Versatile UVM Scoreboarding

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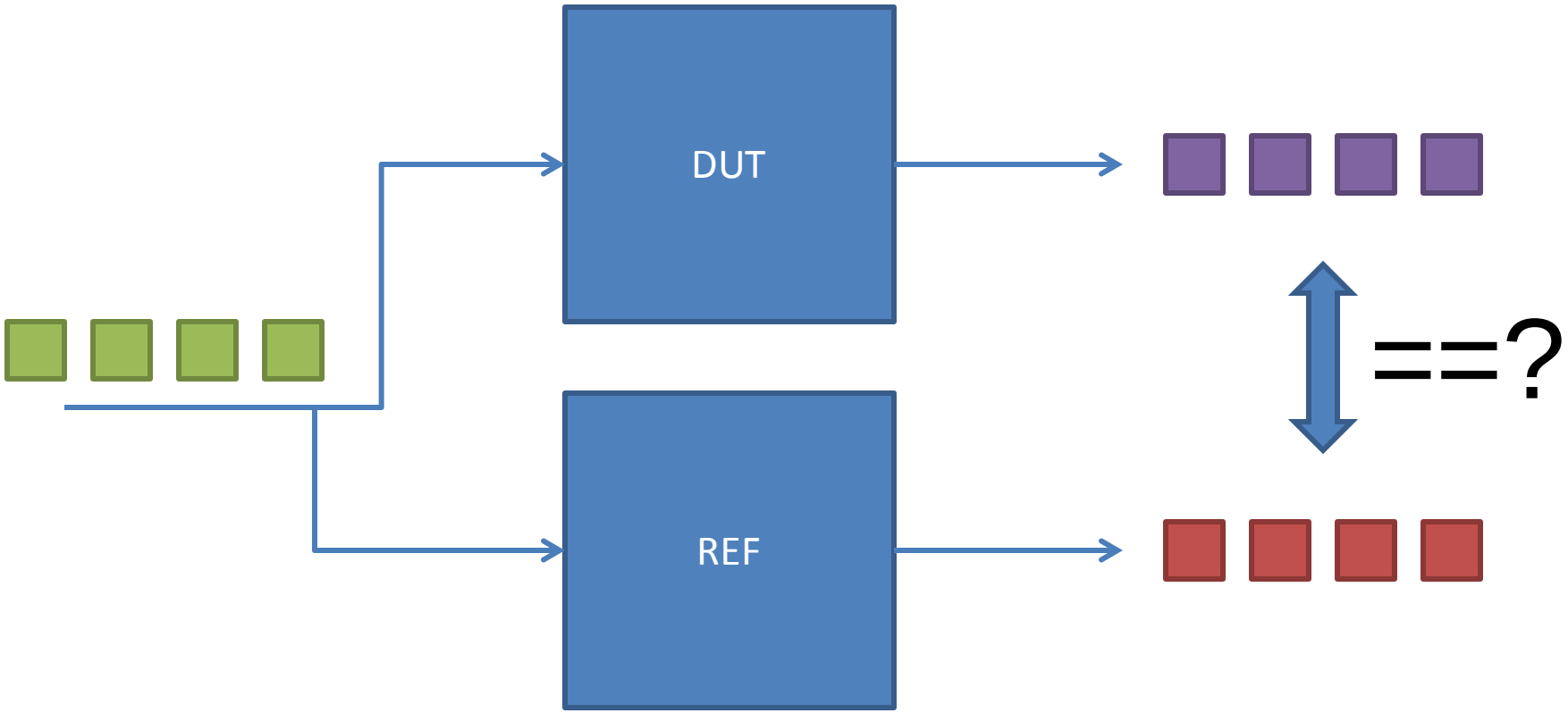
A Scoreboard (Noun)

Scoreboarding (Verb)

- ***Scoreboarding*** is a … method, … , for dynamically scheduling a pipeline so that the instructions can execute out of order …. In a scoreboard, the data dependencies of every instruction are logged …

  (Source: Wikipedia)

HDL Scoreboards
(UVM, VMM, OVM, AVM, yourVM…)



Motivation – Current UVM Scoreboard Landscape

- UVM native scoreboard is empty
- Existing user donations are limited in versatility
  - Employ blocking ”expect” function as REF
  - Inhibits use of time consuming REFs (e.g. SystemC)
  - Inhibits use of multiple concurrent models
- A reusable SCB is key for productivity and easy debug
  - We identify same principle structure across designs
- Some test bench stats from 8 SV test benches
  - 10 – 75K lines
  - Scoreboards were 3-25% of the test bench size, in avg 15%

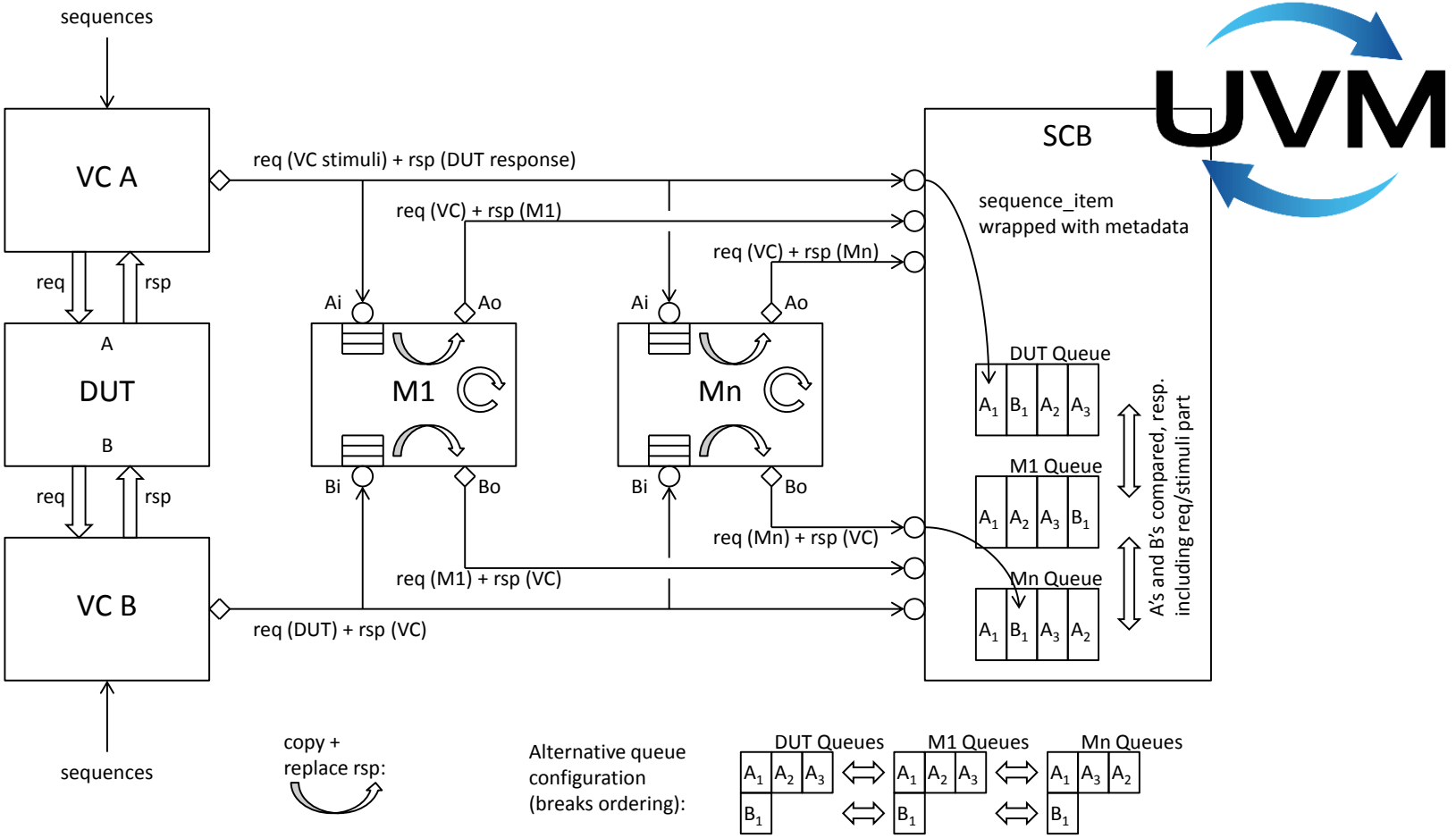
SCB User Needs – What are those?

- Fast out of the box, easy to configure
- Consistent re-use
- Scalability (any number of models, queues, producers, compare methods)
- Clean interfaces to selfcontained models, e.g. SC
- Accellerated debug
- Inherently best performance
  - Wants linear and not polynomial search complexity
- Advanced use : Connect to foreign environments

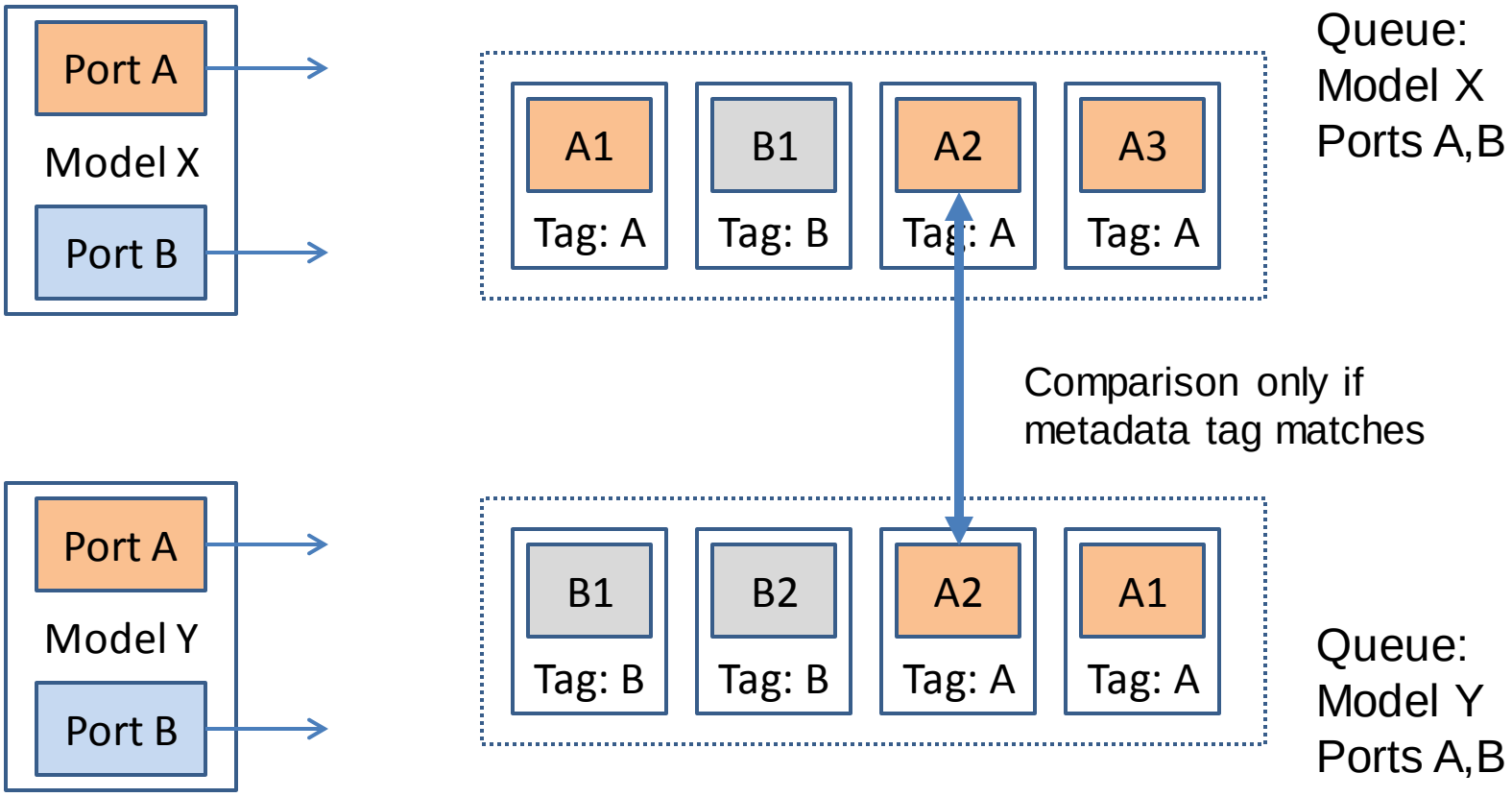
Scalability & Architectural Separation

- Any number of models
  - One primary model, multiple trailing models
  - Design models: RTL, gate, FPGA/ASIC postsil
  - Timed/untimed REF models: SV, SC, Python, C/C++, …
- Any number of queues
  - One queue per model, per port, per transaction type, …
  - Items in queues are tagged with metadata

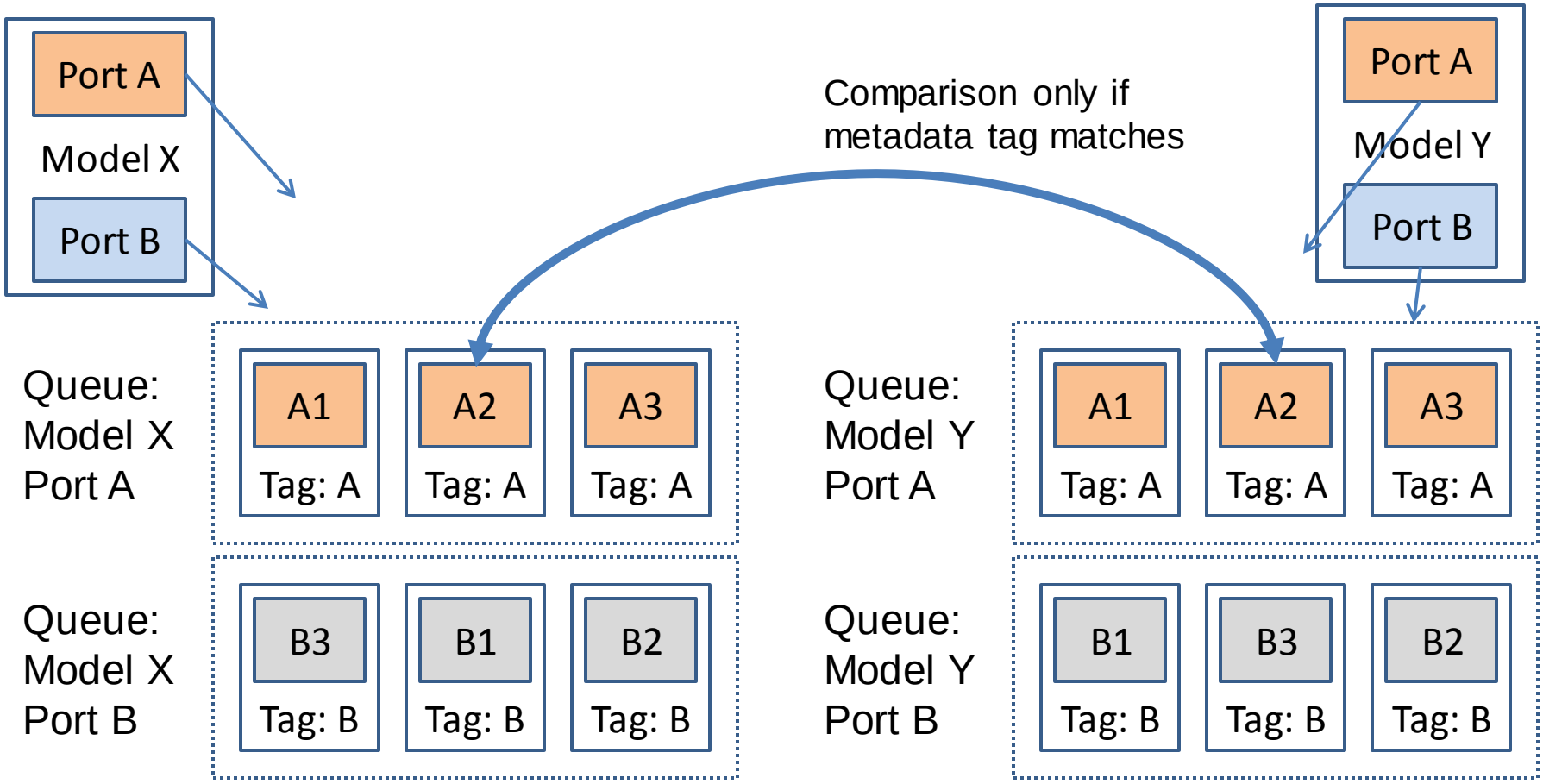
SCB, Bi-dir Port Info Flow (e.g. read/write SoC protocol)



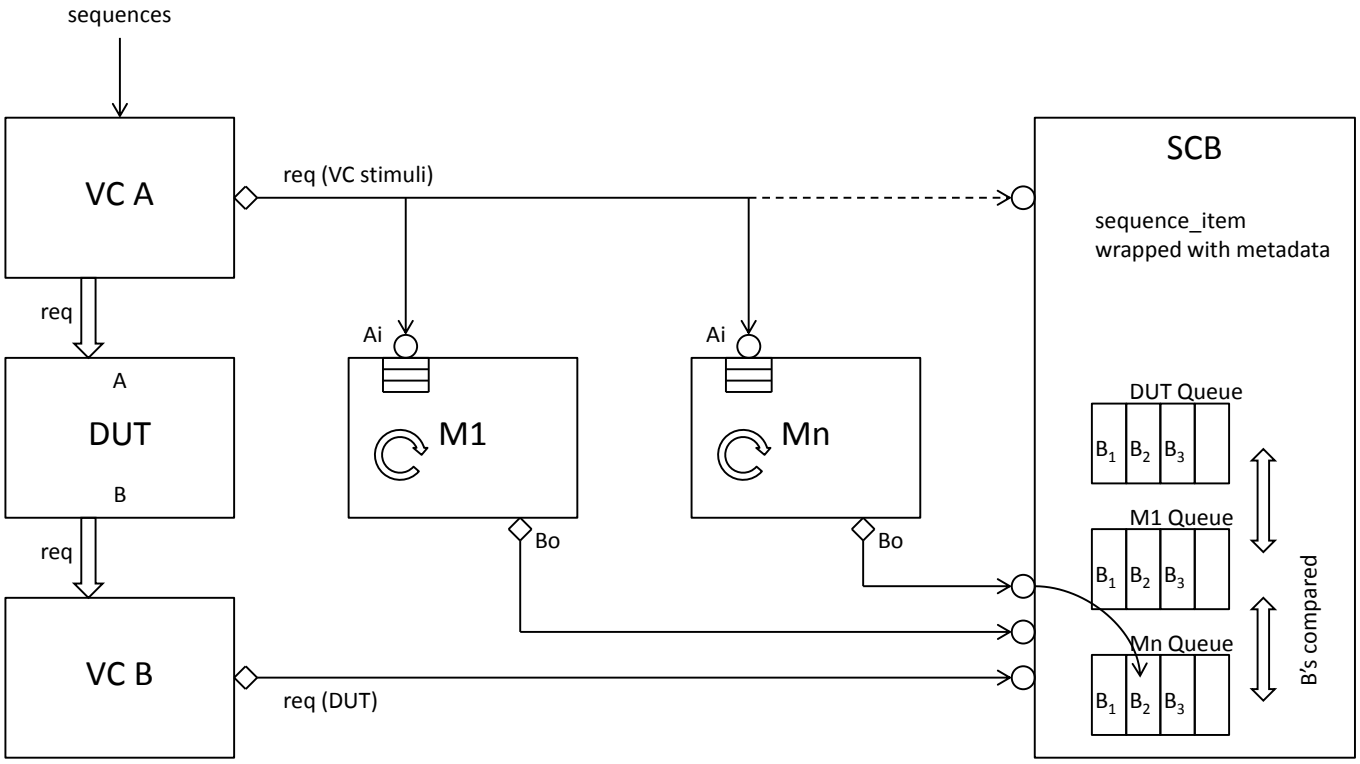
Metadata tagging of Sequence Items: One Queue per Model



Metadata tagging of Sequence Items: One Queue per Model per Port



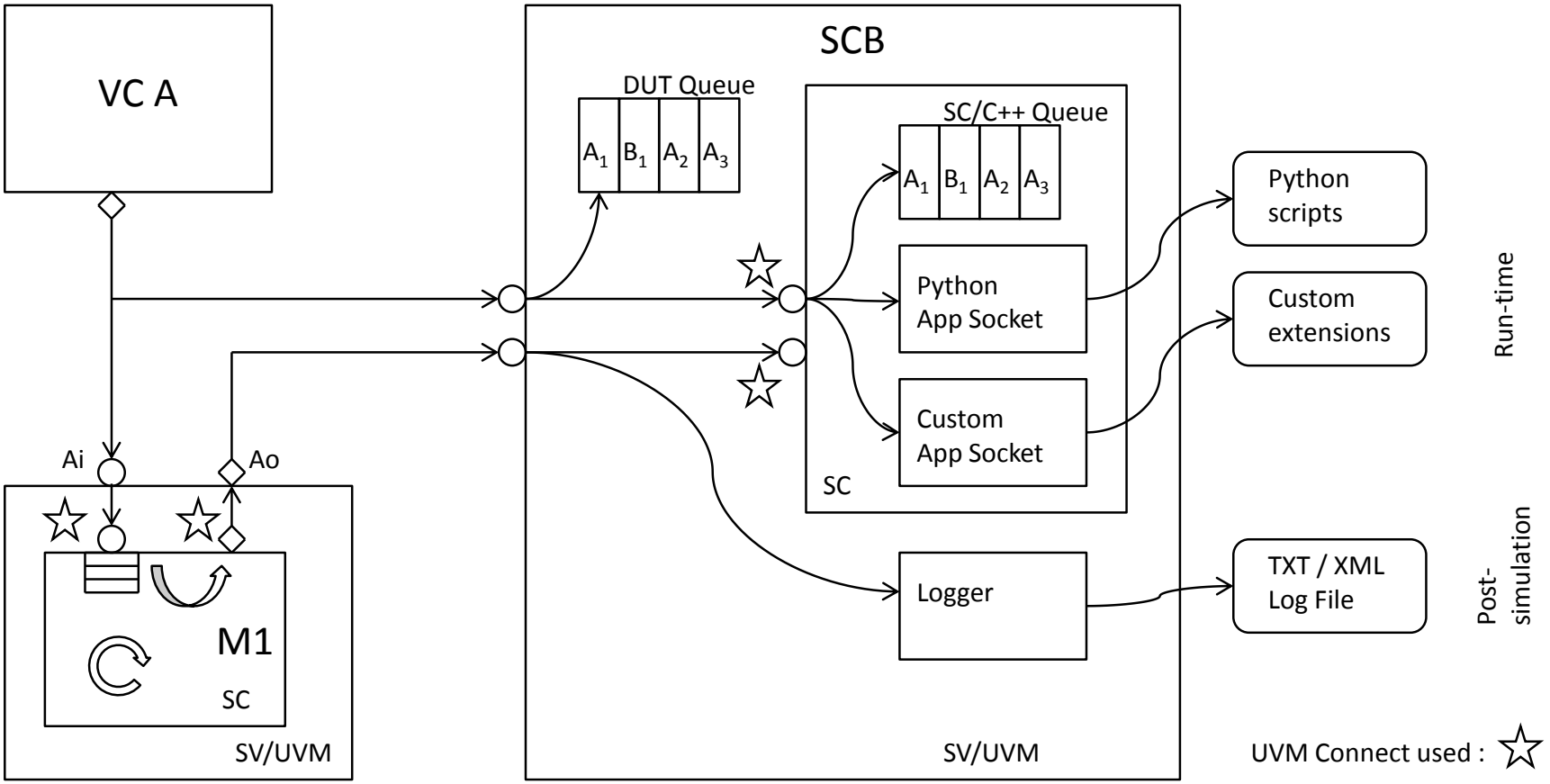
SCB, Uni-dir Port Info Flow (e.g. packet switching)



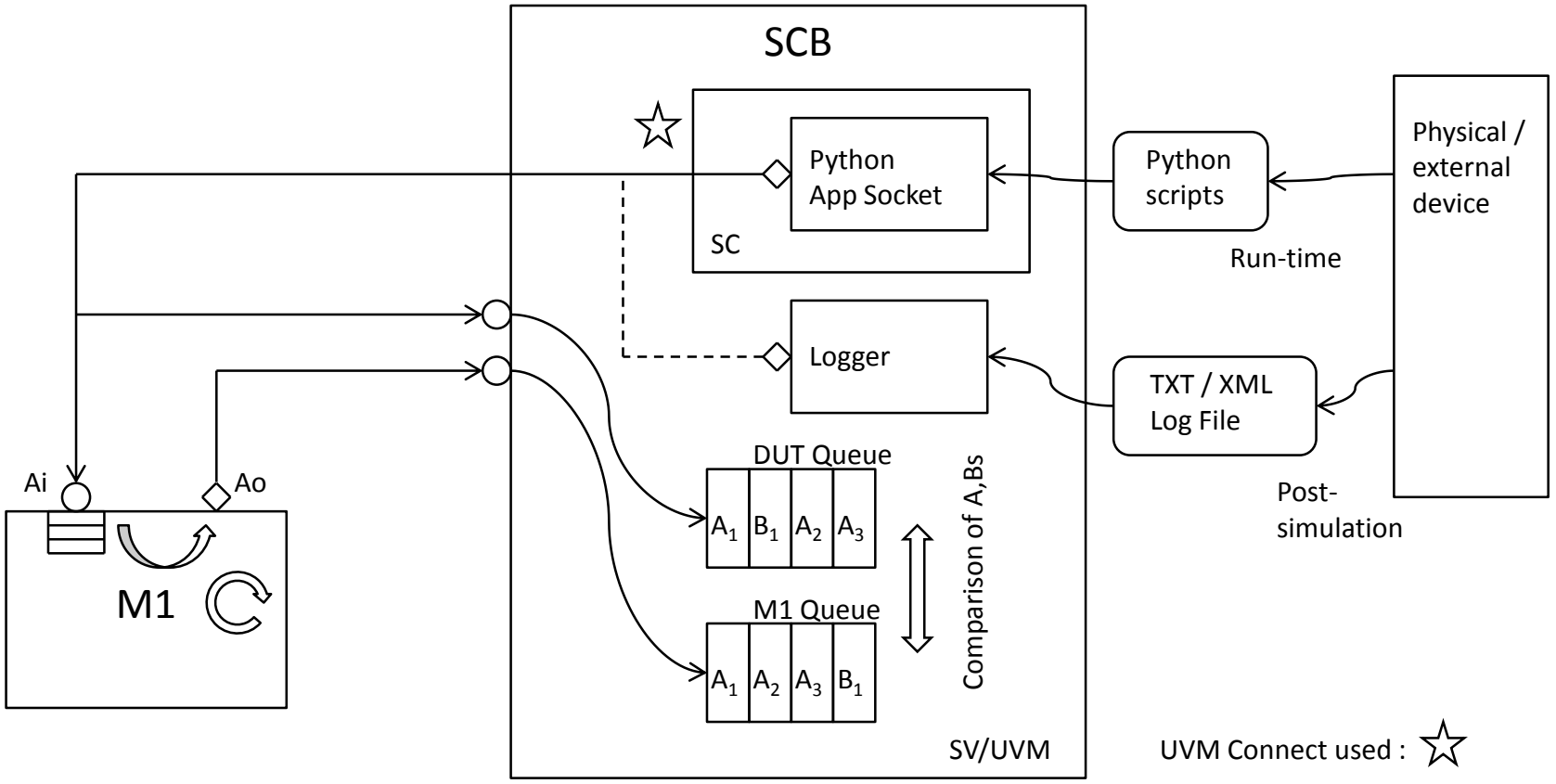
Connectivity

- Logs for post-sim analysis
  - TXT, XML
- Analysis scripts, run-time
  - C/C++/Python
- Non-SV models, run-time
  - C/C++/SC/Py/FPGA/ASIC

Connectivity; external extensions

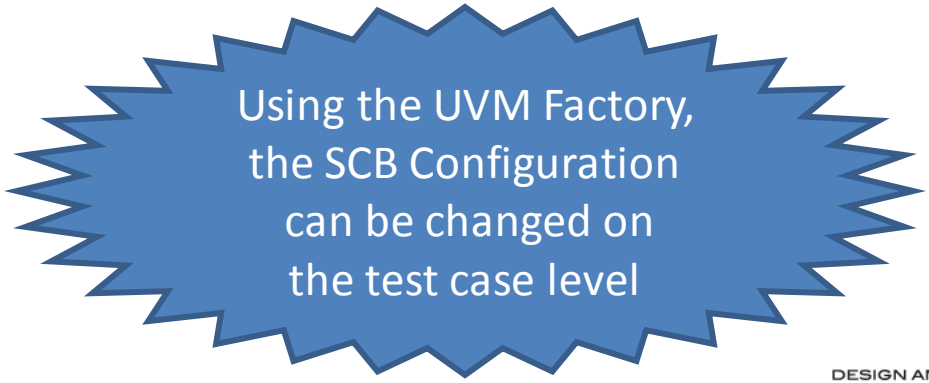


Connectivity; external devices



Configuring the SCB

```
class cl_scb_myconfig extends cl_scb_uvm_config;
  function new(string name = "cl_scb_myconfig");
    scb_cfg.set_queues({“RTL”, “M1”});
    scb_cfg.set_primary_queue(“RTL”);
    scb_cfg.set_producer(“A”, {“RTL”, “M1”});
    scb_cfg.set_producer(“B”, {“RTL”, “M1”});
  endfunction
endclass
```



Insertion of Elements into Queues

Use analysis export offered by API:

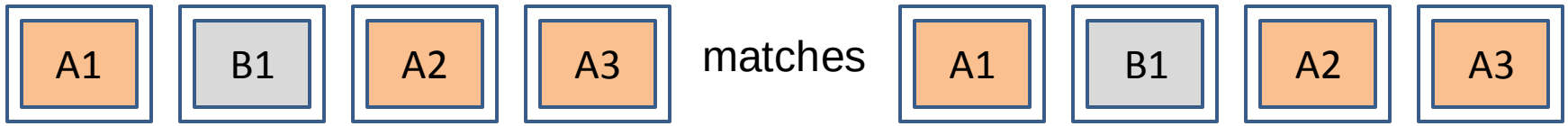
```
cl_scb_uvm scb;
…
myvc.ap.connect(scb.get_aexport("RTL", "A"));
```

Implement analysis export write method, manually add to queue:

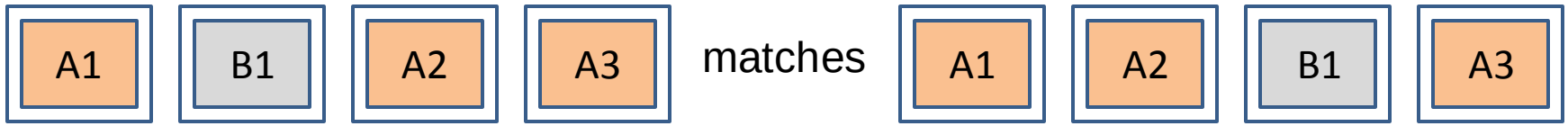
```
function void cl_myscb::write_A(A_seq_item item);
  this.add_item("RTL", "A", item);
endfunction
```

3 Simple Built-in Comparison Methods

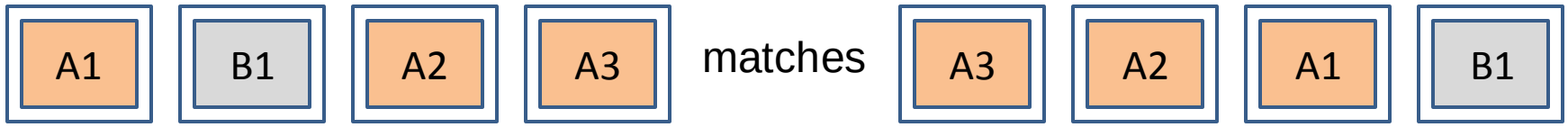
In Order



In Order by Producer



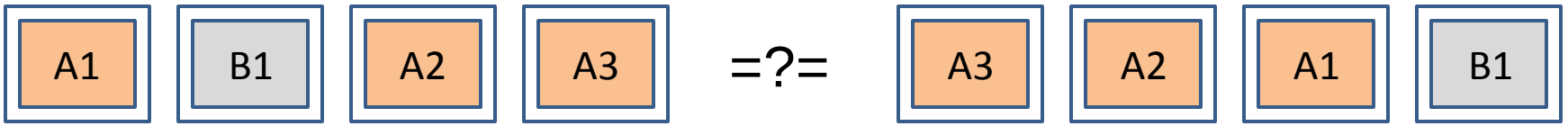
Out of Order :



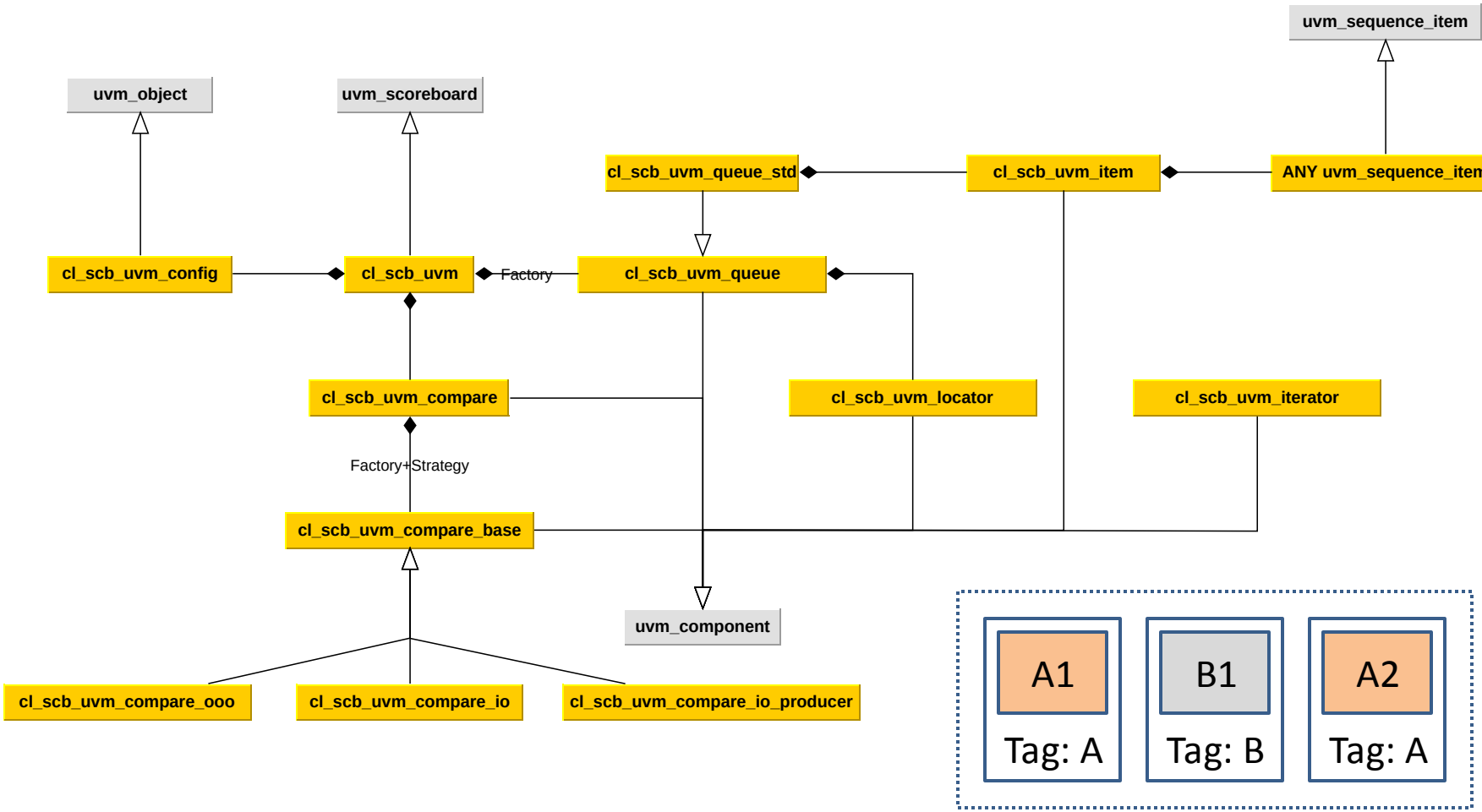
Custom compare methods are easily authored and configured for use on the testcase level

How to Compare Efficiently?

- Do not call A1.compare(A3) repeatedly
  - Polynomic complexity !
- Our SCB instead
  - On insertion, SCB
    - Calculates hash key by MD5'ing A1.pack_bytes()
    - Inserts A1 into associative array
  - On comparison, SCB
    - Calculates hash key by MD5'ing A3.pack_bytes()
    - Checks whether the key exists in the associative array
  - Linear Complexity !



Extensions of UVM Classes



Debug Capabilities

- Comparison error reports
  - What went wrong, remaining contents of queues
- Full scoreboard debug
  - The full queue trace
  - From time zero, or certain window/file size
- Use extern APIs
  - Analysis scripts in e.g. Python
  - XML analysis tools & transformations

Success Stories

- Used across UVM/VMM projects
- 15% code (15% time) saved
- We do SCB setup/config plus validation in less than a day for even complex designs
- Easy for newbees
- Same look&feel across all SCBs
- Out of the box, inherent
  - Top performance
  - Very good debug capabilities
  - Prepared for external interfaces

We are sharing the SCB

- What's in the package?
  - UVM SCB source code
  - Docs
  - Examples
- Register to get code, email
  - info@syosil.com

Questions
Comments
Remarks
?

Thank you!

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