2019 DESIGN AND VERIFICATION™ DVCON CONFERENCE AND EXHIBITION UNITED STATES

Synchronicity:
Bringing Order to the SystemVerilog/UVM Synchronizing Chaos

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Experience. Outcomes.

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Agenda

Discuss synchronizing constructs in...

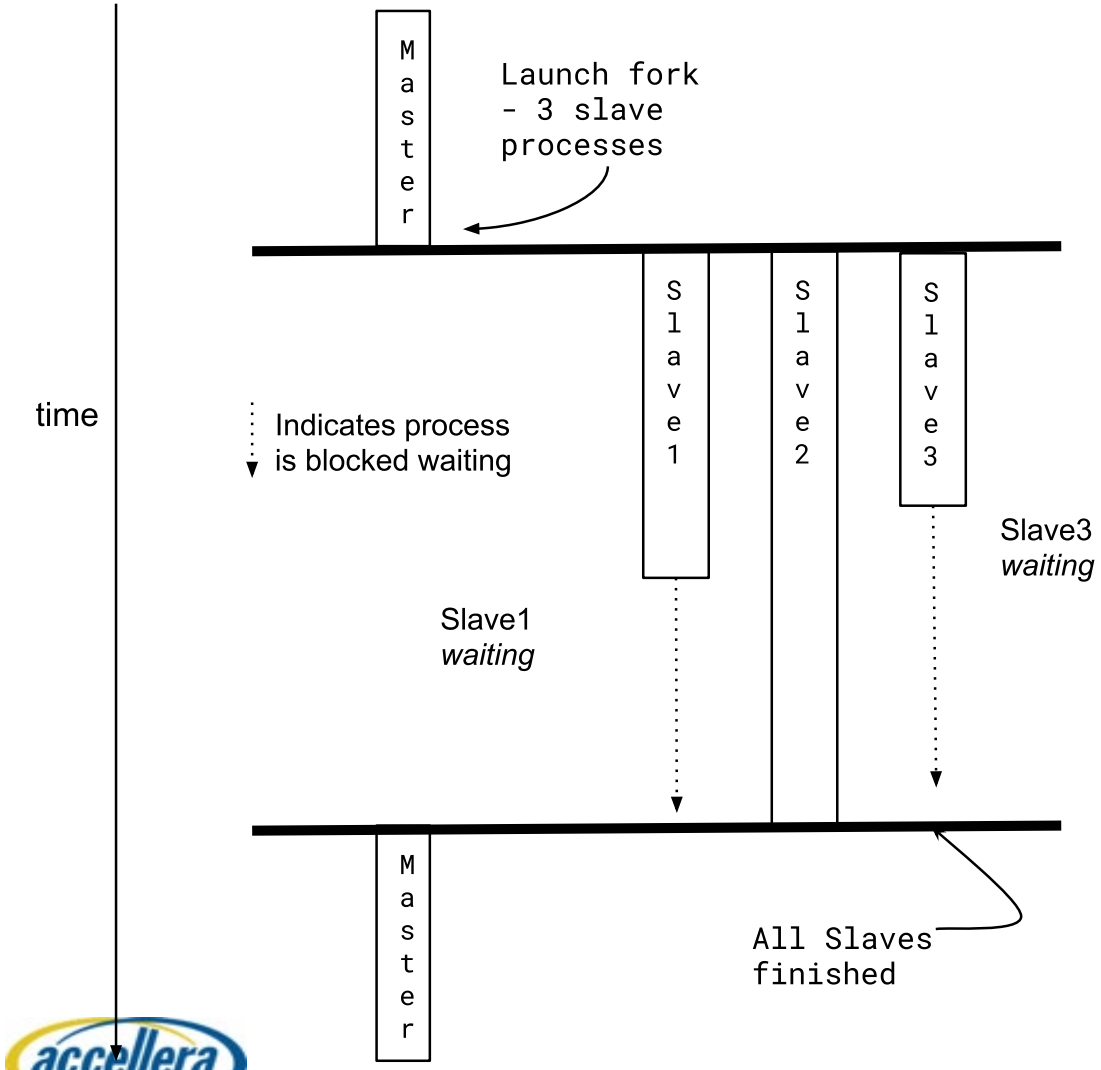
- SystemVerilog ... *very* quick review:
  - `fork-join` + variants; `event`, `semaphore`, `mailbox`
- UVM classes
  - which use or re-implement the above...

Agenda (cont'd)

- UVM ... whirlwind tour of:
  - `uvm_event` + `uvm_event_callback`
  - `uvm_barrier`
  - `uvm_objection`
  - `uvm_subscriber`
  - `uvm_heartbeat`
  - `TLM FIFO`
- Goal: Demonstrate these are superior to their SV equivalents.
- Paper has more details
  - guidance on use-model for each
  - references other papers with innovative use of each class above

Tour de SystemVerilog Synching

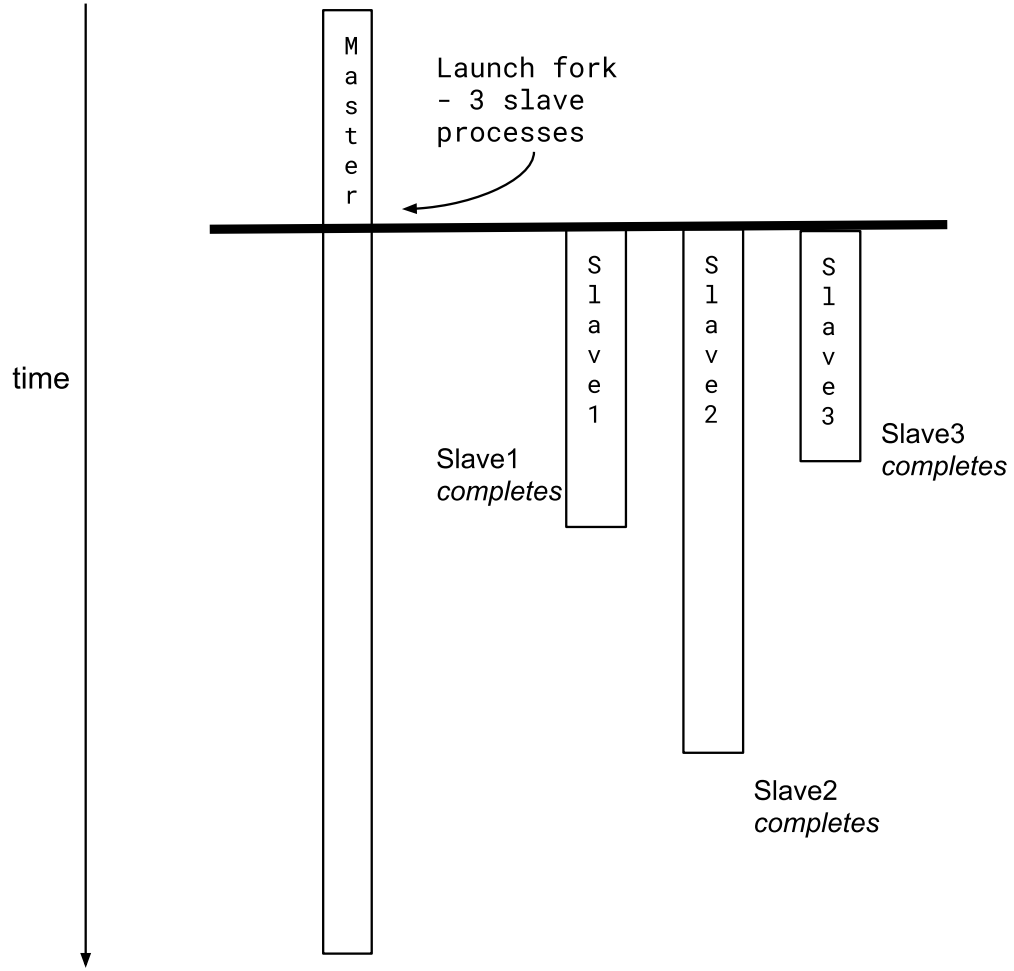
fork-join




```
fork : MASTER_SCOPE
    begin : SLV1_SCOPE
        Slave1();
    end
    begin : SLV2_SCOPE
        Slave2();
    end
    begin : SLV3_SCOPE
        Slave3();
    end
join
```

Tour de SystemVerilog Synching

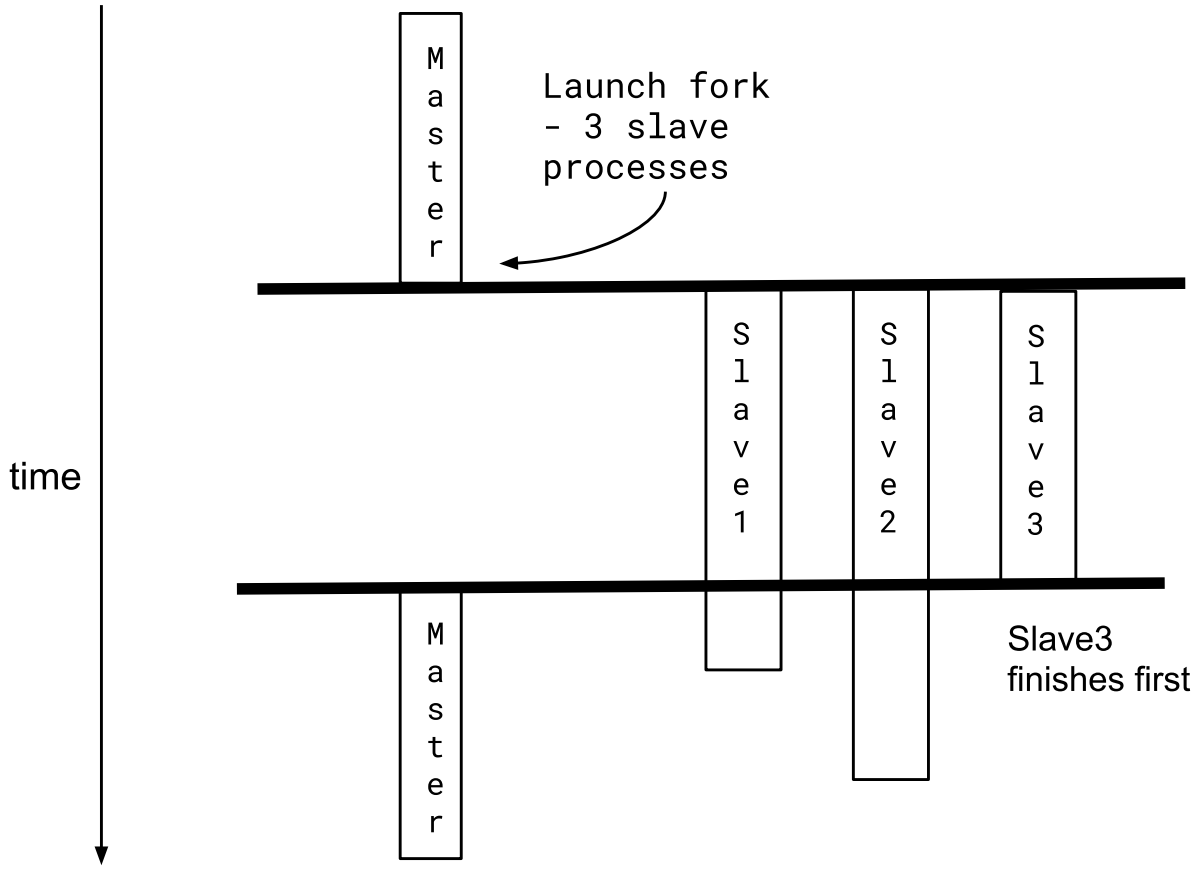
fork-join_none




```
fork : MASTER_SCOPE
    begin : SLV1_SCOPE
        Slave1();
    end
    begin : SLV2_SCOPE
        Slave2();
    end
    begin : SLV3_SCOPE
        Slave3();
    end
join_none
```

Tour de SystemVerilog Synching

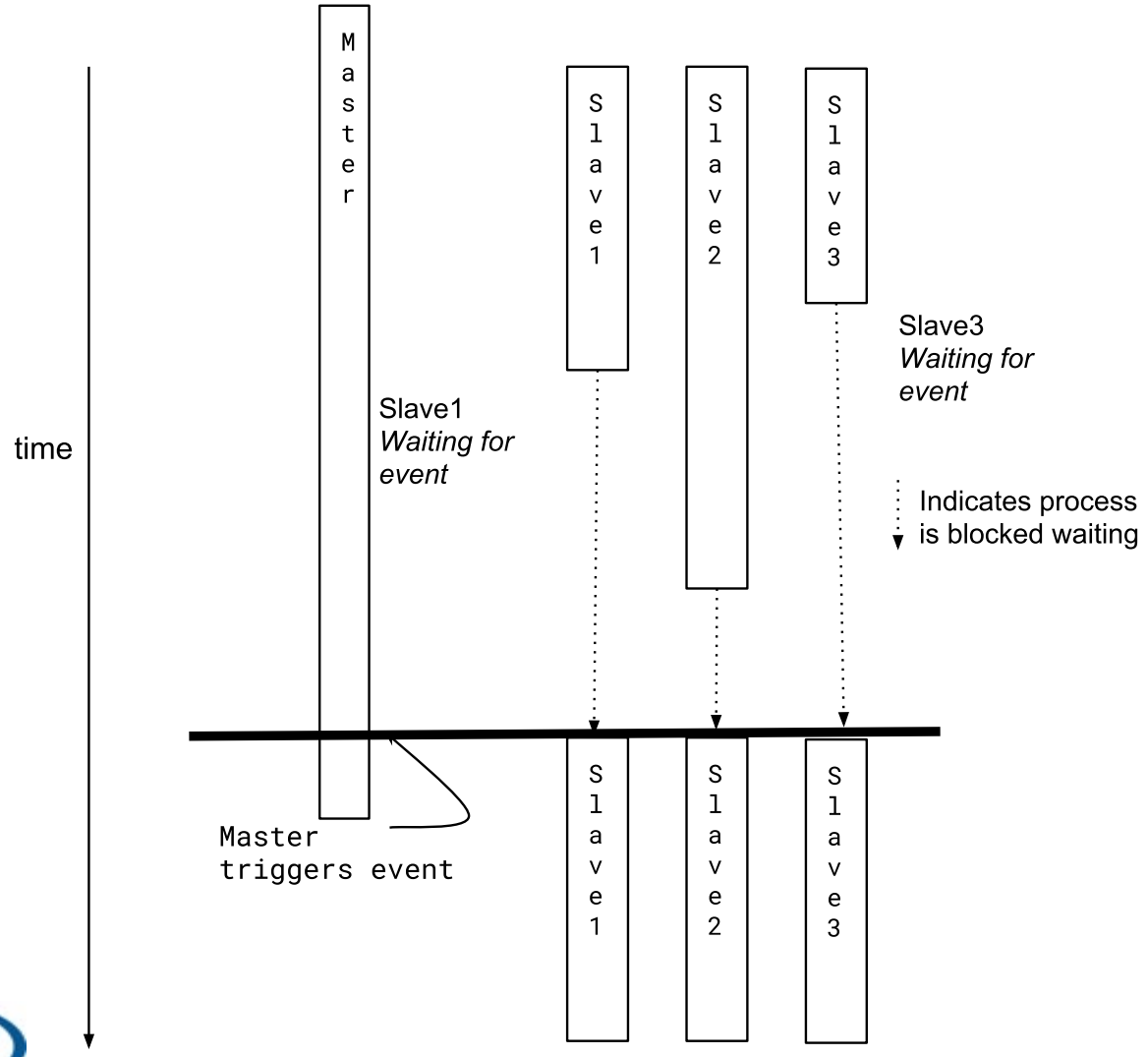
fork-join_any




```
fork
   fork : MASTER_SCOPE
      begin : SLV1_SCOPE
         Slave1();
      end
      begin : SLV2_SCOPE
         Slave2();
      end
      begin : SLV3_SCOPE
         Slave3();
      end
   join_any
   disable_fork;
join
```

Tour de SystemVerilog Synching

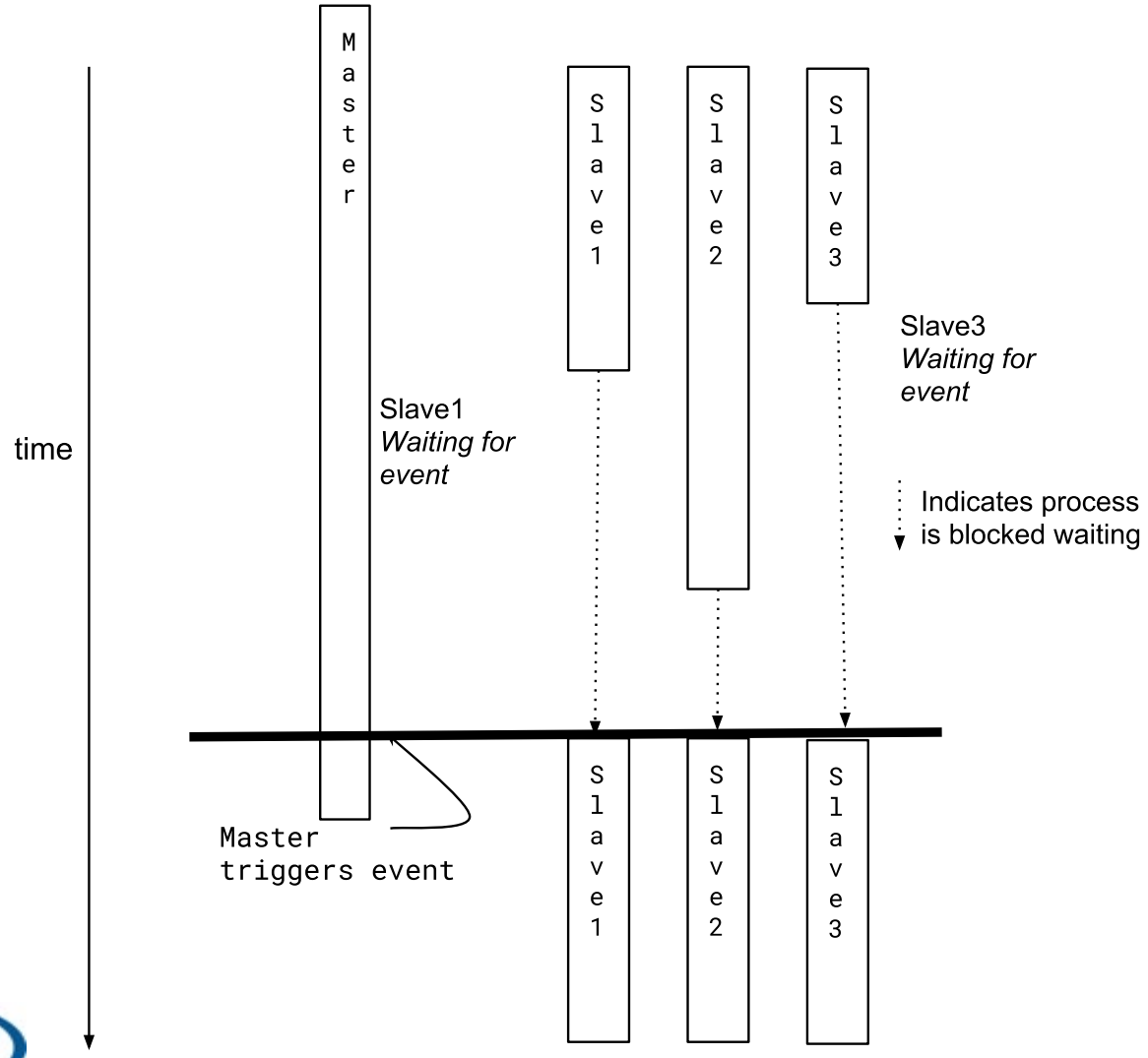
event




```
task Master();
fork
    Slave1();
    Slave2();
    Slave3();
join_none

// wait for some condition
// trigger slaves to wakeup
->wakeup_slave_ev;

endtask: Master
```

Tour de SystemVerilog Synching

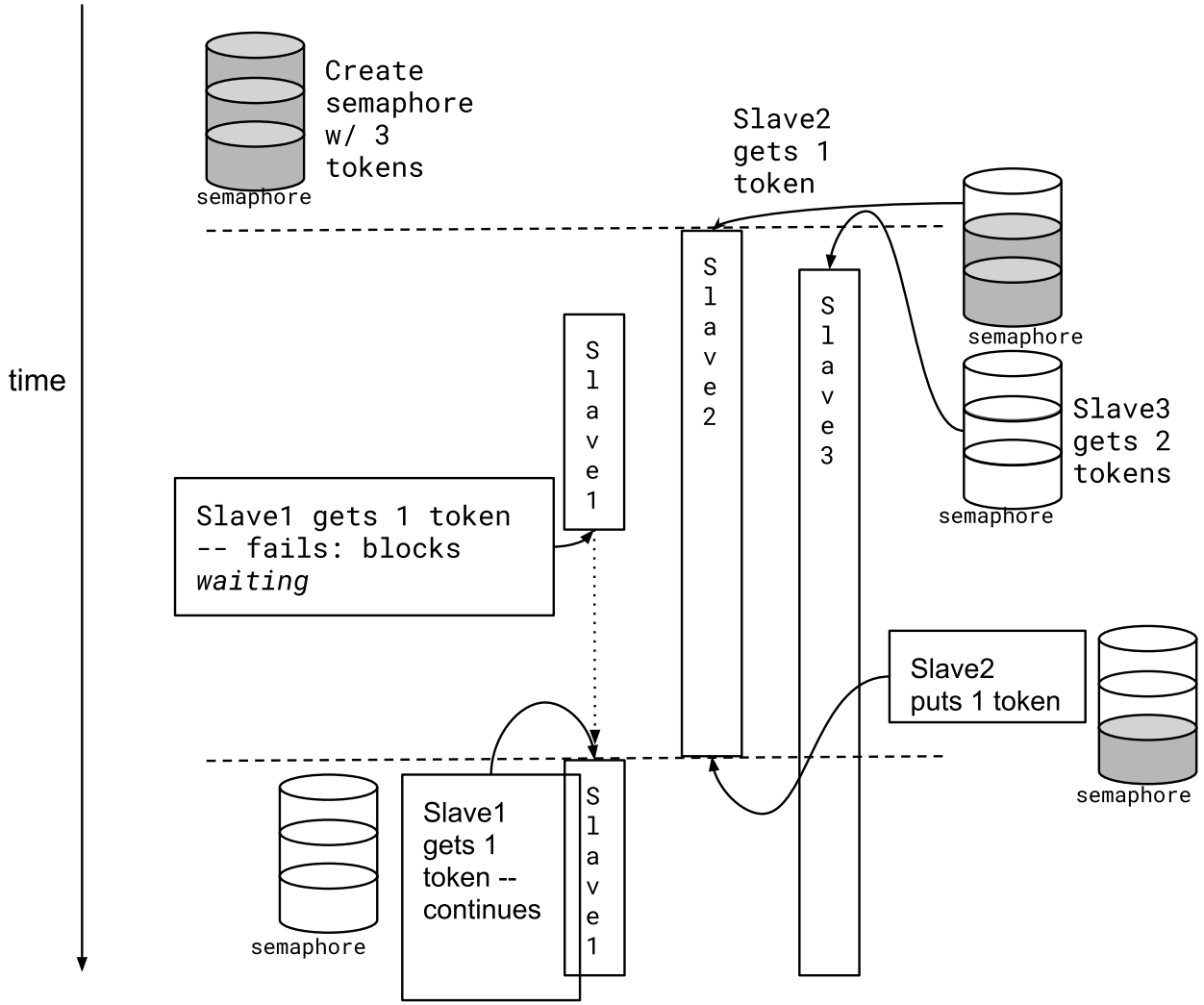
event




```
task Slave1();
   // some processing

   @slave_wakeup_ev;
// or
   wait(slave_wakeup_ev);

   // more processing
endtask: Slave1


Slave2() and Slave3() are
similar
```

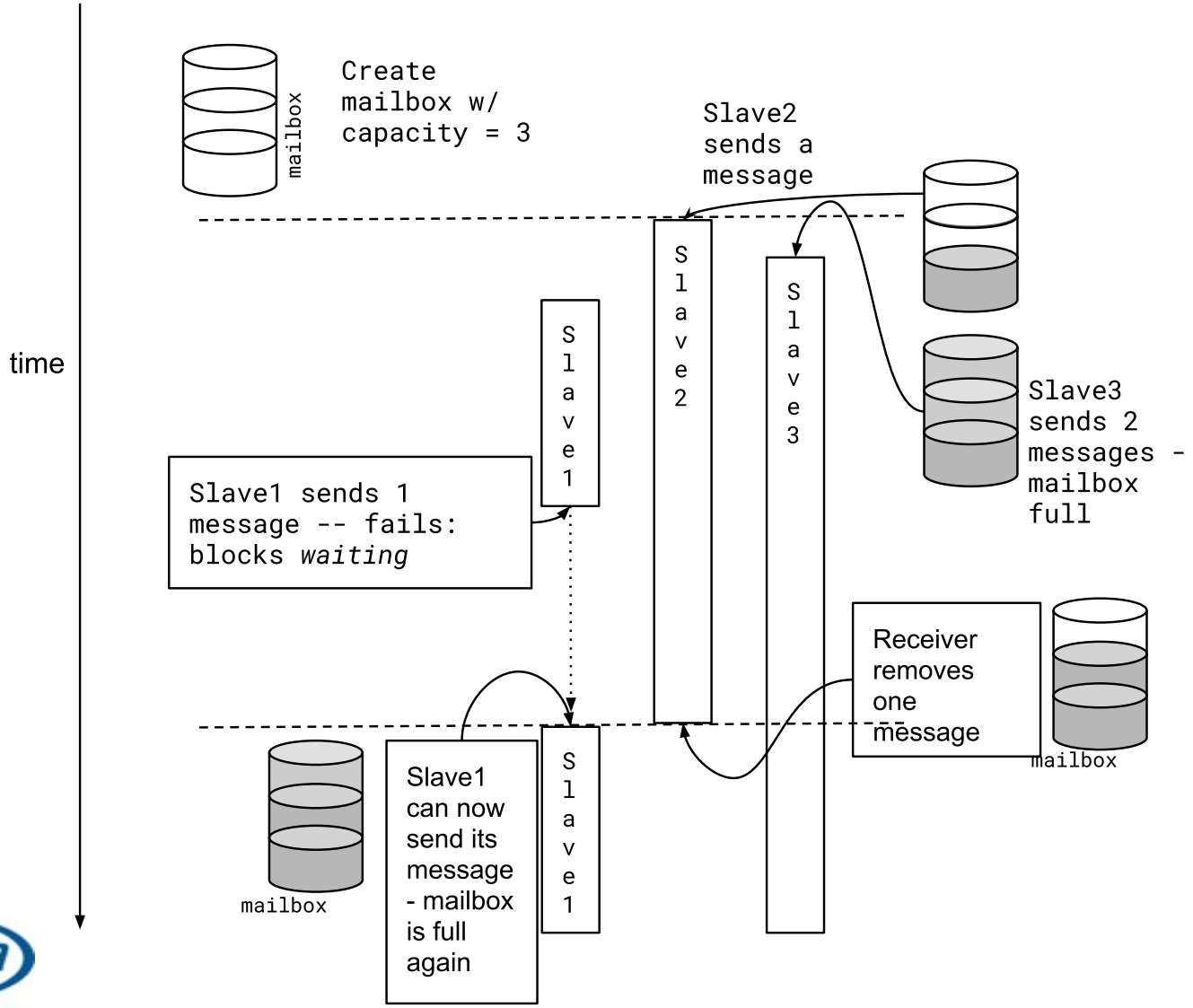
Tour de SystemVerilog Synching

semaphore



Tour de SystemVerilog Synching

`mailbox`



Semaphore and mailbox pictures are same – except:

`mailbox` blocks when it's *full*;

`semaphore` blocks when it's *empty*.

Tour de SystemVerilog Synching

`mailbox`

Uses

- mailboxes hold handles to objects
- synchronization *with* message passing
- so many uses...

Tour de UVM Synching

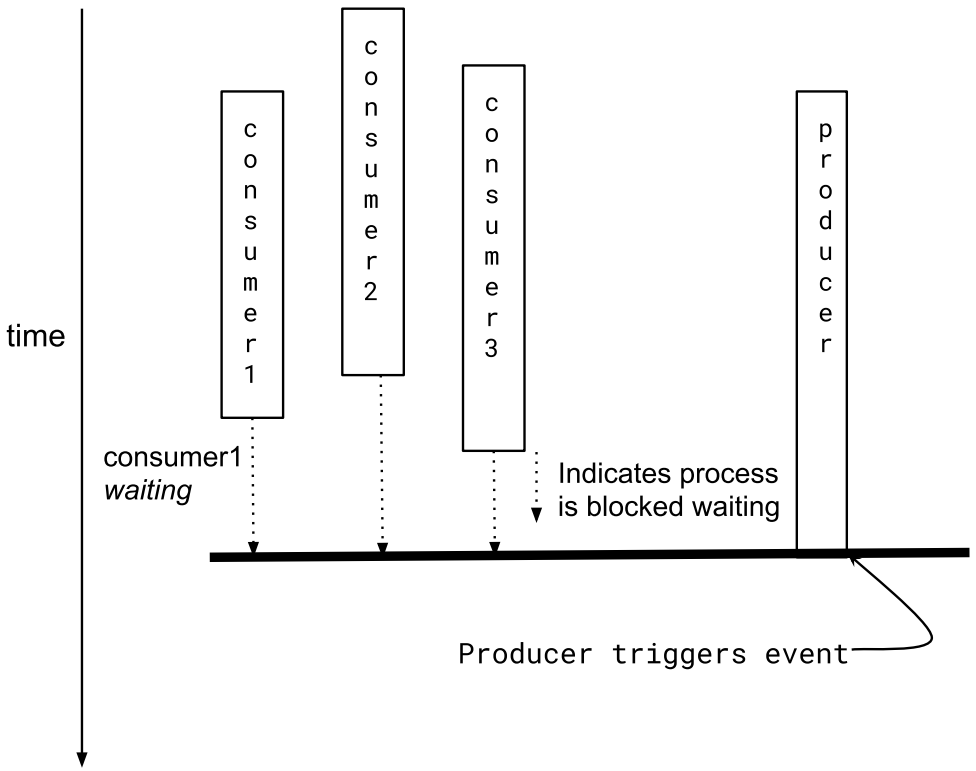
- UVM 1.2...
  - and IEEE-1800-2 (from what I've seen)
- UVM Class is a better choice over its SV equivalent.
  - I'll *try* and convince you of this for *most* applications...
  - I'm too old and wise(?) to never say "never use SV constructs"
  - Recommend: look at the UVM constructs FIRST.
    Then choose the best design choice for your application.

Tour de UVM Synching

SV Construct	UVM Choice
event	`uvm_event`, `uvm_heartbeat`, `uvm_subscriber`
semaphore	`uvm_barrier`, `uvm_objection`
mailbox	TLM FIFO, `uvm_subscriber`

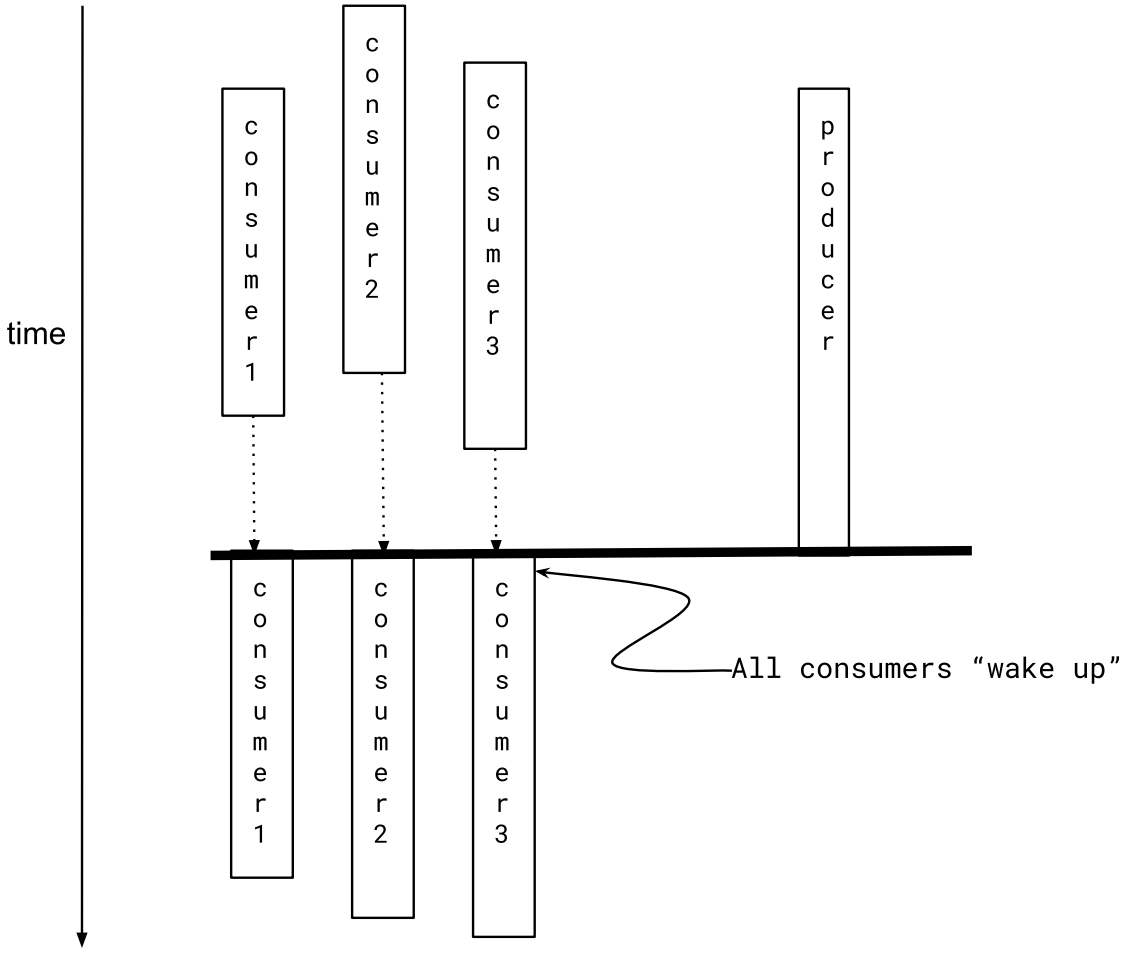
Tour de UVM Synching

uvm_event



Tour de UVM Synching

`uvm_event`



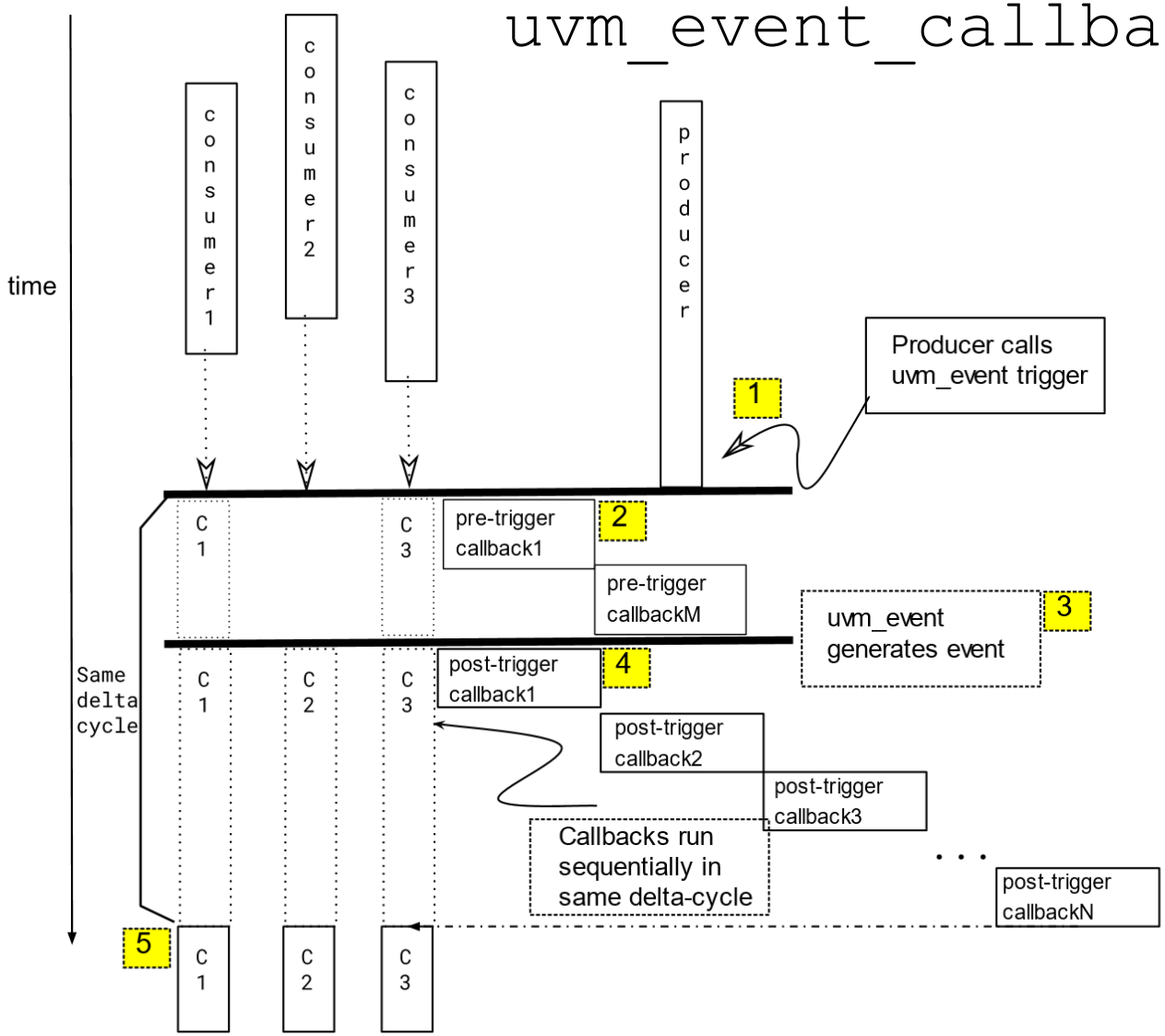
Tour de UVM Synching

`uvm_event`

- Use
  - Broadcast Notification (same as `event`)
  - Optionally add meta-data to event – can be retrieved by *listener*
  - Provides
    - introspection (`is_on/off`, `get_num_waiters`, `get_trigger_time`)
    - mode: trigger sensitive (`wait_trigger`, `wait_ptrigger`)
    - OR level sensitive (`wait_on/off`)
    - control (`reset, cancel`)

Tour de UVM Synching

uvm_event_callback



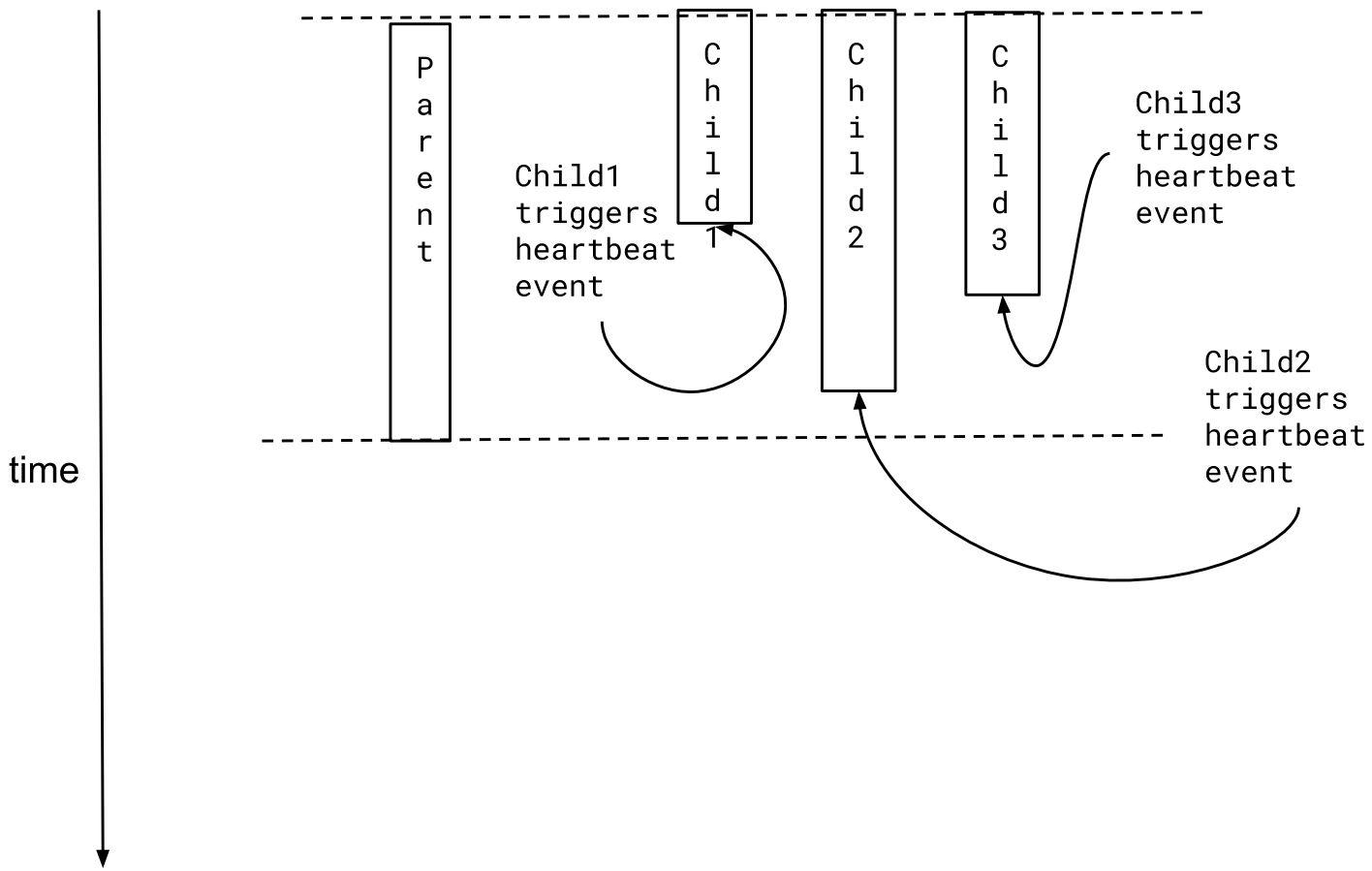
Tour de UVM Synching

`uvm_event_callback`

- Use
  - Filter the event – return value from `pre_trigger()`
  - Process the meta-data associated with event
  - Trigger another event in a daisy-chain

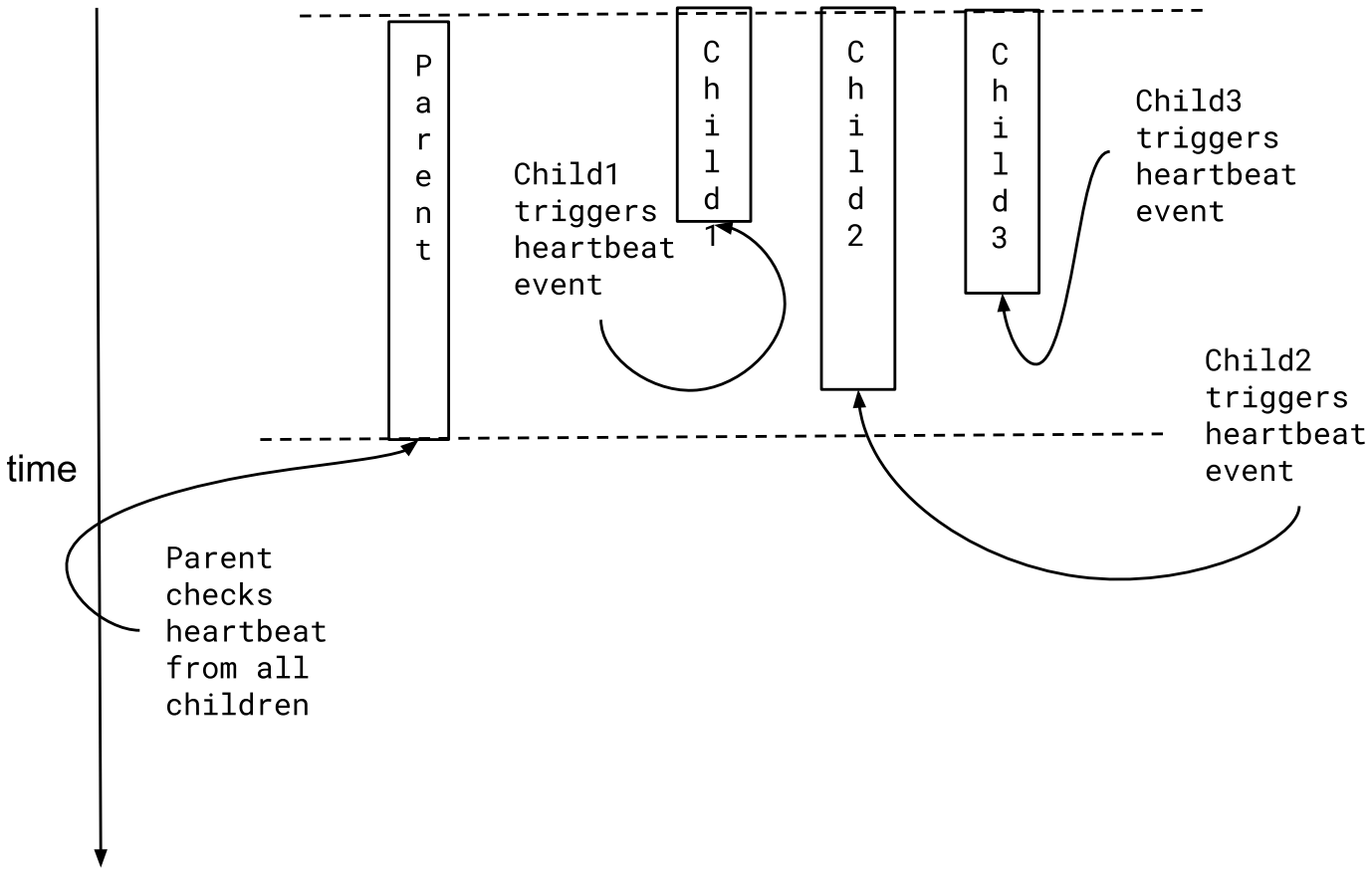
Tour de UVM Synching

uvm_heartbeat



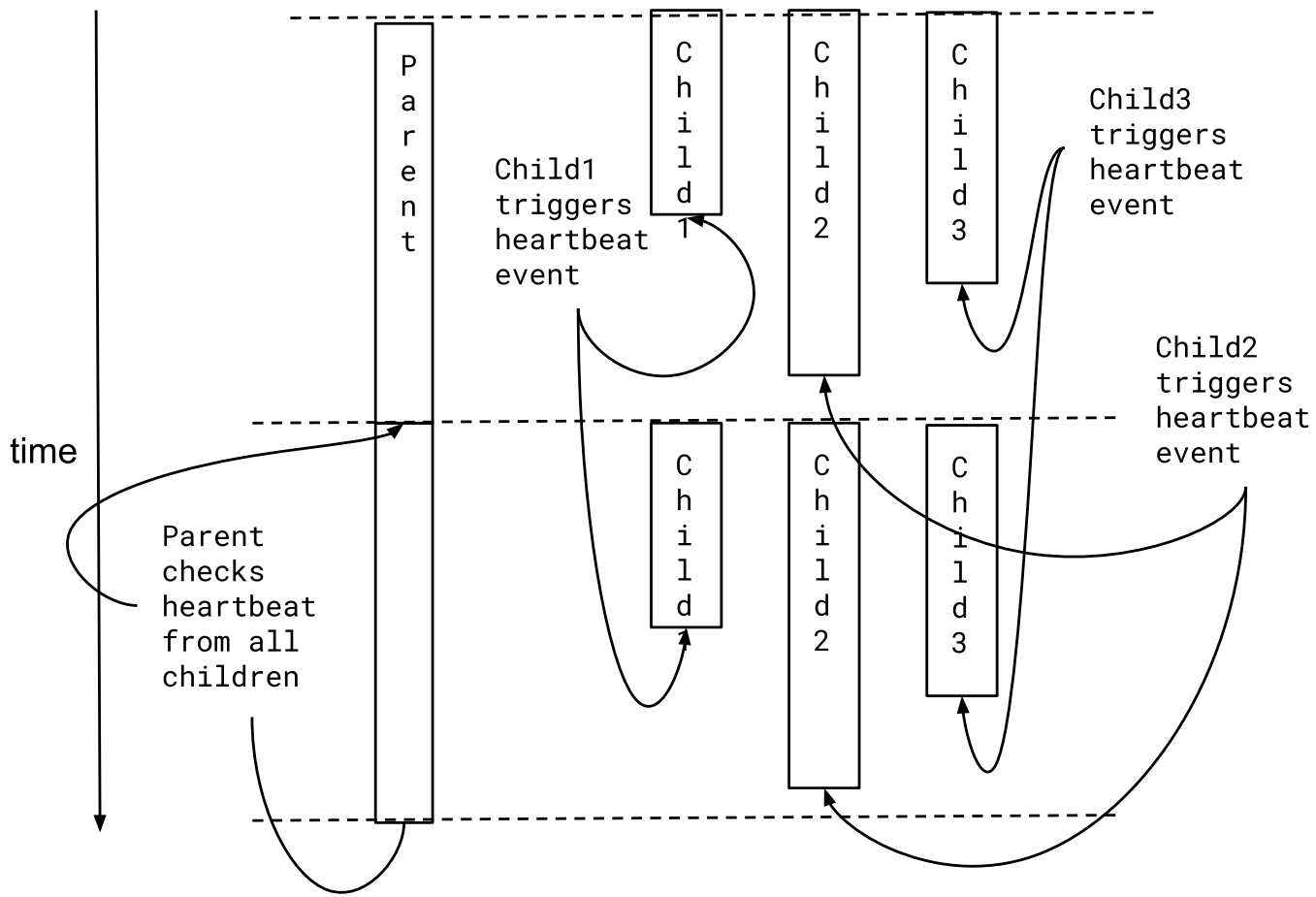
Tour de UVM Synching

uvm_heartbeat



Tour de UVM Synching

uvm_heartbeat



Tour de UVM Synching

uvm_heartbeat

Parent *listens* for heartbeat

```
uvm_event child_hb_ev;
parent_heartbeat.set_heartbeat( child_hb_ev, …
                                q of Child uvm_components )
```

Tour de UVM Synching

uvm_heartbeat

Child is responsible for generating heartbeat

```
uvm_event child_hb_ev;

fork : HEARTBEAT_FORK
  begin : HEARTBEAT_EV_TRIGGER
    forever begin
      #(HEARTBEAT_TIMER_IN_NS * 1ns) child_hb_ev.trigger();
    end
  end
join_none
```

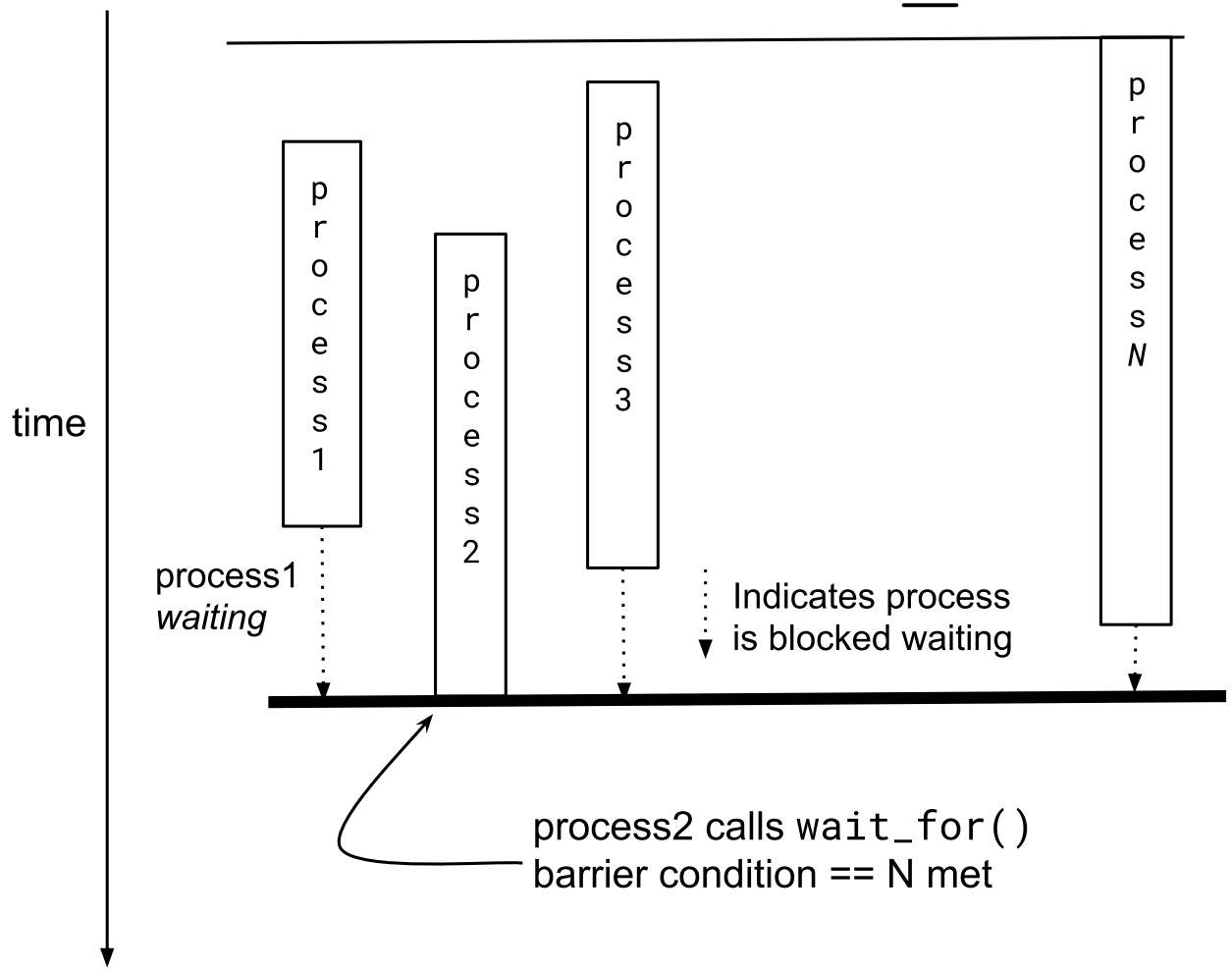
Tour de UVM Synching

uvm_heartbeat

- Uses
  - Allows mode: UVM_**ALL**_ACTIVE, or UVM_**ANY**_ACTIVE, UVM_**ONE**_ACTIVE (or none)
  - (...arguably...) Simpler than uvm_objection
  - Kill a ‘zombie’ child : stop wasting resources
  - Use the “lack” of heartbeat to signal something interesting
    - Wait for ALL heartbeats *after* a reset before proceeding.

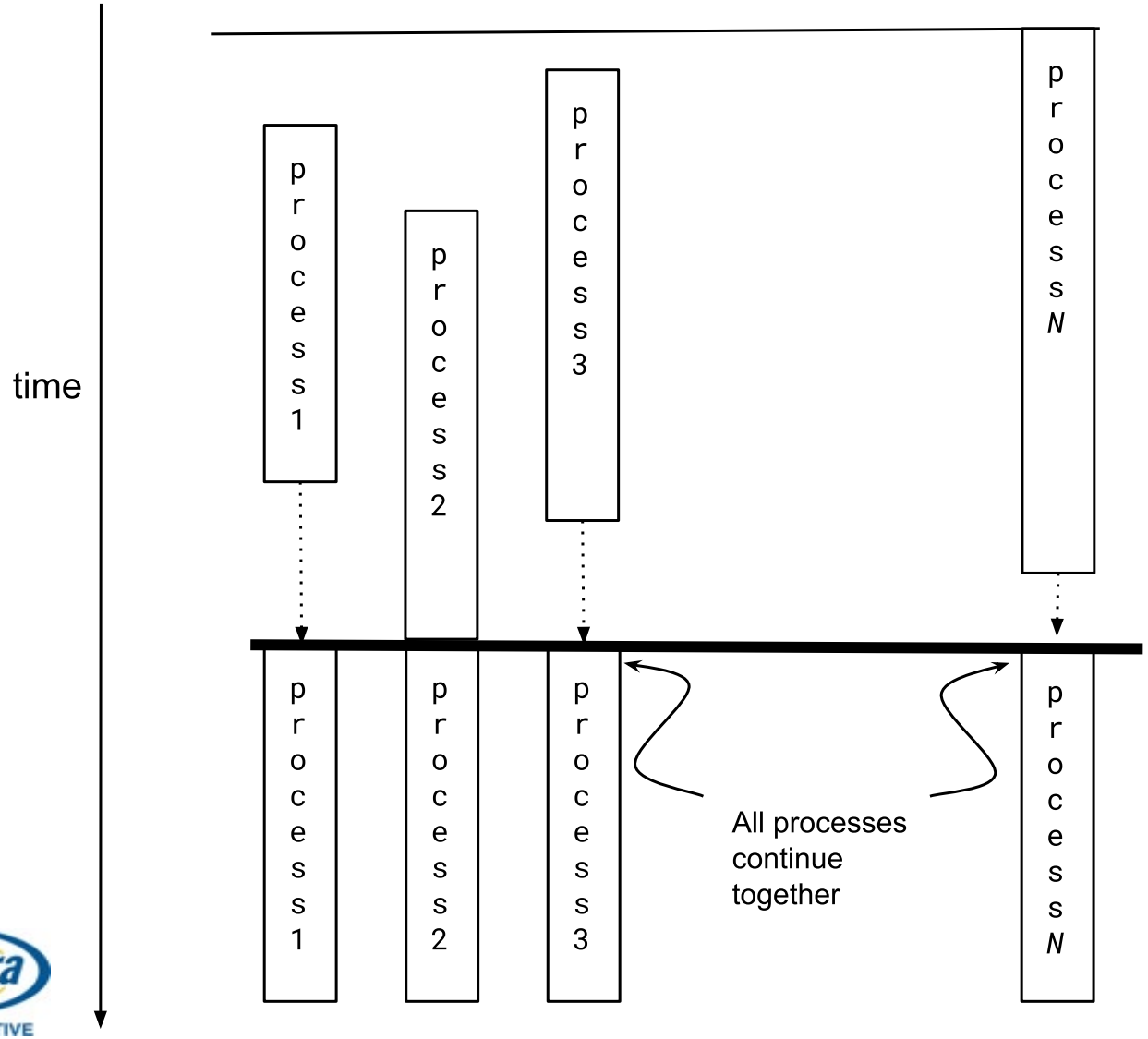
Tour de UVM Synching

`uvm_barrier`



Tour de UVM Synching

uvm_barrier



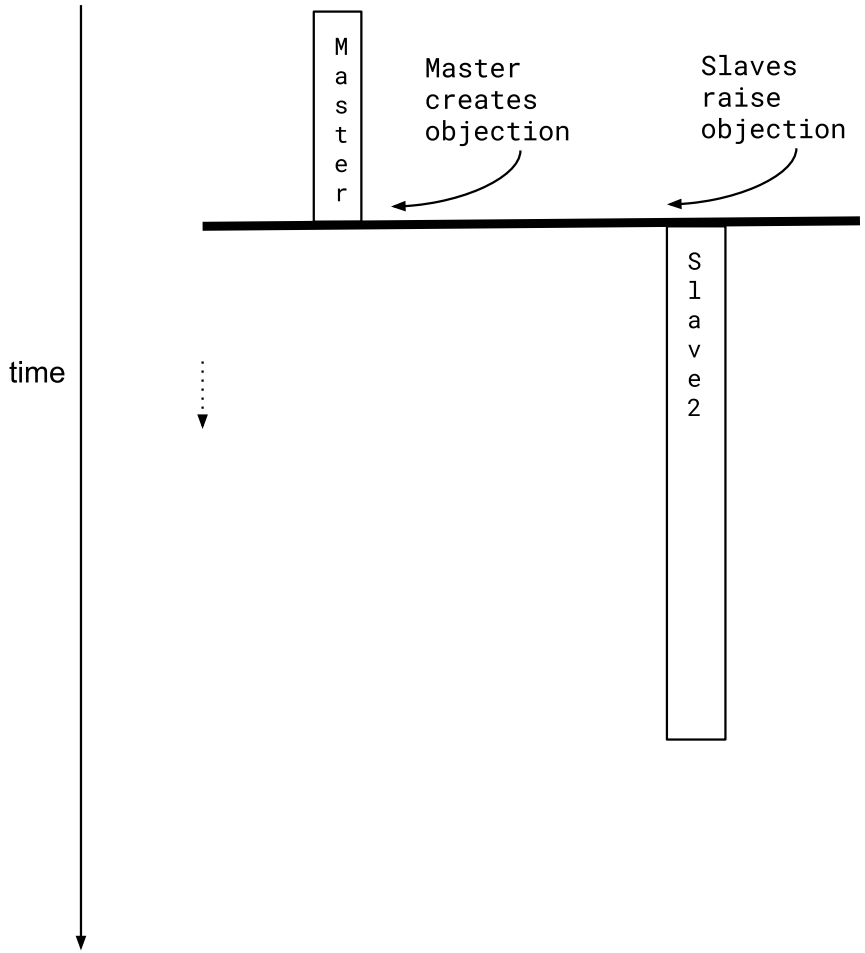
Tour de UVM Synching

`uvm_barrier`

- Uses
  - Similar use to a semaphore
  - Provides
    - introspection (`get_num_waiters`)
    - control (`reset`, `cancel`)
    - `auto-reset` to start the heartbeat automatically
  - When children contribute to a unanimous decision:
    - All scoreboards have completed their *expected* checks
    - multiple channels “synched up”
  - Components can add/delete themselves from the barrier.
  - Recommend wrapping a project layer around this class:
    - Add debug *tracing* capability like the `uvm_objection`

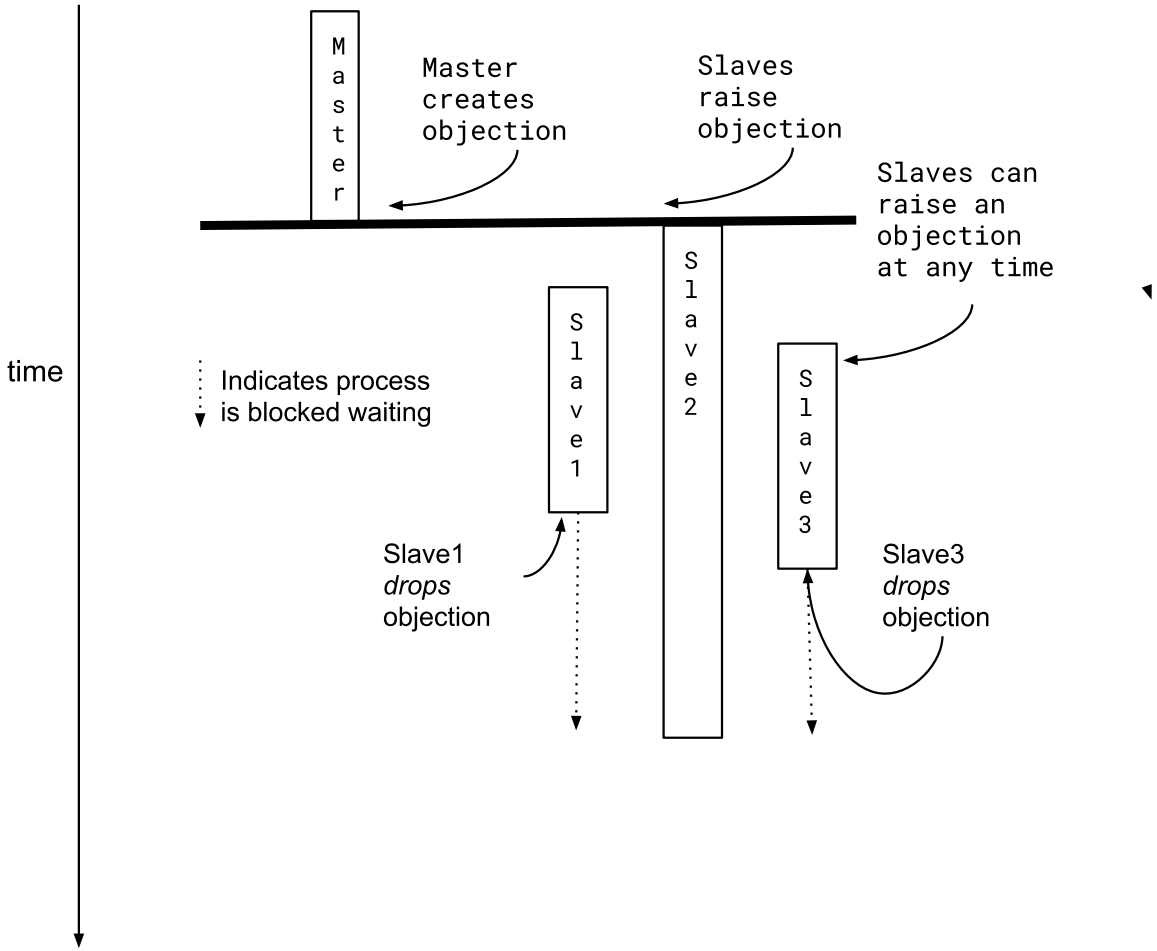
Tour de UVM Synching

uvm_objection



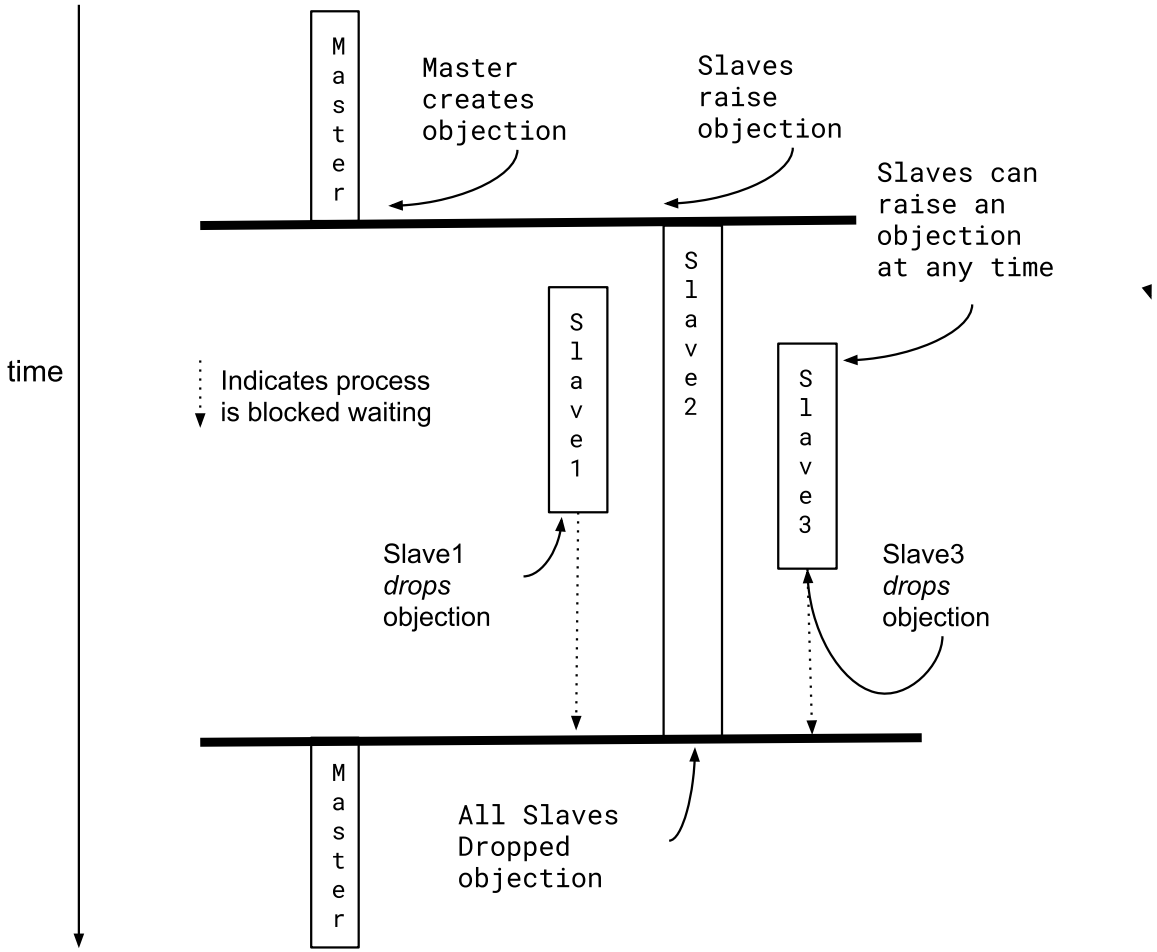
Tour de UVM Synching

uvm_objection



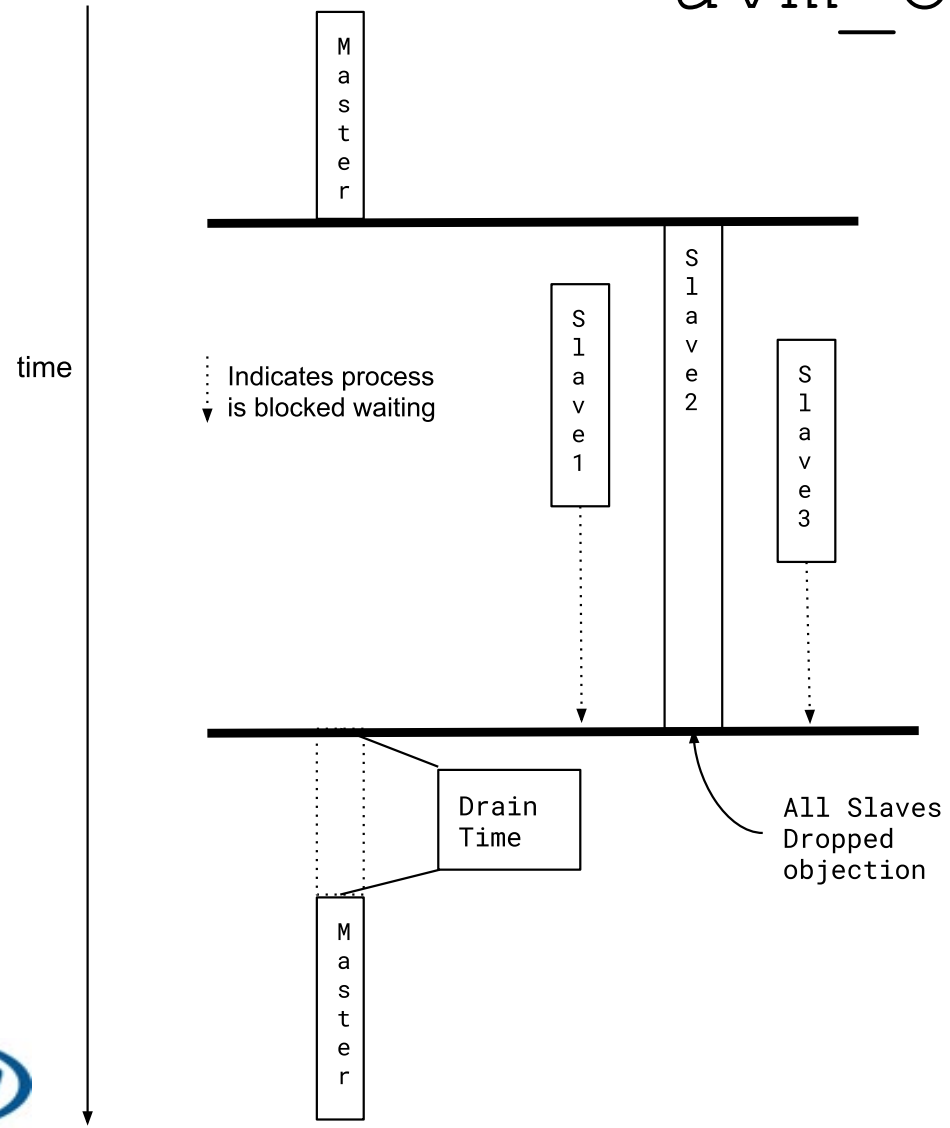
Tour de UVM Synching

uvm_objection



Tour de UVM Synching

uvm_objection



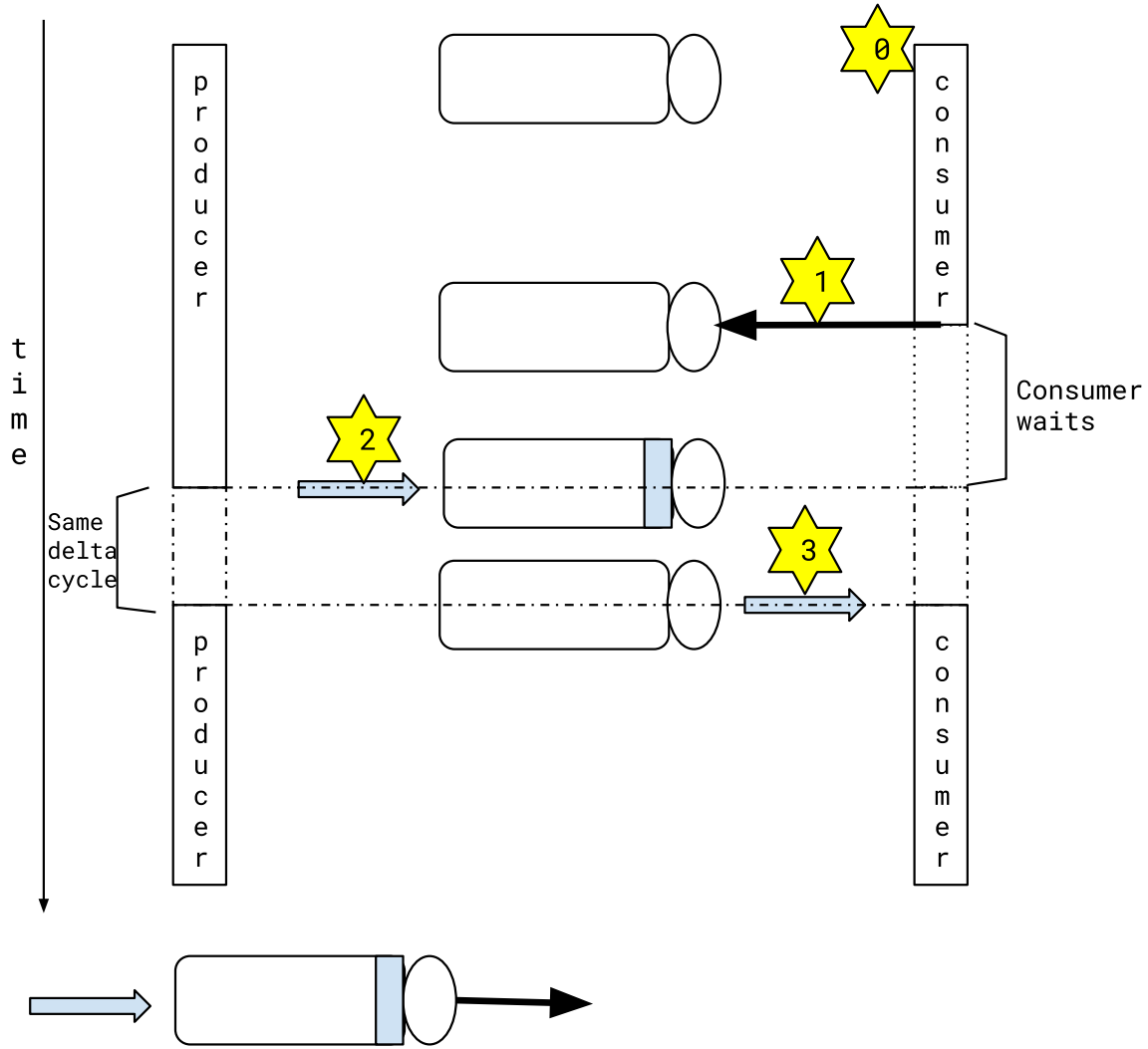
Tour de UVM Synching

`uvm_objection`

- Uses
  - Familiar use in UVM Phasing
  - Similar use to a semaphore and fork-join
  - Debug tracing NOT available in SV constructs (`display_objections`)
  - Can add callbacks at various phases
  - Control: `clear`
  - Introspection: `get_objectors`, `get_objection_count`
  - All components at a certain phase: reset deasserted, synched, end-of-test conditions.

Tour de UVM Synching

TLM FIFO



Tour de UVM Synching

TLM FIFO

- Uses
  - Similar use to a parameterized mailbox
  - Introspection: `is_empty`, `is_full`, `used`, `size`
  - Control: `flush`

Summary

- Overview of SV Synchronization
- Review of UVM classes providing synchronization
- UVM classes provide better functionality over SV equivalent
  - Control
  - Debug tracing
  - Introspection
  - Extensibility

Summary

- Paper provides guidelines and references to other papers using the UVM synchronization classes.
- Future work:
  - Guidelines
  - Would welcome your thoughts

Thank YOU

Questions??