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Run-Time Configuration of a Verification Environment

A Novel Use of the OVM/UVM Analysis Pattern

Authors

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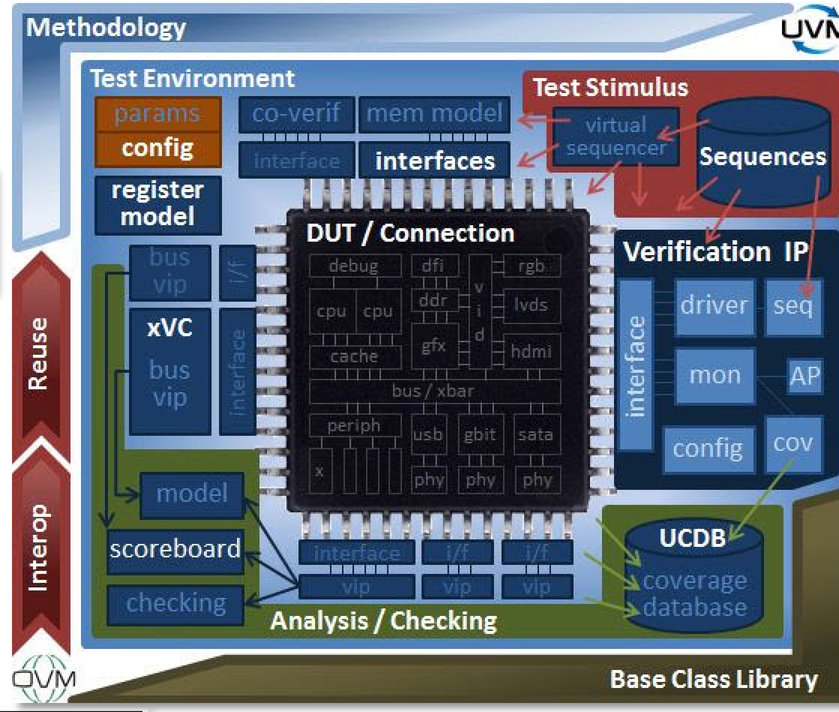
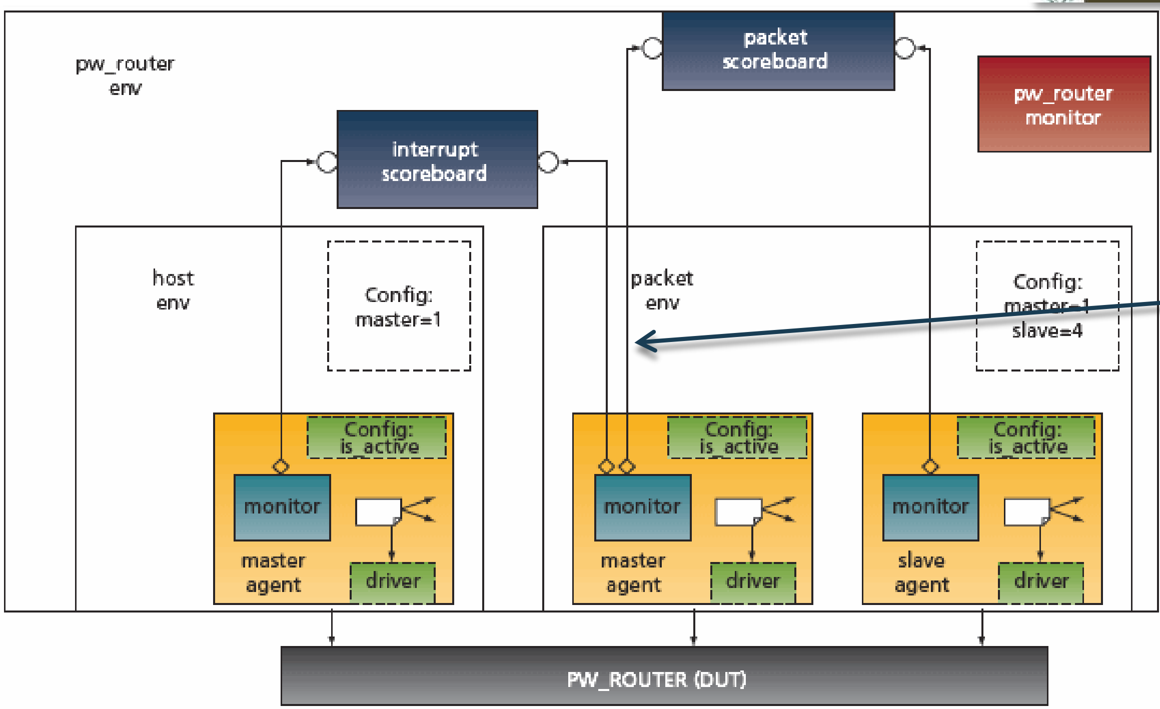
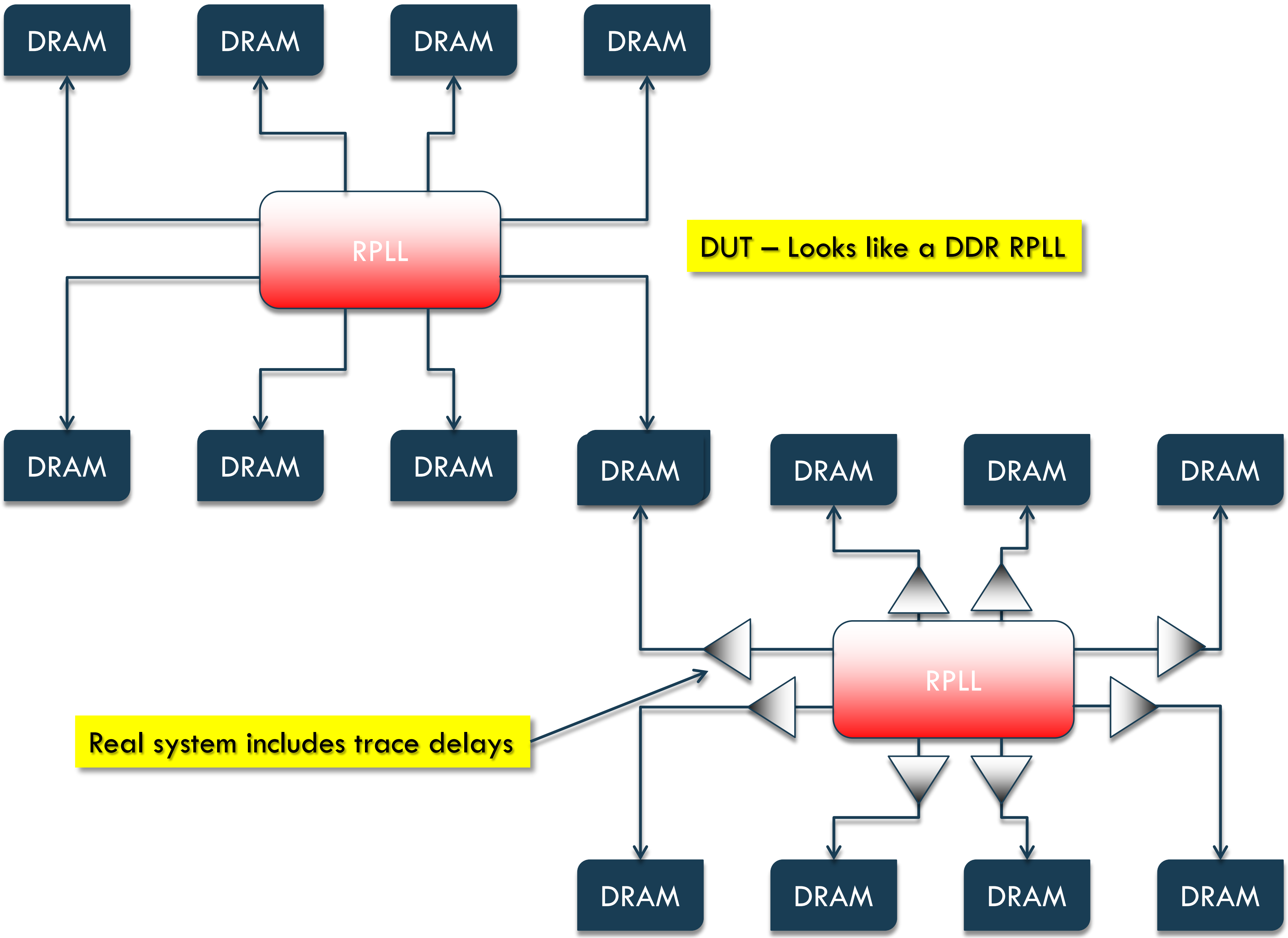
Typical OVM Environment





Common analysis port usage:
Data transactions
e.g. monitor to scoreboard



DRAM
DRAM
DRAM
DRAM
RPLL
DUT – Looks like a DDR RPLL
DRAM
DRAM
DRAM
DRAM
DRAM
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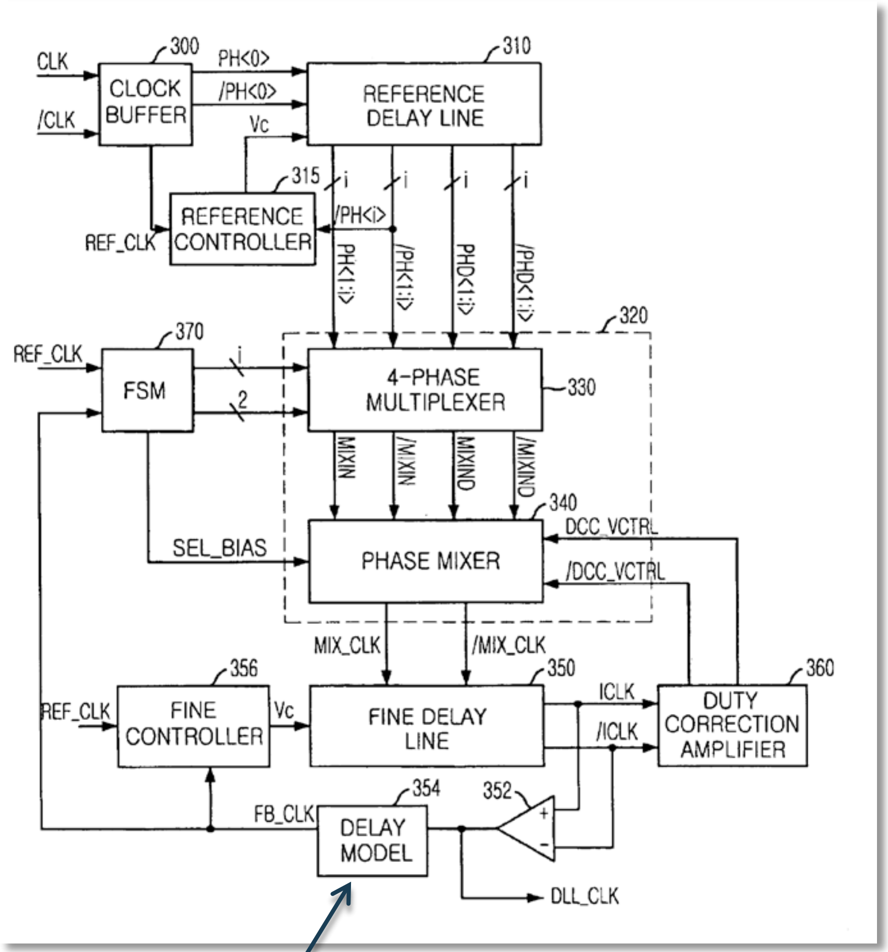
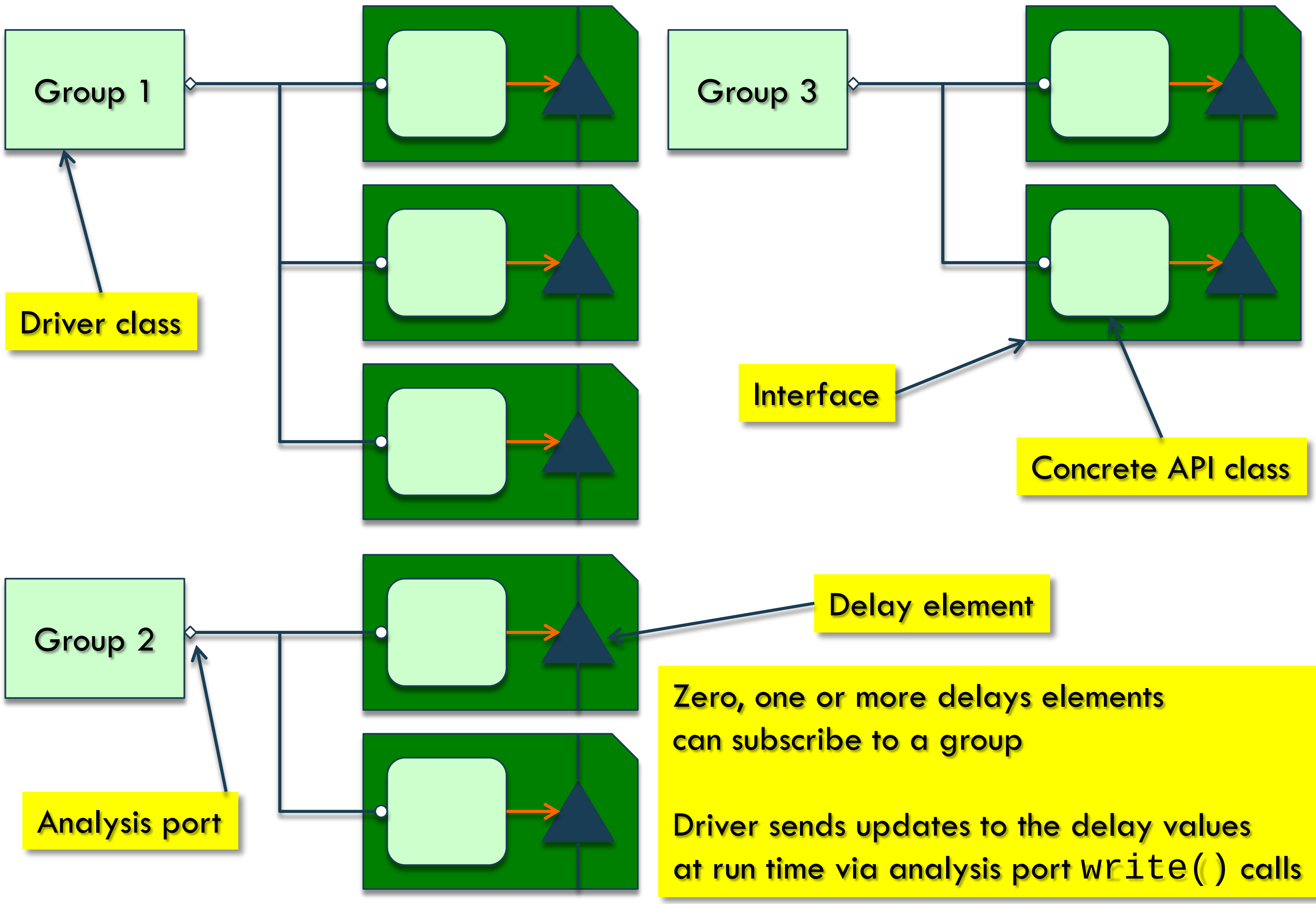
DRAM
RPLL
Real system includes trace delays
DRAM
DRAM
DRAM
DRAM

Example PHY Circuit



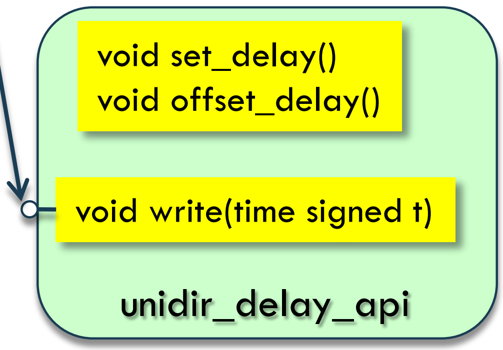
Process/temperature/voltage sensitive delay



Group 1
Group 3
Driver class
Interface
Concrete API class
Group 2
Delay element
Analysis port
Zero, one or more delays elements
can subscribe to a group
Driver sends updates to the delay values
at run time via analysis port write() calls

```
virtual class delay_api_abstract  extends ovm_pkg::ovm_subscriber#(time signed);
class unidir_delay_api extends global_type_Pkg :: delay_api_abstract ;
```

Has analysis export




```
virtual function void set_delay (time the_delay);
   super.set_delay (the_delay);
   delay_val = the_delay;
 endfunction
```

```
virtual function void offset_delay (time signed
the_offset);
   super.offset_delay (the_offset);
   ...
   delay_val = new_delay;
 endfunction
```

```
virtual function void write (time signed t);
   this.offset_delay (t);
endfunction
```

Implementation of `write()` method for ovm_subscriber

- undir_delay_api class IsA ovm_subscriber parameterized for *time signed*
- Implementation of the `write()` method calls the `offset_delay()` method of the concrete class
- This applies an update to the delay value (either positive of negative)
- Checks are made to ensure the time delay never goes negative
- A `write()` to the analysis port of any group updates all the connected subscribers' delay values
- A method-based API is also available to implement delays that do not vary at run-time
- A call to the `set_delay()` method applies values from the configuration object

```
class delay_timing_driver extends ovm_component;

   root_cfg  my_cfg;

   ovm_analysis_port #(time signed) delay_group_control_aps [delay_group_t];
```

Associated array of analysis ports

```
function void connect_group_bl0();

  this.delay_group_control_aps[group_bl0].connect
(`PHY.DQ00__inst.delay_element_in.api.analysis_export);

  this.delay_group_control_aps[group_bl0].connect
(`PHY.DQ01__inst.delay_element_in.api.analysis_export);

  this.delay_group_control_aps[group_bl0].connect
(`PHY.DQ02__inst.delay_element_in.api.analysis_export);

  this.delay_group_control_aps[group_bl0].connect
(`PHY.DQ03__inst.delay_element_in.api.analysis_export);

  this.delay_group_control_aps[group_bl0].connect
(`PHY.DQ04__inst.delay_element_in.api.analysis_export);

  this.delay_group_control_aps[group_bl0].connect
(`PHY.DQ05__inst.delay_element_in.api.analysis_export);

  this.delay_group_control_aps[group_bl0].connect
                                           lysis_export);
                                           .connect
                                           lysis_export);
endfunction
```

```
function void connect_group_bl1();

...

endfunction
```

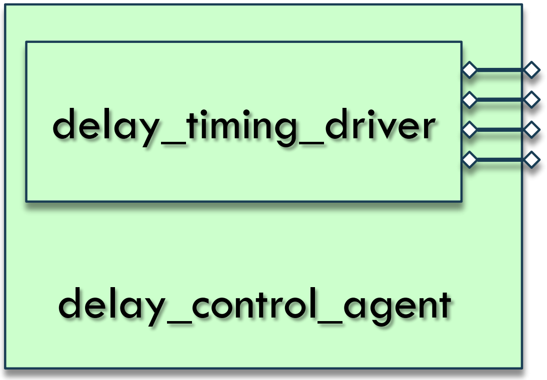
Connection to analysis export in the interface

```
function void connect_all_groups();

  connect_group_bl0();

  connect_group_bl1();

...

endfunction
```

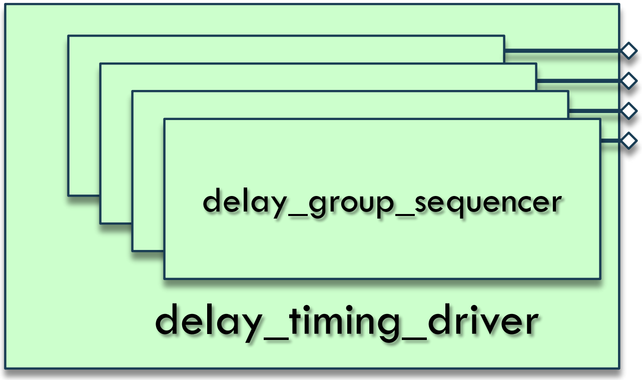
Connection function for each group

```
function void connect();

   super.connect();

   connect_all_groups();

endfunction : connect
```

OVM connect ( ) phase to make the connections



```
class delay_group_sequencer extends ovm_component;
function void connect();
  my_cfg = my_parent.parent_cfg;
  case (my_cfg.delay_timing_config.padgroup_timing_config[my_group].waveform)
    triangle: this.delay_function = ac_triangle_wave::type_id::create("delay_lut_triangle",this);
    sine:     this.delay_function = sine_wave::type_id::create("delay_lut_sine",this);
    square:   this.delay_function = square_wave::type_id::create("delay_lut_square",this);
    ramp:     this.delay_function = ramp_wave::type_id::create("delay_lut_ramp",this);
    impulse:  this.delay_function = impulse_wave::type_id::create("delay_lut_impulse",this);
    noise:    this.delay_function = noise_wave::type_id::create("delay_lut_noise",this);
  endcase
enddfunction
function void send_update(time signed the_time);
   my_parent.delay_group_control_aps [my_group].write(the_time);
endfunction
```



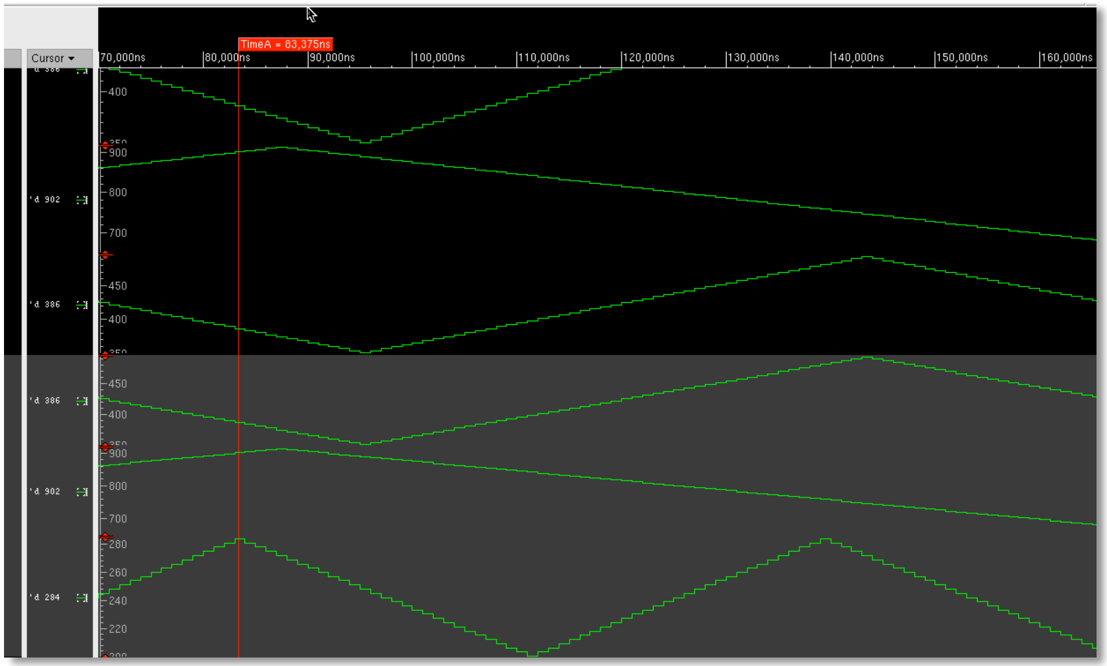
Each group has a sequencer
Waveshape is set from the configuration

Sequencer calls the `write()` method of the driver's analysis port for that group

```
virtual task run();
  time signed the_delay_offset;
    if (this.enabled) begin
    #(this.delay_function.wait_to_start);
     while (this.enabled) begin
       if (this.running) begin
         the_delay_offset = this.delay_function.get_next_value();
         send_update(the_delay_offset);
       end
       #(this.delay_function.update_interval);
      end //while enabled
    end // if enabled
endtask
```

Get the next delay value from the delay_function class's lookup table – allows easy creation of any waveshape

Example simulation
Shows several groups
Triangle-wave timing variation



Performance considerations
396 delay elements in 49 groups updated once every 1000ns
Typical simulation time = 2ms
792,000 value updates require 98,000 calls to `write()`

If using traditional OVM approach:
With 49 groups of elements
Would require 98,000 calls to `set_config_int()` and 792,000 calls to `get_config_int()`

`set_config_int()` and `get_config_int()`
use string lookups and are **expensive** in compute time

Conclusions

- Methodology can be applied to any arbitrary type that needs to be communicated
  - Type *time* used in this particular project
  - More complex transaction type could be further decoded on reception

- Significant performance advantage for this project
  - Alternative would be a large number of calls to set/get_config_int
    - This is expensive due to the string lookups required
  - Set-once delay values were just applied via the delay control class's API
    - No difference in performance to usual set/get_config_int
    - (though a special configuration object used in this project)

- This methodology can also be used with UVM environments