



NVIDIA DOCA DPA HART Management Tool

User Guide

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Chapter 1. Introduction

This table introduces important terms for understanding this document:

Term	Definition
DPA	Data-path accelerator; an auxiliary processor designed to accelerate data-path operations.
DPA partition manager	PCIe device function capable of controlling the entire system's HARTs. On NVIDIA® BlueField®-3 it is the ECPF. The DPA partition manager is by default associated with the default partition.
HART	Hardware thread; a logical DPA processing unit.
HART group	Collection/subset of HARTs which could be created using <code>dpahartmgmt</code> . HART groups are created under a HART partition and could only be formed from the pool of HARTs under that partition.
HART object	HART partition or HART group.
HART partition	An isolated pool of HARTs which may be created using <code>dpahartmgmt</code> . Only when a partition is created and associated with other vHCAs are they able to use hardware resources and execute a DPA software thread.
HART affinity	The method by which a DPA thread is paired with a DPA HART. DPA supports three types of affinity: <ul style="list-style-type: none">▶ <code>none</code> – selects a HART from a pool of all available HARTs▶ <code>strict</code> – select only the specified HART (by ID)▶ <code>group</code> – select a HART from all the HARTs in the specified group

The DPA HART management tool can run either on the host machine or on the target DPU and allows users to manage the DPA's HARTs which are the basic resource of the DPA. The tool enables the resource control of HARTs to optimize computation resources usage of the DPA before using DOCA FlexIO SDK API.

Without HART allocation, a DPA software thread would lack access to the hardware pipeline/CPU time resource, and consequently not be able to execute.

`dpahartmgmt` serves the following main usages:

- ▶ Running a DPA software thread with `strict` affinity on a DPA HART (i.e., running a DPA thread using only the specific preselected HART). For this purpose, `dpahartmgmt` provides an option to query the maximum HART ID allowed to use.
- ▶ Allowing a DPA software thread to run over a DPA HART from a group of HARTs:
 - ▶ Once a HART group is created, it is allocated a subset of HARTs.
 - ▶ `dpahartmgmt` provides an ID to the created group which can be used to run DPA applications with `group` affinity where the affinity ID would be the same as that group's ID.
- ▶ HART partition management - the ability to manage HART partitions.

When the software stack wishes to run a DPA thread with `group` affinity type, one of the available HARTs from the group's collection is used for the execution.



Note: A DPA thread may execute if and only if there is an available HART for it.

Chapter 2. HART Objects

Upon boot, a default HART partition is automatically created. The default HART partition possesses all the system's HARTs. The DPA partition manager function is the only function that belongs to it and can therefore control the entire resources of the system.

When running a DPA thread with `none` affinity, the HART chosen for the DPA thread to run with comes from the partition's pool of HARTs. Namely, from the HARTs belonging only to the DPA device's current partition which were not assigned to any HART groups (on the current partition). If the aforementioned group of HARTs (i.e., the partition's default HART group) is empty, the DPA thread would fail to run with `none` affinity.

Chapter 3. dpahartmgmt Commands

dpahartmgmt enables users to create, destroy, and query HART objects.



Note: dpahartmgmt tool must run with root privileges and users must execute `sudo mst start` before using it.

Top-level dpahartmgmt command syntax:

```
Usage: dpahartmgmt {help|version|hart_group|partition}
```

Type `./dpahartmgmt help` for detailed help

3.1. General Commands

- ▶ Print basic usage information for the tool:

```
dpahartmgmt -h
```

- ▶ Print a detailed help menu of the tool's commands:

```
dpahartmgmt help
```

- ▶ Print version information:

```
dpahartmgmt version
```

3.2. HART Group Commands

The commands listed in the following subsections are used to configure HART groups.

3.2.1. HART Group Command Flags and Arguments

The following table lists the flags relevant for `hart_group` commands. Arguments for the flags must be used within quotes (if more than one) and without extra spaces.

Short Option	Long Option	Description
-h	--help	Print out basic tool usage information.
-d	--dpa_device	The device interface name (MST/PCI/RDMA/NET).

Short Option	Long Option	Description
-r	--range_harts	The range of HARTs to allocate a HART group or a partition. The argument must be provided within quotes.
-g	--id_group	Group ID number. This number must be positive and less than or equal to the <code>max_num_dpa_hart_group</code> parameter which may be retrieved using the command <code>hart_group info -d <device></code> .
-n	--name_group	Group name; 15 character string. The argument must be provided within quotes.
-f	--file_groups	Full path or only the filename if it is located in the same directory as the executable directory (where <code>dpahartmgmt</code> is).

3.2.2. Info HART Group

Print information on the relevant DPA resources for the HART groups:

```
dpahartmgmt hart_group info --dpa_device <device>
```

Example:

```
$ sudo ./dpahartmgmt hart_group info -d mlx5_0
Max number of DPA HART groups: 15
Max number of DPA HARTs in one DPA HART group: 190
Max DPA HART number available to use: 190
Max HART group name length is 15 chars
```

3.2.3. Create HART Group

Create a HART group with the specified name on the provided device's partition. The HARTs indicated by the range are taken from the DPA device's HART partition.

```
dpahartmgmt hart_group create --dpa_device <device> --name_group <name> --range_harts <range>
```

Example:

```
$ sudo ./dpahartmgmt hart_group create -d mlx5_0 -n "HG hello world1" -r "6-8,16,55,70"
Group created successfully-
HART group name: HG hello world1, with id: 1.
Member HARTs are:
6,7,8,16,55,70
```



Note: After successfully creating a HART group, users can run a DPA thread using `group affinity` with the affinity type set to the group's ID.

3.2.4. Destroy HART Group

Destroy a HART group that exists on the device's partition with either the provided group name or ID.

```
dpahartmgmt hart_group destroy --dpa_device <device> [--name_group <name> | --id_group <id>]
```

Example:

```
$ sudo ./dpahartmgmt hart_group destroy -d mlx5_0 -g 0
Group with group id: 0, was destroyed successfully
```

3.2.5. Query HART Group

Query HART groups residing on the provided device's partition. If one of the optional parameters is used, the command only queries the specific group and prints it if it exists:

```
dpahartmgmt hart_group query --dpa_device <device> [--name_group <name> | --id_group <id>]
```

Example:

```
$ sudo ./dpahartmgmt hart_group query -d mlx5_0
1) HART group name: HG hello world, with id: 0.
Member HARTs are:
6,7,8,16,55,70
```

In total there are 1 HART groups configured.

More options:

```
$ sudo ./dpahartmgmt hart_group query -d mlx5_0 -n "HG hello world"
$ sudo ./dpahartmgmt hart_group query -d mlx5_0 -g 0
```

3.2.6. Apply HART Group

Apply the HART groups provided in the file on the device's partition:

```
dpahartmgmt hart_group apply --dpa_device <device> --file_groups <file>
```

File format example:

```
{
  "hart_groups": [
    { "name": "hg1", "range": "178-180"},
    { "name": "hg2", "range": "2-10"}
  ]
}
```



Note: The command removes all the previous HART groups defined on the HART partition that the DPA device belongs to, and applies the ones from the file.

Example:

```
$ sudo ./dpahartmgmt hart_group apply -d mlx5_0 --file_groups example.json

1) HART group name: hg1, with id: 1.
Member HARTs are:
178,179,180

2) HART group name: hg2, with id: 2.
Member HARTs are:
2,3,4,5,6,7,8,9,10
```


In total there are 2 HART groups configured.

3.3. HART Partition Commands

The commands listed in the following subsections are used to configure HART partitions.

3.3.1. HART Partition Command Flags and Arguments

The following table lists the flags relevant for HART `partition` commands. Arguments for the flags must be used within quotes (if more than one) and without extra spaces.

Short Option	Long Option	Description
-h	--help	Print out basic tool usage information.
-d	--dpa_device	The device interface name (MST/PCI/RDMA/NET).
-r	--range_harts	The range of HARTs to allocate a HART group or a partition. The argument must be provided within quotes.
-p	--id_partition	Partition ID number. This number must be positive and less than or equal to the value of <code>max_num_dpa_hart_partition</code> which may be retrieved using the command <code>partition info -d <device></code> .
-v	--vhca_list	The vHCA IDs to be associated with the partition. The argument must be provided within quotes.
-m	--max_num_hart_group	The number of HART groups to reserve for the partition upon its creation.

3.3.2. Info HART Partition

Print the relevant DPA resources of the HART partitions:

```
dpahartmgmt partition info --dpa_device <device>
```

Example:

```
$ sudo ./dpahartmgmt partition info -d mlx5_0
Max number of DPA HART partitions: 15
Max number of VHCAs associated with a single partition: 32
Max number of DPA HART groups: 15
Note- an allocation of a partition consumes from the number of DPA HART *groups*
available to create
```

```
Max DPA HART number available to use: 190
```

3.3.3. Create HART Partition

Create a HART partition on the DPA device:

```
dpahartmgmt partition create --dpa_device <device> --vhca_list <id_list> --
range_harts <range> --max_num_hart_group <max_num>
```

Example:

```
$ sudo ./dpahartmgmt partition create -d mlx5_0 -v 1 -r 10-20 -m 2
Partition created successfully-
HART Partition id: 1. Maximal number of groups: 2
Number of Partition's associated VHCA ids is 1, numbers are listed below:
1
Partition's member HARTs are:
10,11,12,13,14,15,16,17,18,19,20
```

3.3.4. Destroy HART Partition

Destroy a HART partition that exists on the device's partition:

```
dpahartmgmt partition destroy --dpa_device <device> --id_partition <id>
```

Example:

```
$ sudo ./dpahartmgmt partition destroy -d mlx5_0 -p 1
Partition with partition id: 1, was destroyed successfully
```

3.3.5. Query HART Partition

Query HART partitions that reside on the provided device's partition and print out the partition if it exists:

```
dpahartmgmt partition query --dpa_device <device> [--id_partition <id>]
```

Example:

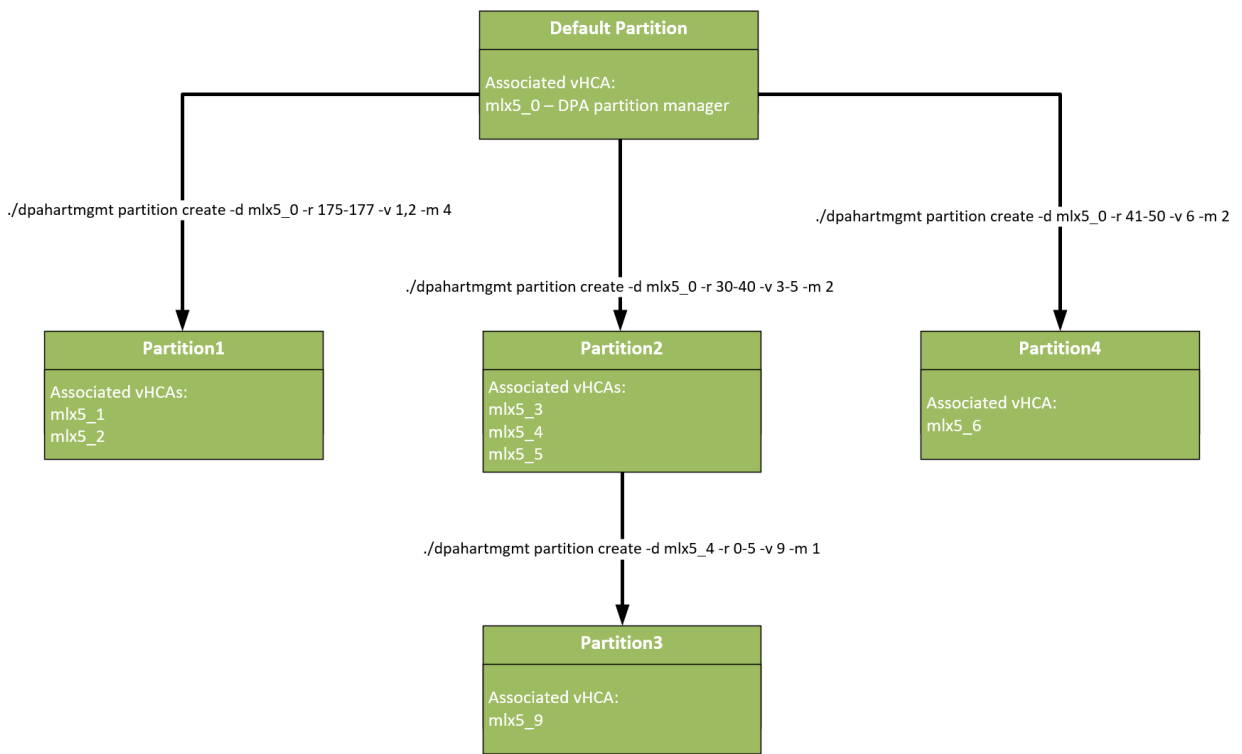
```
$ sudo ./dpahartmgmt partition query -d mlx5_0 -p 1
HART Partition id: 1. Maximal number of groups: 2
Number of Partition's associated VHCA ids is 1, numbers are listed below:
1
Partition's member HARTs are:
10,11,12,13,14,15,16,17,18,19,20
```

More options:

```
$ sudo ./dpahartmgmt partition query -d mlx5_0
```

Chapter 4. vHCAs and Partitions

The following diagram illustrates the ownership and control of a partition by a vHCA and also which vHCAs have claim to (i.e., can use) a partition.



Chapter 5. Known Limitations

- ▶ Currently, `dpahartmgmt` is only supported on the DPU not the host
- ▶ `dpahartmgmt` should run before creating a DPA process so all resources are configured ahead of time
 - ▶ Running the tool over a device with an existing DPA process results in failure
- ▶ The HART group name assigned by the user must be unique for every HART group on a specific partition or the HART group create command fails
- ▶ The creation of a HART partition consumes from the number of HART groups allowed on the vHCA's partition it is created on:
 - ▶ 1 group for the partition itself due to a default group created for each partition
 - ▶ `<max_num>` of groups which is the user's input provided upon partition creation
- ▶ Creating groups or running DPA threads in general (with any affinity) on interfaces other than ECPF, requires a configuration of a valid partition for the specific vHCA
- ▶ Only the default partition is exposed to the real HART numbers, all other partitions the user creates use virtual HARTs
 - ▶ For example, if a user creates a partition with the range of HARTs 20-40, querying the partition info from one of its virtual HCAs (vHCAs) would display HARTs from 0-20. Therefore, the HART whose real number is 39 in this example would correspond to the virtual HART number 19.
- ▶ HART overlap is not allowed on HART objects
- ▶ vHCA ID overlap is not allowed on HART partitions
- ▶ It is not possible to query vHCA IDs with `dpahartmgmt`, these are assumed to be known by the user beforehand
- ▶ Partition destruction fails if there are HART objects that exist on that partition
- ▶ It is not possible to know which HART has been chosen to run on
- ▶ Every vHCA sees the partition it belongs to, and its resources, as the entire world. It only sees:
 - ▶ Groups and partitions it created
 - ▶ The number of HARTs it was given
 - ▶ The `max_num_hart_group` of the partition it belongs to

- ▶ No guarantee regarding HART group ID that will be given on group creation
- ▶ The default groups (of every partition) cannot be managed by the user
- ▶ The HART numbers available are between 0 and the max DPA HART number available to use minus 1 (the upper limit can be queried using the info command specified above)
- ▶ `dpahartmgmt` does not support virtual functions (VFs)
- ▶ It is not possible to create partitions on other vHCAs other than the DPA partition manager function
- ▶ There are at most 16 hardware HART group entities

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