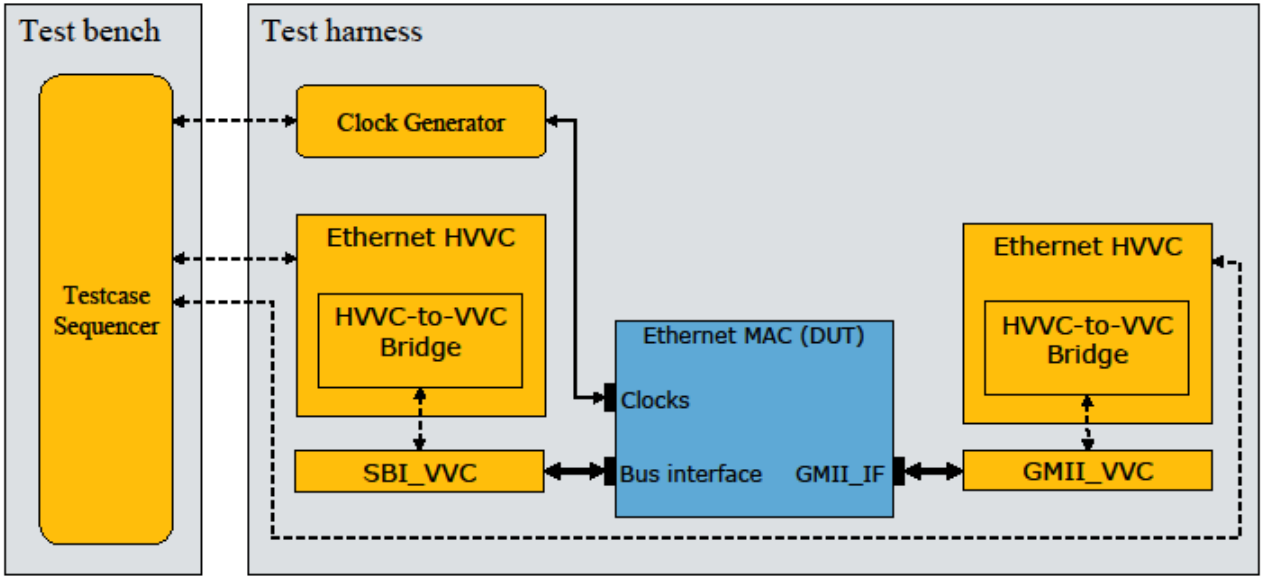
HVVC-to-VVC Bridge

This guide is meant for users that want to make their own HVVC-to-VVC bridge connect.
Users that only write test cases that are using the existing HVVCs and interfaces do NOT need to read this guide.

1 Concept

Many protocols and applications consist of several abstraction levels, e.g. physical layer, link layer, transaction layer, etc. When writing a test case for a higher level you most likely want to ignore the underlaying levels and only deal with the scope of the relevant level. The test case will be less complex and easier to both write and read. A hierarchical VVC (HVVC) is a VVC of a higher protocol level than the physical layer, i.e. it has no physical connections. The test case only communicates with the HVVC which communicate with the lower level. Data is propagated upwards and downwards between the HVVC and DUT through a standard VVC connected to the DUT.
The HVVC-to-VVC Bridge is the connection between a hierarchical VVC (HVVC) and the VVC at a lower protocol level, in this context referred to only as the VVC. Communications between the HVVC and VVC is handled by the HVVC-to-VVC Bridge. Data is transferred between the HVVC and HVVC-to-VVC Bridge on a common interface and converted in the HVVC-to-VVC Bridge to/from the specific interface of the VVC used. An example of this concept used on Ethernet is seen in Figure 1.

Figure 1 Example of HVVC-to-VVC Bridge implemented in an Ethernet HVVC.



1.1 Interface

Communication with the bridge is done through the ports in the HVVC-to-VVC bridge. All data transfer between the HVVC and bridge is in std_logic_vector array format. One port is used for each direction. Data from HVVC to HVVC-to-VVC Bridge is of type t_hvvc_to_bridge, and data from HVVC-to-VVC Bridge to HVVC is of type t_bridge_to_hvvc.

Record ´**t_hvvc_to_bridge**´

Record element	Type	Description
trigger	boolean	Trigger signal.
operation	t_vvc_operation	Operation of the VVC, e.g. RECEIVE or TRANSMIT.
num_data_words	positive	Number of data words transferred.
data_words	t_slv_array	Data sent to the VVC.
dut_if_field_idx	natural	Index of the interface field.
dut_if_field_pos	t_field_position	Position of the interface field within the packet.
msg_id_panel	t_msg_id_panel	Message ID panel of the HVVC. See section 16 of uvvm_vvc_framework/doc/UVVM_VVC_Framework_Essential_Mechanisms.pdf for how to use verbosity control.

Record ´**t_bridge_to_hvvc**´

Record element	Type	Description
trigger	boolean	Trigger signal
data_words	t_slv_array	Data received from the VVC.

1.2 Generic

Generic element	Type	Description
GC_INSTANCE_IDX	integer	Instance index of the VVC.
GC_DUT_IF_FIELD_CONFIG	t_dut_if_field_config_direction_array	Array of IF field configurations, see section 1.3.
GC_MAX_NUM_WORDS	positive	Maximum number of data words transferred in one operation.
GC_PHY_MAX_ACCESS_TIME	time	Maximum time that the PHY interface (lowest protocol level) takes to execute an access, e.g. GMII writing 1 byte. It should account also for any margin it needs, e.g. receiver not ready.
GC_SCOPE	string	Scope of the HVVC-to-VVC Bridge.
GC_WORD_ENDIANNESS	t_word_endianness	Word endianness when converting between different slv array widths, e.g. LOWER_WORD_LEFT.

1.3 DUT interface field configuration

If the interface of the VVC is address-based there needs to be a way to control which address to send the data to. This is done with the DUT IF field configurations. An array of t_dut_if_field_config records is defined by the user and passed to the HVVC-to-VVC Bridge through the generic of the HVVC and HVVC-to-VVC Bridge. When a transmit or receive operation is sent to the HVVC-to-VVC Bridge the index of the DUT IF field config is specified in dut_if_field_idx in the hvvc_to_bridge port. The specified DUT IF field config states the address that shall be accessed. The address associated with each field can easily be changed by changing the DUT IF configuration.

Record ´**t_dut_if_field_config**´

Record element	Type	Description
dut_address	unsigned	Address of the DUT IF field.
dut_address_increment	integer	Incrementation of the address on each access.
data_width	positive	Width of the data per transfer, must be <= bus width.
use_field	boolean	Used by the HVVC to send/request fields to/from the bridge or ignore them when not applicable (e.g. preamble in SBI).
field_description	string	Description of the DUT IF field.

2 User-implementation

The bridge is implemented as an entity and is instantiated inside the HVVC. The different VVC interfaces are implemented as independent architectures due to better readability and extensibility. When adding a new architecture remember to update *t_interface* type in uvvm_util/src/adaptations_pkg.vhd with the new VVC interface name.

2.1 Example of implementation of GMII interface

A snippet of the implementation of GMII is shown as an example bellow.

```
...

-- Execute command
case hvvc_to_bridge.operation is

  when TRANSMIT =>
    -- Convert from t_slv_array to t_byte_array
    v_data_bytes(0 to v_num_data_bytes-1) := convert_slv_array_to_byte_array(hvvc_to_bridge.data_words(0 to
       hvvc_to_bridge.num_data_words-1), v_byte_endianness);
    gmii_write(GMII_VVCT, GC_INSTANCE_IDX, TX, v_data_bytes(0 to v_num_data_bytes-1), "Send data over GMII", GC_SCOPE,
       hvvc_to_bridge.msg_id_panel);
    v_cmd_idx := get_last_received_cmd_idx(GMII_VVCT, GC_INSTANCE_IDX, TX, GC_SCOPE);
    await_completion(GMII_VVCT, GC_INSTANCE_IDX, TX, v_cmd_idx, v_num_transfers*GC_PHY_MAX_ACCESS_TIME, "Wait for write to finish.",
       GC_SCOPE, hvvc_to_bridge.msg_id_panel);

  when RECEIVE =>
    gmii_read(GMII_VVCT, GC_INSTANCE_IDX, RX, v_num_data_bytes, "Read data over GMII", GC_SCOPE, hvvc_to_bridge.msg_id_panel);
    v_cmd_idx := get_last_received_cmd_idx(GMII_VVCT, GC_INSTANCE_IDX, RX, GC_SCOPE);
    await_completion(GMII_VVCT, GC_INSTANCE_IDX, RX, v_cmd_idx, v_num_transfers*GC_PHY_MAX_ACCESS_TIME, "Wait for read to finish.",
       GC_SCOPE, hvvc_to_bridge.msg_id_panel);
    fetch_result(GMII_VVCT, GC_INSTANCE_IDX, RX, v_cmd_idx, v_gmii_received_data, "Fetching received data.", TB_ERROR, GC_SCOPE,
       hvvc_to_bridge.msg_id_panel);
    -- Convert from t_byte_array back to t_slv_array
    bridge_to_hvvc.data_words(0 to hvvc_to_bridge.num_data_words-1) <=
       convert_byte_array_to_slv_array(v_gmii_received_data.data_array(0 to v_num_data_bytes-1), c_data_words_width/8,
       v_byte_endianness);

  when others =>
    alert(TB_ERROR, "Unsupported operation");

end case;

...
```

2.2 Example of instantiation in HVVC

The example bellow shows an instantiation of the HVVC-to-VVC Bridge for GMII in an HVVC. The generics that might change in each instantiation of the HVVC, in this example the ones named GC_* on the right hand side of the generic map, are passed on through the HVVC from the test harness/testbench. Additional interfaces can be added by using the generate statement for each architecture.

```
...

gen_hvvc_bridge : if GC_PHY_INTERFACE = GMII generate
  i_hvvc_to_vvc_bridge : entity bitvis_vip_hvvc_to_vvc_bridge.hvvc_to_vvc_bridge(GMII)
    generic map(
      GC_INSTANCE_IDX        => GC_PHY_VVC_INSTANCE_IDX,
      GC_DUT_IF_FIELD_CONFIG => GC_DUT_IF_FIELD_CONFIG,
      GC_MAX_NUM_WORDS       => C_MAX_PACKET_LENGTH,
      GC_PHY_MAX_ACCESS_TIME => GC_PHY_MAX_ACCESS_TIME,
      GC_SCOPE               => C_SCOPE
    )
    port map(
      hvvc_to_bridge => hvvc_to_bridge,
      bridge_to_hvvc => bridge_to_hvvc
    );
end generate gen_hvvc_bridge;

...
```

3 Procedures

The following procedures are used by the HVVC when transmitting or requesting data from the HVVC-to-VVC Bridge.

Procedure	Description
blocking_send_to_bridge()	**blocking_send_to_bridge(hvvc_to_bridge, bridge_to_hvvc, data_words, dut_if_field_idx, dut_if_field_pos, scope, msg_id_panel)** Sends a data array to the HVVC-to-VVC Bridge and waits for a trigger signalling the bridge has finished. This procedure blocks the sequencer until it is done. Examples: `blocking_send_to_bridge(hvvc_to_bridge, bridge_to_hvvc, v_data_array(0 to 9), C_FIELD_IDX_PAYLOAD, FIRST, C_SCOPE, v_msg_id_panel);`

blocking_request_from_bridge()	**blocking_request_from_bridge(hvvc_to_bridge, bridge_to_hvvc, num_data_words, dut_if_field_idx, dut_if_field_pos, scope, msg_id_panel)**
	
	Requests data from the HVVC-to-VVC Bridge and waits for a trigger signalling the bridge has finished. This procedure blocks the sequencer until it is done.
	
	Examples:
	`blocking_request_from_bridge(hvvc_to_bridge, bridge_to_hvvc, 10, C_FIELD_IDX_PAYLOAD, LAST, C_SCOPE, v_msg_id_panel);`
	`v_receive_words := bridge_to_hvvc.data_words(0 to 9); -- Save the received data`

4 Additional Documentation

Additional documentation about UVVM and its features can be found under “uvvm_vvc_framework/doc/”.