Switch Abstraction Interface
Change Proposal

Title	**SAI Multi NPU**
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Contents

List of Changes

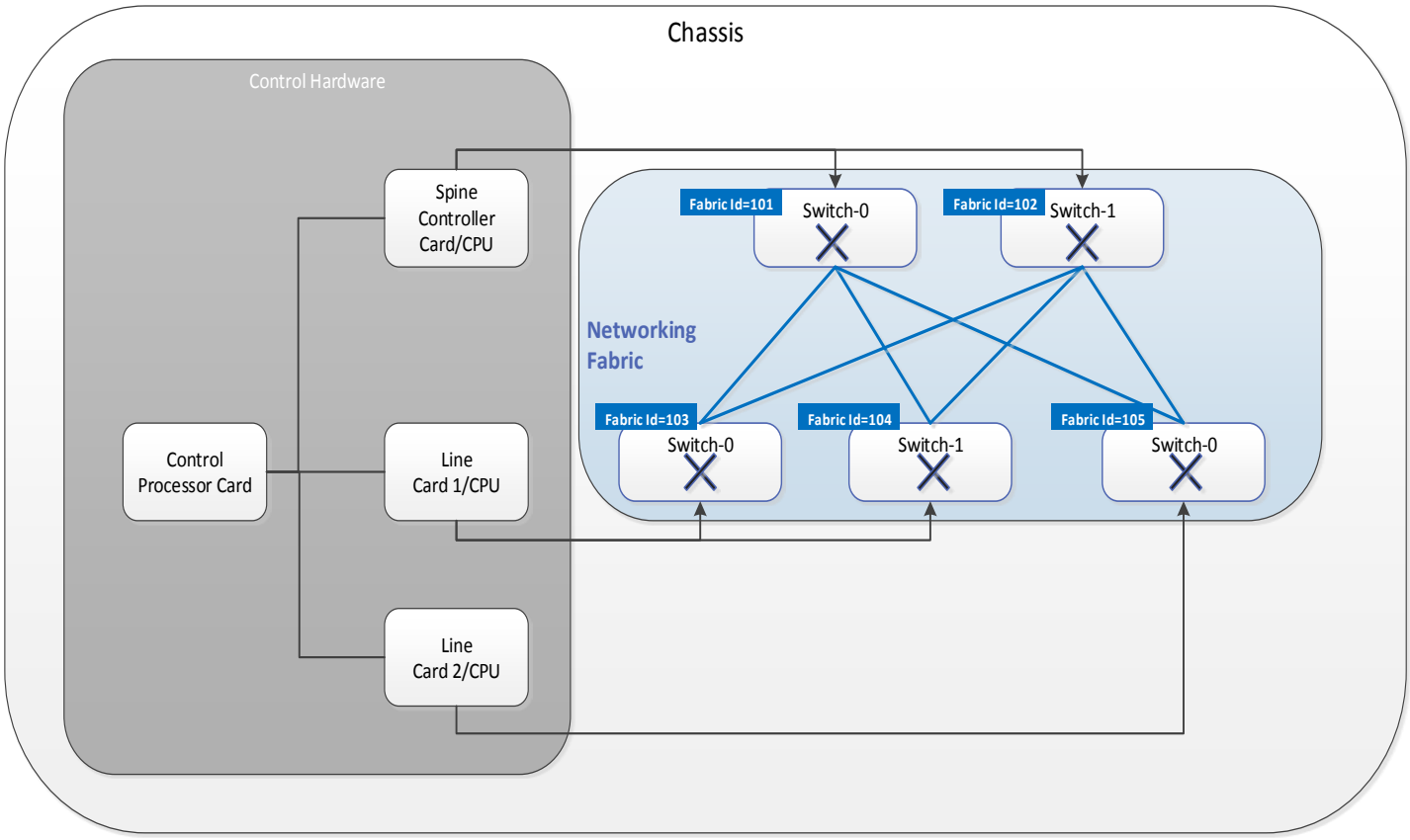
Version	Changes	Name	Date
0.9.3	Base version		7/8/2016

License

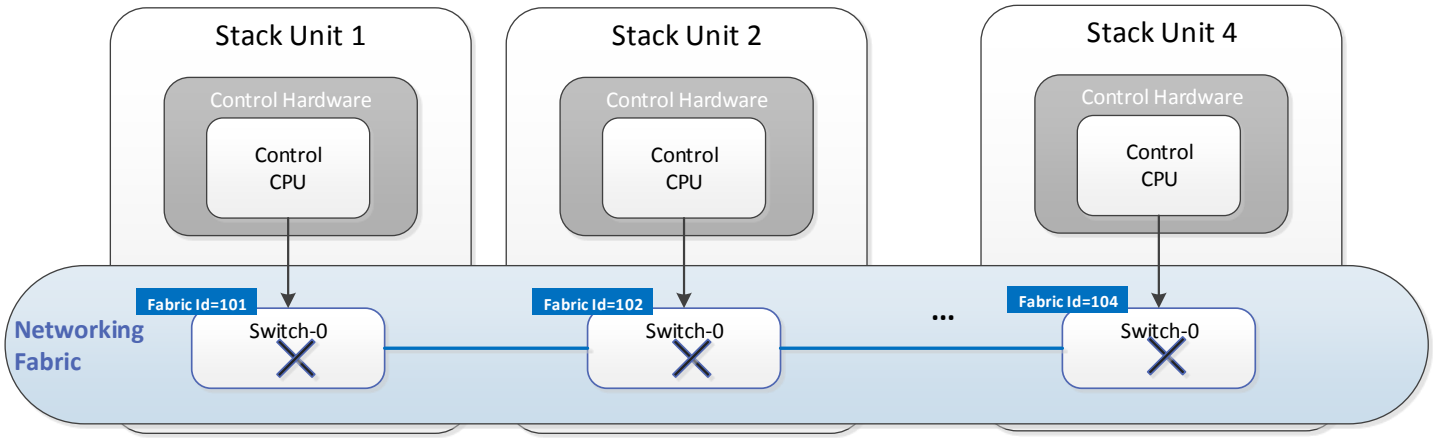
1 Overview

This proposal is intended to enhance the existing SAI API model in order to support multiple NPU's, either on multi-card or single-card systems, such as:

- chassis with control processors (CP) and linecards(LC)
- stacking
- multiple NPU's attached to and controlled from a single card/CPU system (multi-NPU 'pizza-boxes')



Chassis System – with a Spine-Leaf networking fabric



Stacking System

The figures above illustrate two important concepts related to multi-NPU systems:

- The networking fabric requires separate global switch identifiers ("fabric IDs") associated to each NPU in a networking fabric, whether spine-leaf or stacking (or other topologies)
    - For instance, the fabric ID can be used to distinguish port 1 on NPU x from port 1 on NPU y; essentially, each individual port is globally identified by the pair [Global Swich ID/Fabric ID, Local NPU Port ID]; use cases:
        - MLAG / multi-NPU LAG
        - Chassis wide or stack wide MAC address discovery/FDB management
- Controlling SW executed on CPU's that control multiple NPU's (e.g. "Line Card 1" and "Spine Controller", in the figure above) need to be able to identify individual NPUs attached to/controlled from a given CPU.
    - This proposal adds a (local, to the CPU) "switch id" to SAI API in order to allow the host-adapter to identify individual NPU's

The SAI API model is enhanced in order to allow the host-adaptor to control each NPU separately i.e. SAI should be capable of initialize, de-init, restart and power-off each individual NPU and so forth.

Note. It is assumed that both the "switch ID" and "fabric ID" are platform specific parameters, managed by the Host Adapter. In fact, determining "fabric ID's" may be the responsibility of higher software layers, but this is outside the scope of the SAI API specification.

The rest of the document describes changes required to:

- Support a multi-NPU networking fabric
- Support local NPU addressability at the card/CPU level

The two set of changes are independent of each other.

2 Supporting a Multi-NPU networking fabric

The following changes are required in order to support a multi-NPU networking fabric:

- Assigning a unique ID to each NPU in a networking fabric (Fabric/module ID).
- Remote/Global ports (global port identifier in a networking fabric)
- SAI object creation by passing ID (WITHID) –needed for LAG and VxLAN
    - In a multi-NPU networking fabric, multi-NPU LAG / trunk groups must be uniquely identified by a global LAG ID; same concept applies to other SAI objects
- Fabric route table management.

2.1 SAI Unique Fabric/Module ID per NPU

In Chassis or stacking systems each NPU in system needs the unique identifier for fast path switching. By looking at this identifier packets are switched to destination NPU.

This is not NPU ID, NPU ID scope is local to CPU. This Fabric or module ID scope is global to system.

Topology Discovery:

General chassis or stacking model will have their own topology discovery modules to find how many NPU in the system and how they are connected each other. After discovering topology unique fabric/module ID will be assigned to each NPU in the system.

Dynamic Discovery:

- Every unit will participate in discovery with existing fabric id. Example Default fabric id 0 for all units.
- Once Topology discovered, each unit will be assigned with correct unique fabric ID in that system.

Fixed Topology:

- In Fixed Chassis, User can predefine fabric id's for each NPU in their product.

SAI should have option to set the fabric id as part of switch initialization or after switch init. This depends on the NPU capability.

2.1.1 Specification

This section describes an overview of the proposed API changes in order to support a fabric ID.

2.1.1.1 Changes in sai.h

New function **sai_fabric_id_query**

(applies to approach 1 described in section Unique OID)

```
/**
 * Routine Description:
 *     @brief  Given an object ID, return the fabric ID that the object belongs to.
 *
 * Arguments:
 *     @param[in] sai_object_id
 *
```

```
 * Return Values:
 *    @return  Return SAI_FABRIC_ID_INVALID when sai_object_id is not valid.
 *             Otherwise, return a valid sai_fabric_id_t identifier
 */
sai_fabric_id_t sai_fabric_id_query(
    _In_ sai_object_id_t sai_object_id);
```

2.1.1.2 Changes in saiswitch.h

```
/** READ-WRITE */

/* Set Fabric ID allowed only after deleting all SAI objects from switch*/
SAI_SWITCH_ATTR_FABRIC/MODULE_ID


#define SAI_KEY_SWITCH_FABRIC_ID                "SAI_SWITCH_FABRIC_ID"
```

2.2 SAI Remote/Global OID

In a Multi-NPU system, global or system-wide NPU ports refer to the union of all ports on all NPUs on all line cards or stack members.

Each NPU has its own SAI instance. Each SAI instance will allocate SAI Port ID for ports on its own NPU. But since these port IDs are local to each NPU, the Port IDs generated by two different SAI Instances will overlap.

In the fast-path packet processing pipeline, the MAC and Route Table entries are looked up at the ingress NPU whereas the destination port may be on a different destination NPU. Since looking up the MAC or Route table in both the ingress and destination NPUs affects throughput, typically NPUs use the concept of Global NPU ports to refer to remote ports - so the MAC and Route table entries at the Ingress NPU are programmed with Global NPU Port ID of the remote NPU port.

In order to support this every SAI instance participating in a multi-NPU system should also support the concept of global NPU ports.

2.2.1 Unique OID

MAC or Route table can point to ports in other NPUs, using internal H/W tables directly programmed with remote port or fabric + port combination. Based on this setup packets are transmitted (directed) to a remote NPU.

SAI OID representation is internal to each SAI vendor implementation. In case more than one SAI implementation for same NPU vendor and this combination we are using it same chassis. Then remote port representation by one implementation should be known to other unless we have explicit pass through mechanism like port and fabric id per port from host.

Approach 1: Fixed OID format

To make SAI oid's are unique per each NPU in topology, we can include Fabric ID as part of OID.

To support this we can define the SAI OID format so that every vendor will use this format for create OID. By doing this Any SAI implementation can derive the Fabric ID from the OID itself.

Example: Port UOID Representation:

SAI UOID includes,

Object Type : Type of the object : SAI_OBJECT_PORT

Object Id : Id corresponding to the object Type : SAI PORT ID

Reserved : Reserved field for future

Reserved	Objects Type	Object Id
(4)	(12)	(48)

SAI Port Object ID Representation:

A SAI port (UINT64) can have the following information embedded in it

- Port Type - Supports more than just Front-Panel user Port or CPU port.
- NPU/Fabric ID - Needed in a system with Multi NPU's, we need to program a distinct Fabric ID for each NPU in a networking fabric
- NPU Logical Port Number. Logical Port numbers can be same as HW Port number/gport or it can be mapped to HW port depending on the NPU..

Reserved	Port Type	Fabric Id	Port Number
4 Bits	4 Bits	8 bits	32 Bits
47 – 44	43 – 40	39 – 32	31 – 0

Approach 2: Configure Fabric ID per port.

For local SAI port oid's, Fabric ID can be derived from Switch attribute or you can set this as part of create/set port attributes.

2.2.2 Exchange SAI OID's between SAI instances.

SAI port OID format not generic, To use remote port OID in the local SAI instance, host adaptor has to pass oid's created in one SAI instance to other units. Remote port OID's are cached in the other SAI

instances other than the local SAI. This can be used for validations and configure the fabric ID for remote port OID.

This can be avoided incase if we fix the OID format, so that SAI implementation will understand remote port OID and just it for getting Fabric ID. Then we no need to exchange any information of remote OID's. While Creating we have to take care SAI OID is created with correct Fabric ID included.

2.2.3 Specification

This section describes an overview of the proposed interface/API for approach 2.

2.2.3.1 Changes in saiport.h

```
/* Local port oid, Default – SAI_SWITCH_ATTR_FABRIC_ID */

SAI_PORT_ATTR_FABRIC/MIDULE_ID
```

```
   /** Local Ports Creation for NPU */

   typedef sai_status_t(*sai_create_port_fn)(
    _Out_ sai_object_id_t* port_id,
     _In_ uint32_t attr_count,
     _In_ sai_attribute_t *attr_list
   );
```

```
/** Local Ports remove for NPU */
typedef sai_status_t(*sai_remove_port_fn)( _In_ sai_object_id_t port_id)


/**
 * Routine Description:
 *    @brief Add remote ports to a SAI.
 *
 * Arguments:
 *    @param[in] port_count - number of ports
 *    @param[in] port_oid - array of remote port oid's
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_add_remote_ports_fn)(
        _In_ uint32_t port_count,
        _In_ const sai_object_id_t* port_oids
    );


/**
 * Routine Description:
 *    @brief Remove remote ports oids from a SAI
 *
 * Arguments:
 *    @param[in] port_count - number of ports
 *    @param[in] port_oids - array of remmote port oids.
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
```

```
typedef sai_status_t (*sai_remove_remote_ports_fn)(
    _In_ uint32_t port_count,
    _In_ const sai_object_id_t* port_oids
    );

typedef struct _sai_port_api_t
{
    sai_add_remote_ports_fn         add_ports;
    sai_remove_remote_ports_fn      remove_ports;
} sai_port_api_t;
```

2.3 SAI Port as Fabric Port

In Chassis or staking some port in in NPU will be used to connect as fabric links or backplane. This port may carry the packet from one unit to other unit with special encapsulation etc.

2.3.1 Specification

```
/**
 *  @brief Attribute data for SAI_PORT_ATTR_TYPE
 */
typedef enum _sai_port_encp_type_t
{
    /** Actual port. N.B. Different from the physical port. */
    SAI_PORT_ENCAP_TYPE_ETHERNET,

    /** CPU Port */
    SAI_PORT_ENCAP_TYPE_FABRIC,

} sai_port_encap_type_t;

/* Default – SAI_PORT_ENCAP_TYPE_ETHERNET*/

SAI_PORT_ATTR_ENCAP_TYPE;
```

2.4 SAI Object Creation By passing ID

There is a requirement to have the notion of global Port OID as captured in the Section 4 SAI Remote/Global OID. Further, there is also a need for having global OID for certain SAI objects in the Multi NPU system. This is required when the forwarding lookup happens only in ingress NPU and the destination information is carried as meta-data to the egress NPU. Some examples are captured below.

Examples:

LAG object

- SAI LAG object can have member ports spanning across multiple NPU in the system. If a packet enters the ingress NPU on one of the LAG member ports, the Source LAG Id assigned for the packet is usually carried as a meta-data to the remote NPU for reasons like flooding the packets to member ports in the remote NPU.
- This requires the LAG Id to be globally unique across the multiple NPUs.
-

VxLAN Tunnel

- SAI VxLAN maps the bridge port to a VNI and FDB entry on the access network is learnt on the bridge port
- Bridge port Id has to be globally unique across the multiple NPUs just like the port OID so that the FDB entry can point to a bridge port id in the remote NPU.

Multicast Group ID

- When a packet is destined to a Multicast Group Id that has member ports in remote NPU, the Multicast Group Id has to be looked up in the remote NPU for replicating to the local egress ports that are part of the group.
- This requires the multicast group id to be globally unique across the multiple NPUs.

To provide the more flexibility and control to host, SAI API needs to be extended to program object with the given Id. This will also solve the Multi NPU requirements.

2.4.1 Specification

Proposal is to have the attribute in all the objects as platform specific and opaque (to the host adapter) "hardware identifier". This identifier needs to be provided at object creation time.

Example:

```
/** SAI LAG HWID list [sai_u32_list_t] */
   SAI_LAG_ATTR_HWID_LIST,
```

2.5 SAI Fabric Route Table

In general, in a Chassis or Stacking environment, routing traffic from one NPU to other NPU is managed by a routing table based on fabric id's and fabric ports.

This table helps to:

- Obtain the shortest path to reach the destination NPU.
- Preventing loops.

This table can be changed based on topology changes and this topology changes can be detected from software or hardware. Controlling this table form host depends on NPU/SDK capability.

2.5.1 Specification

A new port attribute is added, to specify the list of fabric ID's that can be accessed through the given port.

```
  /** Fabric ID list [uint8_t]
    * Port can be used to route traffic to fabric in the list.
    * Modify needs to provide the new list.
    */
  SAI_PORT_ATTR_ROUTE_FABRIC_ID_LIST,
```

3 Support local NPU addressability at the card/CPU level

Supporting individual NPU addressability requires the definition of a Switch ID. The Switch ID is used to identify individual NPU's in all SAI functions (e.g. 'create' functions). The "switch ID" is local to a CPU.

- This provides SAI with capability to allow the host-adapter to address an individual NPU attached to a card/CPU.

3.1 SAI object creation using SWITCH ID

Controlling multiple NPU from a single CPU can be achieved either by:

- Having separate SAI instances for each NPU in the system.
    - A more detailed discussion about this approach is provided as an Appendix
- Controlling multiple NPU's using a single SAI instance.

Note that this proposal "augments" the SAI API's with a switch ID, thus allowing the host-adapter to use a single SAI instance to control multiple NPUs (vs. using the driver/SAI Instance approach).

Examples of operations that require addressing an individual NPU

- Switch init/deinit/restart/power-off per NPU.
- FDB entry can be programmed only in case VLAN has member ports in NPU.
- Multicast group id based on egress port list.

Current SAI specification defines:

sai_switch_profile_id_t profile_id:

- Host will pass the profile Id, this will be used to retrieve values needed switch init by using service_method table.
- This can be same incase if we have the similar NPU in line card.
- Scope of this platform dependent.

(SAI_MAX_HARDWARE_ID_LEN) char* switch_hardware_id:

This is to represent switch NPU details as string.

Example:

NPU number, PCI location and driver instance or only the driver instance to use for particular NPU.

switch_hardware_id – NPUXXX-PCIXXX-0 , NPUXXX-PCIYYY-1 or 0, 1

3.2 Specification

SAI object creation should be enhanced to supported configuration per NPU granularity. This attribute is valid only for create (CREATE_ONLY) and also it is optional attribute for any object, if this attribute is not mentioned as part of creation it will use the default SWITCH id i.e 0.

3.2.1 Changes in saiswitch.h

```
typedef UINT32  sai_switch_id_t;
/**
* Routine Description:
*   SDK initialization. After the call the capability attributes should be
*   ready for retrieval via sai_get_switch_attribute().
*
* Arguments:
*   @param[in] profile_id - Handle for the switch profile.
*   @param[in] switch_hardware_id - Switch hardware ID to open
*   @param[in] firmware_path_name - Vendor specific path name of the firmware
*                                   to load
*   @param[in] switch_notifications - switch notification table
* Return Values:
*   @return SAI_STATUS_SUCCESS on success
*           Failure status code on error
*/
typedef sai_status_t (*sai_initialize_switch_fn)(
    _In_ sai_switch_profile_id_t profile_id,
    _In_  sai_switch_id_t switch_id,
    _In_reads_z_(SAI_MAX_HARDWARE_ID_LEN) char* switch_hardware_id,
    _In_reads_opt_z_(SAI_MAX_FIRMWARE_PATH_NAME_LEN) char* firmware_path_name,
    _In_ sai_switch_notification_t* switch_notifications,
    );

/**
 * Routine Description:
 *   @brief Release all resources associated with currently opened switch
 *
 * Arguments:
 *   @param[in] warm_restart_hint - hint that indicates controlled warm restart.
 *                              Since warm restart can be caused by crash
 *                              (therefore there are no guarantees for this call),
 *                              this hint is really a performance optimization.
 *
 * Return Values:
 *   None
 */
typedef void (*sai_shutdown_switch_fn)(
     _In_ sai_switch_id_t  switch_id,
     _In_ bool warm_restart_hint
    );

/**
 * Routine Description:
 *   @brief Disconnect this SAI library from the SDK.
 *
 * Arguments:
 *   None
 * Return Values:
 *   None
 */
typedef void (*sai_disconnect_switch_fn)(
    _In_ sai_switch_id_t  switch_id

    );


/**
 * Routine Description:
 *    @brief Set switch attribute value
 *
```

```
 * Arguments:
 *    @param[in] attr - switch attribute
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_set_switch_attribute_fn)(
     _In_ sai_switch_id_t  switch_id,
    _In_ const sai_attribute_t *attr
    );

/**
 * Routine Description:
 *    @brief Get switch attribute value
 *
 * Arguments:
 *    @param[in] attr_count - number of switch attributes
 *    @param[inout] attr_list - array of switch attributes
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_get_switch_attribute_fn)(
    _In_ sai_switch_id_t switch_id,
    _In_ sai_uint32_t attr_count,
    _Inout_ sai_attribute_t *attr_list
    );

/**
 * Routine Description:
 *   @brief Switch shutdown request callback.
 *   Adapter DLL may request a shutdown due to an unrecoverable failure
 *   or a maintenance operation
 *
 * Arguments:
 *   None
 *
 * Return Values:
 *   None
 */
typedef void (*sai_switch_shutdown_request_fn)( _In_ sai_switch_id_t  switch_id);


/**
 * Routine Description:
 *   @brief Switch oper state change notification
 *
 * Arguments:
 *  @param[in] switch_oper_status - new switch oper state
 *
 * Return Values:
 *    None
 */
typedef void (*sai_switch_state_change_notification_fn)( sai_switch_id_t  switch_id,
    _In_ sai_switch_oper_status_t switch_oper_status
    );
```

3.2.2 Notifications

A switch ID parameter must be added to all notifications API's (below), in order to identify the individual NPU which triggers a given notification:

```
typedef struct _sai_switch_notification_t
{
    sai_switch_state_change_notification_fn on_switch_state_change;
    sai_fdb_event_notification_fn           on_fdb_event;
    sai_port_state_change_notification_fn   on_port_state_change;
    sai_port_event_notification_fn          on_port_event;
    sai_switch_shutdown_request_fn          on_switch_shutdown_request;
    sai_packet_event_notification_fn        on_packet_event;
} sai_switch_notification_t;
```

For instance:

```
/**
 * Routine Description:
 *   @brief Switch oper state change notification
 *
 * Arguments:
 *  @param[in] switch_id - switch identifier
 *  @param[in] switch_oper_status - new switch oper state
 *
 * Return Values:
 *    None
 */
typedef void (*sai_switch_state_change_notification_fn)(
    _In_ sai_switch _id_t switch_id,
   _In_ sai_switch_oper_status_t switch_oper_status
    );
```

3.2.3 Adding switch ID to all SAI API's

IMPORTANT NOTE. There are two possible solutions to addressing an individual NPU in the SAI API:

1. Add an explicit 'switch ID' parameter to **all** SAI functions
2. Introduce (optional) attributes to represent the switch ID for each SAI object

The two possible approaches are illustrated for the SAI port object (saiport.h); other object would need similar interface changes.

Approach 1 is more tedious to implement; however, it is:

- Consistent with changes required for notifications and the switch object
- Less ambiguous: the switch ID is not actually an object attribute; rather, it is represents the "address" of an individual switch.

3.2.3.1 Changes in saiport.h

A switch ID parameter is added to the port notification functions. Note that these changes are required regardless of whether we select approach #1 or approach #2 discussed above.

```
/**
 * Routine Description:
 *   Port state change notification
```

```
 *   Passed as a parameter into sai_initialize_switch()
 *
 * Arguments:
*    @param[in] switch_id - switch identifier
 *   @param[in] count - number of notifications
 *   @param[in] data  - array of port operational status
 *
 * Return Values:
 *    None
 */
typedef void (*sai_port_state_change_notification_fn)(
     _In_ sai_switch _id_t switch_id,
    _In_ uint32_t count,
    _In_ sai_port_oper_status_notification_t *data
    );

/**
 * Routine Description:
 *   @brief Port event notification
 *
 * Arguments:
*    @param[in] switch_id - switch identifier
 *    @param[in] count - number of notifications
 *    @param[in] data  - array of port events

 * Return Values:
 *    None
 */
typedef void (*sai_port_event_notification_fn)(
     _In_ sai_switch _id_t switch_id,
    _In_ uint32_t count,
    _In_ sai_port_event_notification_t *data
    );
```

Approach #1

Only the 'set' and 'get' functions are illustrated here. Similar changes apply to all functions of the API.

```
/**
 * Routine Description:
 *   @brief Set port attribute value.
 *
 * Arguments:
 *    @param[in] switch_id - switch identifier
 *    @param[in] port_id - port id
 *    @param[in] attr - attribute
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_set_port_attribute_fn)(
     _In_ sai_switch _id_t switch_id,
    _In_ sai_object_id_t port_id,
    _In_ const sai_attribute_t *attr
```

```
    );


/**
 * Routine Description:
 *   @brief Get port attribute value.
 *
 * Arguments:
 *    @param[in] switch_id - switch identifier
 *    @param[in] port_id - port id
 *    @param[in] attr_count - number of attributes
 *    @param[inout] attr_list - array of attributes
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_get_port_attribute_fn)(
    _In_ sai_switch _id_t switch_id,
    _In_ sai_object_id_t port_id,
    _In_ uint32_t attr_count,
    _Inout_ sai_attribute_t *attr_list
    );
```

Approach #2

```
typedef enum _sai_port_attr_t
{
    /** READ-ONLY */
    SAI_PORT_ATTR_SWITCH_ID,

} sai_port_attr_t;
```

3.2.3.2 Changes in saivlan.h

```
typedef enum _sai_vlan_attr_t
{
    /** READ-ONLY */
    SAI_VLAN_ATTR_SWITCH_ID,

} sai_vlan_attr_t;
/**
 * Routine Description:
 *    @brief Create a VLAN
 *
 * Arguments:
 *    @param[in] switch_id - switch identifier
 *    @param[in] vlan_id - VLAN id
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_create_vlan_fn)(
    _In_ sai_switch_id_t switch_id,
    _In_ sai_vlan_id_t vlan_id
    );
```

```
/**
 * Routine Description:
 *    @brief Remove a VLAN
 *
 * Arguments:
 *    @param[in] vlan_id - VLAN id
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_remove_vlan_fn)(
     _In_ sai_switch_id_t switch_id
     _In_ sai_vlan_id_t vlan_id
    );

/**
 * Routine Description:
 *    @brief Set VLAN attribute Value
 *
 * Arguments:
 *    @param[in] switch_id - switch identifier
 *    @param[in] vlan_id - VLAN id
 *    @param[in] attr - attribute
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_set_vlan_attribute_fn)(
    _In_ sai_switch_id_t switch_id,
    _In_ sai_vlan_id_t vlan_id,
    _In_ const sai_attribute_t  *attr
    );

/**
 * Routine Description:
 *    @brief Remove VLAN configuration (remove all VLANs).
 *
 * Arguments:
 *    @param[in] switch_id - switch identifier
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_remove_all_vlans_fn)(
    _In_ sai_switch_id_t switch_id
     );

/**
 * Routine Description:
 *    @brief Add Port to VLAN
 *
 * Arguments:
 *    @param[in] switch_id - switch identifier
 *    @param[in] vlan_id - VLAN id
 *    @param[in] port_count - number of ports
 *    @param[in] port_list - pointer to membership structures
 *
 * Return Values:
```

```
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_add_ports_to_vlan_fn)(
    _In_ sai_switch_id_t switch_id,
    _In_ sai_vlan_id_t vlan_id,
    _In_ uint32_t port_count,
    _In_ const sai_vlan_port_t *port_list → This is switch local port list.
    );

    Or
Based on port oid,we can configure it on specific NPU internaly.

/**
 * Routine Description:
 *   @brief Get vlan statistics counters.
 *
 * Arguments:
 *    @param[in] switch_id - switch identifier
 *    @param[in] vlan_id - VLAN id
 *    @param[in] counter_ids - specifies the array of counter ids
 *    @param[in] number_of_counters - number of counters in the array
 *    @param[out] counters - array of resulting counter values.
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_get_vlan_stats_fn)(
    _In_ sai_switch_id_t switch_id,
    _In_ sai_vlan_id_t vlan_id,
    _In_ const sai_vlan_stat_counter_t *counter_ids,
    _In_ uint32_t number_of_counters,
    _Out_ uint64_t* counters
    );
```

3.2.3.3 Changes in saifdb.h

```
typedef enum _sai_fdb_entry_attr_t
{
    /** FDB entry on NPU (CREATE_ONLY),
        Default to 0 */
    SAI_FDB_ENTRY_ATTR_SWITCH_ID,
}

/**
 * Routine Description:
 *    @brief Remove FDB entry
 *
 * Arguments:
 *    @param[in] fdb_entry - fdb entry
 *
 * Return Values:
 *    @return SAI_STATUS_SUCCESS on success
 *            Failure status code on error
 */
typedef sai_status_t (*sai_remove_fdb_entry_fn)(
     _In_ sai_switch_id_t switch_id,
    _In_ const sai_fdb_entry_t* fdb_entry
    );

  Or

typedef struct _sai_fdb_entry_t
```

```
{
    sai_mac_t mac_address;
    sai_vlan_id_t vlan_id;
     sai_switch_id_t switch_id;

} sai_fdb_entry_t;
```

3.2.3.4 Changes in sailag.h

```
typedef enum _sai_lag_attr_t
{
    /** CREATE_ONLY),
        Default to 0 */
    SAI_LAG_ATTR_SWITCH_ID,
} sai_lag_attr_t;
```

3.2.3.5 Changes in saistp.h

```
typedef enum _sai_stp_attr_t
{

    /** CREATE_ONLY),
        Default to 0 */
    SAI_STP_ATTR_SWITCH_ID,

    /** READ-WRITE */

} sai_stp_attr_t;
```

3.2.3.6 Changes in saiacl.h

```
typedef enum _sai_acl_table_attr_t
{

    /** CREATE_ONLY),
        Default to 0 */
    SAI_ACL_TABLE_ATTR__SWITCH_ID,

    /** READ-WRITE */

} sai_acl_table_attr_t;

typedef enum _sai_acl_entry_attr_t
{

    /** CREATE_ONLY),
        Default to 0 */
    SAI_ACL_ENTRY_ATTR_SWITCH_ID,

    /** READ-WRITE */

} sai_acl_table_attr_t;

    /** CREATE_ONLY),
        Default to 0 */
    SAI_ACL_COUNTER_ATTR_SWITCH_ID,
```

```
    /** CREATE_ONLY),
        Default to 0 */
    SAI_ACL_RANGE_ATTR_SWITCH_ID,
```

3.2.3.7 Changes in Routing

```
    /** CREATE_ONLY),
        Default to 0 */
SAI_VIRTUAL_ROUTER_ATTR_SWITCH_ID,
SAI_ROUTER_INTERFACE_ATTR_SWITCH_ID,
SAI_NEXT_HOP_ATTR_SWITCH_ID
SAI_NEXT_HOP_GROUP_ATTR_SWITCH_ID
SAI_NEIGHBOR_ATTR_SWITCH_ID
SAI_ROUTE_ATTR_SWITCH_ID
```

3.2.3.8 Changes in saimirror.h

```
    /** CREATE_ONLY),
        Default to 0 */
SAI_MIRROR_SESSION_ATTR_SWITCH_ID,
```

3.2.3.9 Changes in saisamplepacket.h

```
    /** CREATE_ONLY),
        Default to 0 */
SAI_SAMPLEPACKET_ATTR_SWITCH_ID,
```

3.2.3.10 Changes in QoS

```
    /** CREATE_ONLY),
        Default to 0 */
SAI_QUEUE_ATTR_SWITCH_ID,
SAI_WRED_ATTR_SWITCH_ID,
SAI_POLICER_ATTR_SWITCH_ID,
SAI_NEXT_HOP_ATTR_SWITCH_ID,
SAI_SCHEDULER_GROUP_ATTR_SWITCH_ID,
SAI_HASH_ATTR_SWITCH_ID,
```

4 Appendix A: Using threads or processes to identify local individual NPU's/Switches

Theoretically, it would be possible to start a separate process (or thread) for each individual NPU. While this avoids pervasive changes to the existing SAI API, this approach simply "pushes" the problem to a higher application layer (and thus is not preferred). Any multi-NPU aware host-adapter or application needs to:

- Manage a table of mappings of process/thread ID to switch ID
- (Likely) Implement switch ID aware "wrapper" functions