Mutable Verification environments through Visitor and Dynamic Register map Configuration

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2020 DESIGN AND VERIFICATION™ DVCON CONFERENCE AND EXHIBITION EUROPE

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Motivation

- Mutable Verification Environment: a verification environment that is able to change dynamically the self-checking capabilities according to the DUT configuration
- Simplify generation of Mutable Verification Environments
  - Optimize the Synchronization of UVM Register Models with any Verification Component in the environment
  - Provide a mechanism to easily add new capabilities to existing Verification Components

Register Model Synch: State of the Art

	Custom Code	IP-XACT flow	UVM Register Map Dynamic Configuration
Pros	• Code optimized: events generated only where needed	• Code optimized: events generated only where needed	• More flexibility: Event generation can be dynamically configured • Reduce code impact in case of customization needed on high number of registers

Cons	• Error prone in case of high number of registers to customize	• Error prone in case of high number of registers to customize
		• Need to rerun the entire flow in case of changes in register customization
		• Different version of the same IP-XACT description. One for Design and one for Verification
			• Size Overhead affecting all the fields of the entire register map
			  • 9 extra variables
			  • 4 extra uvm events
			• Performance Impact
			  • Events associated to fields and not to regs

Optimized Register Map Dynamic Configuration (I)

- Define a dedicated structure to store synch event enables and the register callback extension.

```
typedef struct { bit pre_rd, pre_wr, post_rd, post_wr; } field_desc;
…
class uvm_reg_trig_cbs extends uvm_reg_cbs;
`uvm_object_utils(uvm_reg_trig_cbs)
field_desc fld_list [string];
uvm_event_pool ep;
function new(string name = "uvm_reg_trig_cbs");
super.new(name);
ep = uvm_event_pool::get_global_pool();
endfunction
…
```

Optimized Register Map Dynamic Configuration (II)

```
…
virtual task post_write(uvm_reg_item rw);
…
$cast(fld, rw.element);
d = event_data::type_id::create("d");
fld_d = fld_list[fld.get_name()];
if(fld_d.post_wr) begin
  event_name = {"post_wr_", fld.get_name()};
  trigger = ep.get(event_name);
  d.val= fld.get();
  `uvm_info(get_name(), "**** Firing Post Write trigger ****", UVM_NONE)
  trigger.trigger(d);
end
endtask : post_write
endclass
```

Optimized Register Map Dynamic Configuration (III)

- Instantiate and connect reg callbacks in Verif. Environment

```
class top_sve extends uvm_env;
…
virtual function void connect_register_callbacks();
…
cbs = uvm_reg_trig_cbs::type_id::create("cbs");
cbs.fld_list = field_list;
foreach(field_list[key]) begin
        …
        f = regmodel[i].get_field_by_name(key);
        if(f != null)
        uvm_callbacks#(uvm_reg_field, uvm_reg_trig_cbs)::add(f, cbs);
        …
end
endfunction : connect_register_callbacks
```

Optimized Register Map Dynamic Configuration (IV)

```
…
virtual function void connect_phase(uvm_phase phase);
super.connect_phase(phase);
…
connect_register_callbacks();
endfunction : connect_phase
endclass: top_sve
```

- Configure synch event generation

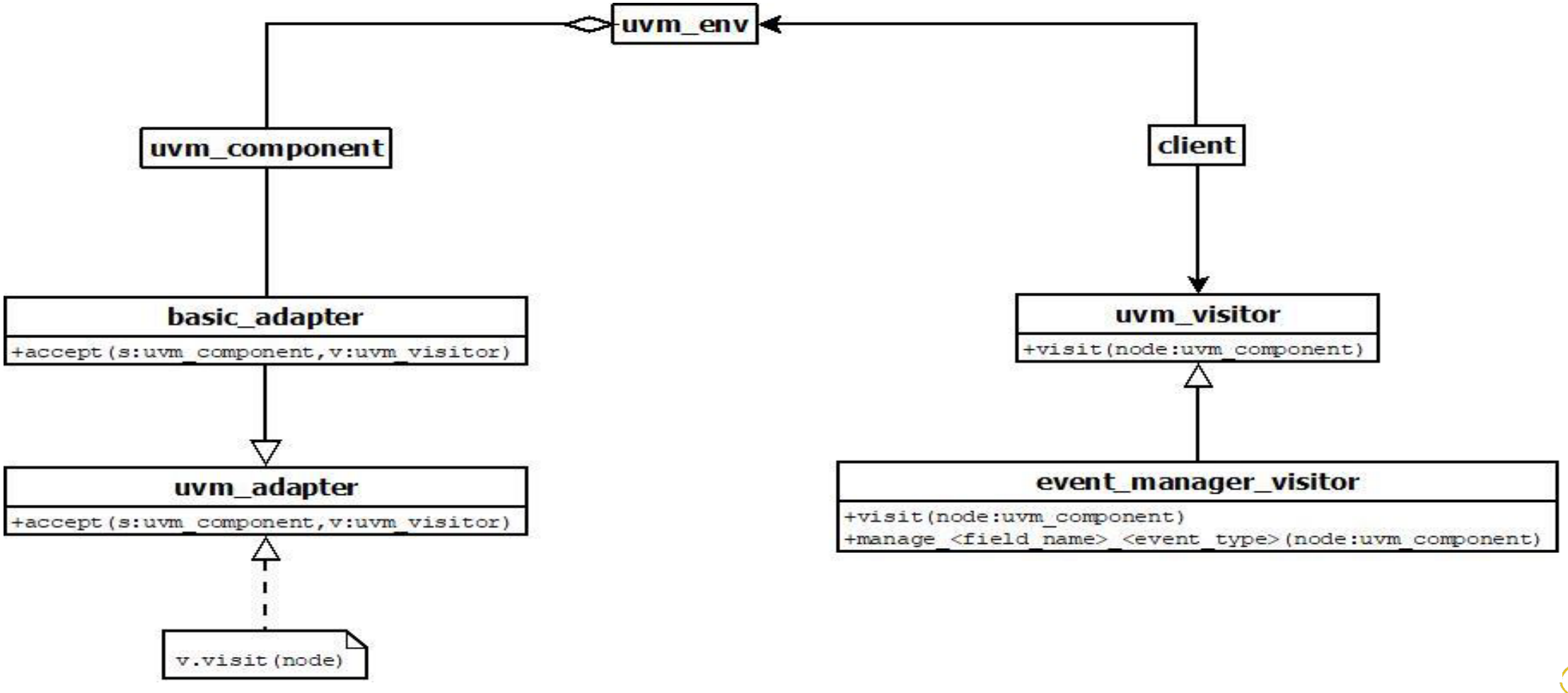
```
//field name, pre_rd, pre_wr, post_rd, post_wr
field1              0       1        0         1
field2              1       0        1         0
field3              0       0        1         1
```

Common VIP Extension Flow

- Verification Component capabilities can be extended as follow:
  - Create an extension class of the Verification Component with the new capabilities
  - Using UVM override mechanism replace the original version of the Verification Component with the new one

- Cons: Significant overhead in term of lines of code -> error prone

Verification Component Extension (I)



Verification Component Extension (II)

- Define UVM Visitor to manage Synch Event from Register Models

```
class event_manager_visitor extends uvm_visitor;
virtual function void visit(uvm_component node);
if (node.get_object_type() == vip_monitor::type_id::get()) begin
fork
        manage_field1_pre_wr(node);
        manage_field1_post_wr(node);
        …
join_none
end
…
endfunction
```

Verification Component Extension (III)

```
…
virtual task manage_field1_pre_wr(uvm_component node);
…
event_name = "pre_wr_field1;
$cast(mon, node);
…
forever begin
        ev.wait_trigger_data(obj);
        $cast(d, obj);
        mon.vif.sig1 = d.val;
end
endtask
…
endclass
```

Verification Component Extension (IV)

- Define the UVM Visitor Adapter

```
class basic_adapter extends uvm_visitor_adapter;
virtual function void accept(uvm_component s, uvm_visitor v,
uvm_structure_proxy#(uvm_component) p, bit invoke_begin_end=1'b1);
if(invoke_begin_end)
v.begin_v();
v.visit(s);
if(invoke_begin_end)
v.end_v();
endfunction
function new (string name = "");
super.new(name);
endfunction
endclass
```

Verification Component Extension (V)

- Instantiate and connect adapter and visitor in Verif. Environment

```
class top_sve extends uvm_env;
…
virtual function void start_of_simulation_phase(uvm_phase phase);
event_manager_visitor event_manager_v;
uvm_top_down_visitor_adapter adapter;
uvm_component_proxy proxy;
event_manager_v = new("event_manager_v");
adapter = new("adapter");
proxy = new("proxy");
adapter.accept(this, event_manager_v, proxy);
endfunction : start_of_simulation_phase
endclass: top_sve
```

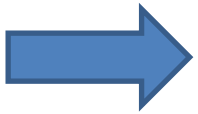
Use Case (I)

- DUT: SerDes IP
- Legacy Verification Component used to measure injected ppm
  - PRE: Enable/Disable Verification Component explicitly using “enable” signal in SV Interface
  - POST: Enable/Disable features according to configurations on DUT

Use Case (II)

Previous Solution

```
regmap_write_field("en_count_tx",1'b1);
// Enable PPM estimator
force tb_top.ppm_tx.en = 1'b1;
#(100us);
// Disable PPM estimator
force tb_top.ppm_tx.en = 1'b0;
regmap_write_field("en_count_tx",1'b0);
#(1us);
current_ppm = tb_top.ppm_tx.actual_ppm;
```



Current Solution

```
// Automatically Enable PPM estimator with
write at 1 on en_count_tx
regmap_write_field("en_count_tx1",1'b1);
#(100us);
// Automatically Disable PPM estimator
with write at 0 on en_count_tx
regmap_write_field("en_count_tx",1'b0);
#(1us);
current_ppm = tb_top.ppm_tx.actual_ppm;
```

Conclusion

- Simplified approach to create Mutable Verification Environment
- Optimized Register Map Dynamic Configuration
  - Reduced Data Overhead
  - Reduced number of Synch Events.
- Extension through UVM Visitor -> reduced error prone approach

Questions