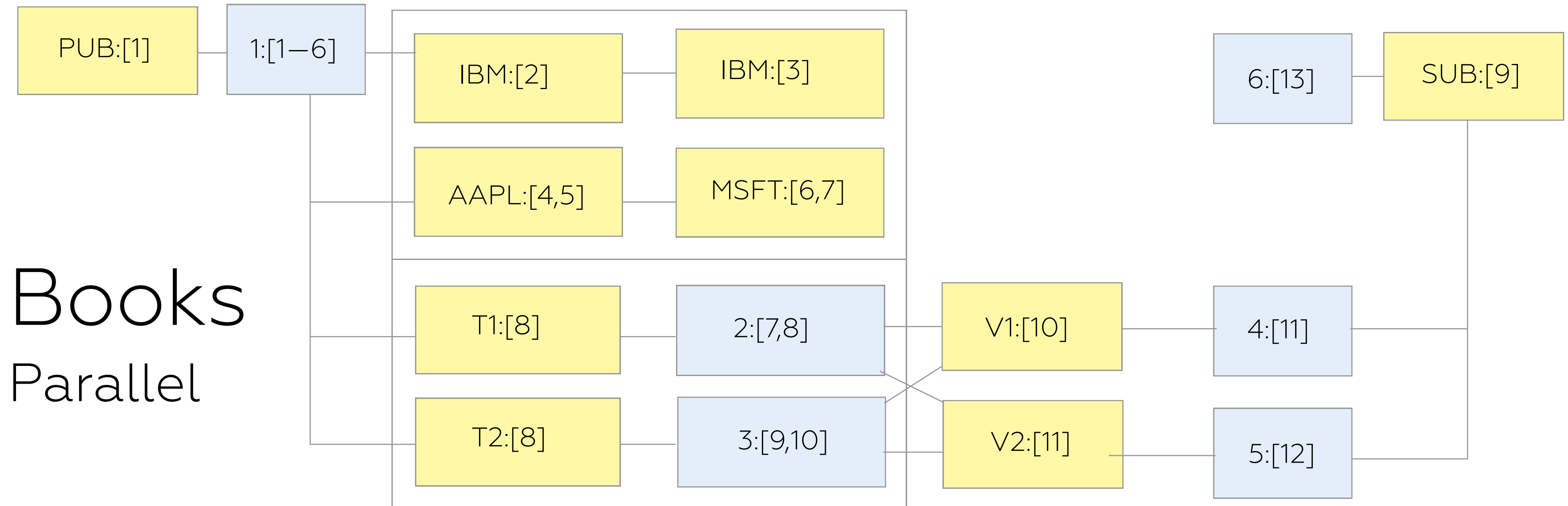
io	seq	ring
register	spawn	join
send	cursor	split
sync	reactor	timer

12x CPU Cores: In: [1] Order Books: [2,3,4,5,6,7] Traders: [8] Out: [9]



8x32K MEM Regions: Input Queue: [1] Reducing Queues: [2,3,4,5,6,7]

12x CPU Cores: In: [1] Order Books: [2,3,4,5,6,7] Traders: [8] Out: [9]
Venues: [10,11]



8x32K MEM Regions: Input Queue: [1] Reducing Queues: [2,3,4,5,6]

Book: AAPL

id	side	time	vol	price	venue
====	====	=====	=====	=====	=====
3	ASK	09:05:01:123871012	200	20.30	1
1	ASK	09:01:12:192090139	100	20.30	2
2	ASK	09:03:25:716945237	100	20.25	1
5	BID	09:08:42:134673465	200	20.20	1
4	BID	09:06:11:784316783	100	20.15	1
6	BID	09:09:37:834852874	200	20.15	2