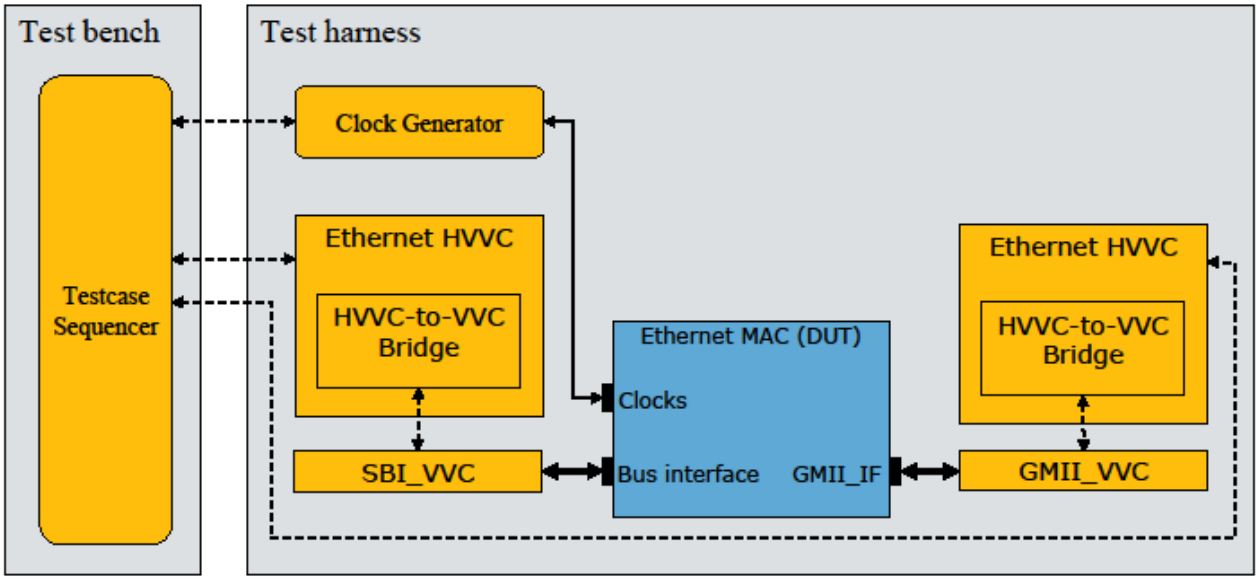
HVVC-to-VVC Bridge

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

Communications with the bridge is done through the ports in the HVVC-to-VVC bridge. All data transfer between the HVVC and bridge is in byte 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_sub_vvc_operation	The operation of the VVC, e.g. RECEIVE or TRANSMIT
num_data_bytes	positive	The number of bytes of data that is transferred.
data_bytes	t_byte_array	Data sent to the VVC.
dut_if_field_idx	integer	The index of the interface field.
current_byte_idx_in_field	natural	The byte number in the interface field.
msg_id_panel	t_msg_id_panel	Message ID panel

Record ´**t_bridge_to_hvvc**´

Record element	Type	Description
trigger	boolean	Trigger signal
data_bytes	t_byte_array	Data received from the VVC.

1.2 Generic

Generic element	Type	Description
GC_INTERFACE	t_interface	The interface of the VVC.
GC_INSTANCE_IDX	integer	Instance index of the VVC.
GC_CHANNEL	t_channel	Channel of the VVC.
GC_DUT_IF_FIELD_CONFIG	t_dut_if_field_config_channel_array	Array of IF field configurations.
GC_SCOPE	string	Scope of the HVVC-to-VVC Bridge.

1.3 DUT interface field configuration

If the interface of the VVC is address-based there need 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	The width of the data per transfer, must be <= bus width.
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 interfaces are implemented in a case statement in the architecture. New VVC interfaces are added here.

2.1 Example of implementation of GMII interface

The implementation of GMII is shown as an example bellow.

```
...

when GMII =>

  case hvvc_to_bridge.operation is

    when TRANSMIT =>
      gmii_write(GMII_VVCT, GC_INSTANCE_IDX, TX, hvvc_to_bridge.data_bytes(0 to hvvc_to_bridge.num_data_bytes-1), "Send data over
          GMII", GC_SCOPE, USE_PROVIDED_MSG_ID_PANEL, 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, hvvc_to_bridge.num_data_bytes*shared_gmii_vvc_config(TX,
          GC_INSTANCE_IDX).bfm_config.clock_period+hvvc_to_bridge.field_timeout_margin, "Wait for send to finish.", GC_SCOPE,
          USE_PROVIDED_MSG_ID_PANEL, hvvc_to_bridge.msg_id_panel);

    when RECEIVE =>
      gmii_read(GMII_VVCT, GC_INSTANCE_IDX, RX, hvvc_to_bridge.num_data_bytes, "Read data over GMII", GC_SCOPE,
          USE_PROVIDED_MSG_ID_PANEL, 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, hvvc_to_bridge.num_data_bytes*shared_gmii_vvc_config(RX,
          GC_INSTANCE_IDX).bfm_config.clock_period+hvvc_to_bridge.field_timeout_margin, "Wait for read to finish.", GC_SCOPE,
          USE_PROVIDED_MSG_ID_PANEL, 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,
          USE_PROVIDED_MSG_ID_PANEL, hvvc_to_bridge.msg_id_panel);
      bridge_to_hvvc.data_bytes(0 to hvvc_to_bridge.num_data_bytes-1) <= v_gmii_received_data(0 to hvvc_to_bridge.num_data_bytes-1);

...
```

2.2 Example of instantiation in HVVC

The example bellow shows an instantiation of the HVVC-to-VVC Bridge 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.

```
...

i_hvvc_to_vvc_bridge : entity bitvis_vip_hvvc_to_vvc_bridge.hvvc_to_vvc_bridge
  generic map(
    GC_INTERFACE           => GC_INTERFACE,
    GC_INSTANCE_IDX        => GC_VVC_INSTANCE_IDX,
    GC_CHANNEL             => C_CHANNEL,
    GC_DUT_IF_FIELD_CONFIG => GC_DUT_IF_FIELD_CONFIG,
    GC_MAX_NUM_BYTES       => C_MAX_PACKET_LENGTH,
    GC_SCOPE               => C_SCOPE
  )
  port map(
    hvvc_to_bridge => hvvc_to_bridge,
    bridge_to_hvvc => bridge_to_hvvc
  );

...
```

3 Procedures

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

Procedure	Description
hvvc_to_bridge_trigger()	**hvvc_to_bridge_trigger(hvvc_to_bridge)** The hvvc_to_bridge_trigger () procedure generates a trigger pulse on the trigger in the hvvc_to_bridge record.

send_to_bridge()	**send_to_bridge(hvvc_to_bridge, operation, data_bytes, dut_if_field_idx, current_byte_idx_in_field, msg_id_panel)**
	send_to_bridge(hvvc_to_bridge, operation, num_data_bytes, dut_if_field_idx, current_byte_idx_in_field, msg_id_panel)
	
	Sends operation to HVVC-to-VVC Bridge.
	
	Examples:
	`send_to_bridge(hvvc_to_bridge, TRANSMIT, v_transmit_bytes, 0, 0, v_msg_id_panel); -- Transmit byte array v_transmit_bytes`
	`send_to_bridge(hvvc_to_bridge, RECEIVE, 10, 0, 0, v_msg_id_panel); -- Receive 10 bytes`

blocking_send_to_bridge()	**blocking_send_to_bridge(hvvc_to_bridge, bridge_to_hvvc, operation, data_bytes, dut_if_field_idx, current_byte_idx_in_field, msg_id_panel)**
	blocking_send_to_bridge(hvvc_to_bridge, bridge_to_hvvc, operation, num_data_bytes, dut_if_field_idx, current_byte_idx_in_field, msg_id_panel)
	
	Sends operation to HVVC-to-VVC Bridge and awaits trigger.
	
	Examples:
	`-- Transmit byte array v_transmit_bytes`
	`blocking_send_to_bridge(hvvc_to_bridge, bridge_to_hvvc, TRANSMIT, v_transmit_bytes, 0, 0, v_msg_id_panel);`
	`blocking_send_to_bridge(hvvc_to_bridge, bridge_to_hvvc, RECEIVE, 10, 0, 0, v_msg_id_panel); -- Receive 10 bytes`
	`v_receive_bytes := bridge_to_hvvc.data_bytes(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/”.