



ROCm™ Data Center Tool™ User Guide

Revision:	1201
Issue Date:	December 2020

Specification Agreement

This Specification Agreement (this “Agreement”) is a legal agreement between Advanced Micro Devices, Inc. (“AMD”) and “You” as the recipient of the attached AMD Specification (the “Specification”). If you are accessing the Specification as part of your performance of work for another party, you acknowledge that you have authority to bind such party to the terms and conditions of this Agreement. If you accessed the Specification by any means or otherwise use or provide Feedback (defined below) on the Specification, You agree to the terms and conditions set forth in this Agreement. If You do not agree to the terms and conditions set forth in this Agreement, you are not licensed to use the Specification; do not use, access or provide Feedback about the Specification. In consideration of Your use or access of the Specification (in whole or in part), the receipt and sufficiency of which are acknowledged, You agree as follows:

1. You may review the Specification only (a) as a reference to assist You in planning and designing Your product, service or technology (“Product”) to interface with an AMD product in compliance with the requirements as set forth in the Specification and (b) to provide Feedback about the information disclosed in the Specification to AMD.
2. Except as expressly set forth in Paragraph 1, all rights in and to the Specification are retained by AMD. This Agreement does not give You any rights under any AMD patents, copyrights, trademarks or other intellectual property rights. You may not (i) duplicate any part of the Specification; (ii) remove this Agreement or any notices from the Specification, or (iii) give any part of the Specification, or assign or otherwise provide Your rights under this Agreement, to anyone else.
3. The Specification may contain preliminary information, errors, or inaccuracies, or may not include certain necessary information. Additionally, AMD reserves the right to discontinue or make changes to the Specification and its products at any time without notice. The Specification is provided entirely “AS IS.” AMD MAKES NO WARRANTY OF ANY KIND AND DISCLAIMS ALL EXPRESS, IMPLIED AND STATUTORY WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT, TITLE OR THOSE WARRANTIES ARISING AS A COURSE OF DEALING OR CUSTOM OF TRADE. AMD SHALL NOT BE LIABLE FOR DIRECT, INDIRECT, CONSEQUENTIAL, SPECIAL, INCIDENTAL, PUNITIVE OR EXEMPLARY DAMAGES OF ANY KIND (INCLUDING LOSS OF BUSINESS, LOSS OF INFORMATION OR DATA, LOST PROFITS, LOSS OF CAPITAL, LOSS OF GOODWILL) REGARDLESS OF THE FORM OF ACTION WHETHER IN CONTRACT, TORT (INCLUDING NEGLIGENCE) AND STRICT PRODUCT LIABILITY OR OTHERWISE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.
4. Furthermore, AMD’s products are not designed, intended, authorized or warranted for use as components in systems intended for surgical implant into the body, or in other applications intended to support or sustain life, or in any other application in which the failure of AMD’s product could create a situation where personal injury, death, or severe property or environmental damage may occur.
5. You have no obligation to give AMD any suggestions, comments or feedback (“Feedback”) relating to the Specification. However, any Feedback You voluntarily provide may be used by AMD without restriction, fee or obligation of confidentiality. Accordingly, if You do give AMD Feedback on any version of the Specification, You agree AMD may freely use, reproduce, license, distribute, and otherwise commercialize Your Feedback in any product, as well as has the right to sublicense third parties to do the same. Further, You will not give AMD any Feedback that You may have reason to believe is (i) subject to any patent, copyright or other intellectual property claim or right of any third party; or (ii) subject to license terms which seek to require any product or intellectual property incorporating or derived from Feedback or any Product or other AMD intellectual property to be licensed to or otherwise provided to any third party.

6. You shall adhere to all applicable U.S. import/export laws and regulations, as well as the import/export control laws and regulations of other countries as applicable. You further agree to not export, re-export, or transfer, directly or indirectly, any product, technical data, software or source code received from AMD under this license, or the direct product of such technical data or software to any country for which the United States or any other applicable government requires an export license or other governmental approval without first obtaining such licenses or approvals; or in violation of any applicable laws or regulations of the United States or the country where the technical data or software was obtained. You acknowledge the technical data and software received will not, in the absence of authorization from U.S. or local law and regulations as applicable, be used by or exported, re-exported or transferred to: (i) any sanctioned or embargoed country, or to nationals or residents of such countries; (ii) any restricted end-user as identified on any applicable government end-user list; or (iii) any party where the end-use involves nuclear, chemical/biological weapons, rocket systems, or unmanned air vehicles. For the most current Country Group listings, or for additional information about the EAR or Your obligations under those regulations, please refer to the U.S. Bureau of Industry and Security's website at <http://www.bis.doc.gov/>.

7. The Software and related documentation are "commercial items", as that term is defined at 48 C.F.R. §2.101, consisting of "commercial computer software" and "commercial computer software documentation", as such terms are used in 48 C.F.R. §12.212 and 48 C.F.R. §227.7202, respectively. Consistent with 48 C.F.R. §12.212 or 48 C.F.R. §227.7202-1 through 227.7202-4, as applicable, the commercial computer software and commercial computer software documentation are being licensed to U.S. Government end users (a) only as commercial items and (b) with only those rights as are granted to all other end users pursuant to the terms and conditions set forth in this Agreement. Unpublished rights are reserved under the copyright laws of the United States.

8. This Agreement is governed by the laws of the State of California without regard to its choice of law principles. Any dispute involving it must be brought in a court having jurisdiction of such dispute in Santa Clara County, California, and You waive any defenses and rights allowing the dispute to be litigated elsewhere. If any part of this agreement is unenforceable, it will be considered modified to the extent necessary to make it enforceable, and the remainder shall continue in effect. The failure of AMD to enforce any rights granted hereunder or to take action against You in the event of any breach hereunder shall not be deemed a waiver by AMD as to subsequent enforcement of rights or subsequent actions in the event of future breaches. This Agreement is the entire agreement between You and AMD concerning the Specification; it may be changed only by a written document signed by both You and an authorized representative of AMD.

DISCLAIMER

The information contained herein is for informational purposes only, and is subject to change without notice. In addition, any stated support is planned and is also subject to change. While every precaution has been taken in the preparation of this document, it may contain technical inaccuracies, omissions and typographical errors, and AMD is under no obligation to update or otherwise correct this information. Advanced Micro Devices, Inc. makes no representations or warranties with respect to the accuracy or completeness of the contents of this document, and assumes no liability of any kind, including the implied warranties of noninfringement, merchantability or fitness for particular purposes, with respect to the operation or use of AMD hardware, software or other products described herein. No license, including implied or arising by estoppel, to any intellectual property rights is granted by this document. Terms and limitations applicable to the purchase or use of AMD's products are as set forth in a signed agreement between the parties or in AMD's Standard Terms and Conditions of Sale.

[This page is intentionally left blank]

Table of Contents

Table of Contents	5
Chapter 1 Overview	7
1.1 ROCm™ Data Center Tool.....	7
1.1.1 Objective	7
1.1.2 Terminology.....	7
1.1.3 Target Audience.....	8
Chapter 2 Installation and Integration	9
2.1 Supported platforms.....	9
2.2 Prerequisites.....	9
2.2.1 Install gRPC.....	9
2.2.2 Pre-built Packages.....	11
2.3 Components	13
2.4 Starting ROCm Data Center Tool.....	14
2.4.1 Standalone mode.....	14
2.4.2 Embedded mode.....	15
Chapter 3 Feature Overview.....	17
3.1 Discovery	17
3.2 Groups.....	18
3.2.1 GPU Groups.....	18
3.2.2 Field Groups.....	18
3.2.3 Device Monitoring.....	19
3.2.4 Job Stats	19
Chapter 4 Third-Party Integration	22
4.1.1 Python Bindings.....	22
4.1.2 Prometheus Plugin	23
Chapter 5 Developer Handbook	27
5.1.1 Prerequisites for building RDC.....	27
5.1.2 Building and Installing RDC	27
5.1.3 Building documentation.....	28

5.1.4 Build unit tests for ROCm Data Center Tool™ 28

5.1.5 Test 28

5.2 Authentication 28

5.2.1 Generating Files for Authentication 28

5.2.2 Verifying Files for Authentication 30

Chapter 6 ROCm™ Data Center API (Alpha Release)..... 32

6.1 RDC API 32

6.2 Job stats use case 33

Chapter 1 Overview

1.1 ROCm™ Data Center Tool

The ROCm™ Data Center Tool™ simplifies the administration and addresses key infrastructure challenges in AMD GPUs in cluster and datacenter environments. The main features are:

- GPU telemetry
- GPU statistics for jobs
- Integration with third-party tools
- Open source

The tool can be used in stand-alone mode if all components are installed. However, the existing management tools can use the same set of features available in a library format.

Refer [Starting RDC](#) for details on different modes of operation.

1.1.1 Objective

This user guide is intended to:

- Provide an overview of the ROCm Data Center Tool features
- Describe how system administrators and Data Center (or HPC) users can administer and configure AMD GPUs
- Describe the components
- Provide an overview of the open source developer handbook

1.1.2 Terminology

Term	Description
RDC	ROCm™ Data Center Tool
Compute node (CN)	One of many nodes containing one or more GPUs in the Data Center on which compute jobs are run
Management node (MN) or Main console	A machine running system administration applications to administer and manage the Data Center

Term	Description
GPU Groups	Logical grouping of one or more GPUs in a compute node
Fields	A metric that can be monitored by the RDC, such as GPU temperature, memory usage and power usage
Field Groups	Logical grouping of multiple fields
Job	A workload that is submitted to one or more compute nodes

1.1.3 Target Audience

The audience for the AMD ROCm Data Center™ tool consists of:

- **Administrators:** The tool will provide cluster administrator with the capability of monitoring, validating, and configuring policies.
- **HPC Users:** Provides GPU centric feedback for their workload submissions
- **OEM:** Add GPU information to their existing cluster management software
- **Open Source Contributors:** RDC is open source and will accept contributions from the community

For more information about the API, see the *AMD ROCm Data Center API Guide (Alpha Release)*.

Chapter 2 Installation and Integration

2.1 Supported platforms

The ROCm Data Center Tool™ (RDC) is part of the AMD ROCm™ software and is available on the distributions supported by AMD ROCm.

- Ubuntu 18.04.4 (Kernel 5.3)
Note: In the AMD ROCm v3.10 release, pre-built packages are only available for Ubuntu.
- CentOS v7.7 (Using devtoolset-7 runtime support)
- RHEL v7.7 (Using devtoolset-7 runtime support)
- SLES 15 SP1
- CentOS and RHEL 8.1(Kernel 4.18.0-147)

2.2 Prerequisites

For RDC installation from prebuilt packages, follow the instructions in this section.

2.2.1 Install gRPC

The following components are required as RDC relies on them for communication and authentication:

- gRPC along with protoc
- protoc plugins

For more information on gRPC, see the gRPC GitHub locations at:

- <https://github.com/grpc/grpc/blob/v1.25.0/src/cpp/README.md>
- <https://github.com/grpc/grpc/blob/master/BUILDING.md>

Note: CMake 3.15 or greater is required to build gRPC

```
$ sudo apt-get install -y automake make g++ unzip
$ sudo apt-get install -y build-essential autoconf libtool pkg-config
$ sudo apt-get install -y libgflags-dev libgtest-dev
$ sudo apt-get install -y clang-5.0 libc++-dev curl
$ git clone -b v1.28.1 https://github.com/grpc/grpc
$ cd grpc
$ git submodule update --init
$ mkdir -p cmake/build
$ cd cmake/build
# By default (without using the CMAKE_INSTALL_PREFIX option), the following
will install
# to /usr/local lib, include and bin directories
$ cmake -DgRPC_INSTALL=ON \
  -DBUILD_SHARED_LIBS=ON \
  <-DCMAKE_INSTALL_PREFIX=<install dir>> ../..
$ make
$ sudo make install
$ sudo ldconfig
```

2.2.1.1 Authentication keys

The ROCm Data Center (RDC)™ tool can be used with or without authentication. If authentication is required, then proper authentication keys need to be configured.

On how to configure SSL keys, refer section 5.2 *Authentication* in this document.

2.2.2 Pre-built Packages

The RDC tool is packaged as part of the ROCm software repository. You must install the AMD ROCm software before installing RDC. For details on how to install ROCm, see the AMD ROCm Installation Guide.

Follow the instructions below to install RDC after installing of the ROCm package:

2.2.2.1 Ubuntu

```
$ sudo apt-get install rdc
# to install a specific version
$ sudo apt-get install rdc<x.y.z>
```

2.2.2.2 SLES 15 Service Pack I

In the AMD ROCm v3.10 release, the pre-built package is not available for SLES 15 Service Pack (SP) 1. You must build and install the ROCm Data Center (RDC) tool from the source.

NOTE: By default (without using the CMAKE_INSTALL_PREFIX option), the following installations will occur in the */usr/local lib, include, and bin* directories.

To build the RDC tool from source:

1. Build and install gRPC.

```
$ git clone -b v1.28.1 https://github.com/grpc/grpc && cd grpc
$ git submodule update --init
$ mkdir -p cmake/build && cd cmake/build/
$ cmake -DgRPC_INSTALL=ON \
  -DBUILD_SHARED_LIBS=ON \
  <-DCMAKE_INSTALL_PREFIX=<gRPC install dir>> ../../
$ make
$ sudo make install
$ echo "<gRPC install dir>/lib" | sudo tee /etc/ld.so.conf.d/grpc.conf
```

2. Build and install the ROCm Data Center Tool (RDC).

```
$ git clone https://github.com/RadeonOpenCompute/rdc && cd rdc

$ mkdir -p build && cd build

$ cmake -DROCM_DIR=/opt/rocm \
  -DGRPC_ROOT=<grpc install dir> \
  <-DCMAKE_INSTALL_PREFIX=< RDC install dir>> ../..

$ make

$ sudo make install
```

3. Update the system library path.

NOTE: The following commands must be executed as root (sudo). It is recommended to insert the commands into a script and run the script as root.

```
$ RDC_LIB_DIR=<RDC install dir>/lib

$ GRPC_LIB_DIR=<grpc install dir>/lib

$ echo "$GRPC_LIB_DIR" > /etc/ld.so.conf.d/x86_64-librdc_client.conf

$ echo "$GRPC_LIB_DIR"64 >> /etc/ld.so.conf.d/x86_64-librdc_client.conf

$ echo "$RDC_LIB_DIR" >> /etc/ld.so.conf.d/x86_64-librdc_client.conf

$ echo "$RDC_LIB_DIR"64 >> /etc/ld.so.conf.d/x86_64-librdc_client.conf

$ ldconfig
```

2.3 Components

The ROCm Data Center Tool™ components are as follows:

RDC (API) Library

This library is the central piece, by interacting with different modules, that provides all the features described. This shared library provides C API and Python bindings so that third-party tools should be able to use it directly if required.

RDC Daemon (rdcd)

The daemon will record telemetry information from GPUs. It will also provide an interface to RDC command-line tool (rdci) running locally or remotely. It depends on the above RDC Library for all the core features.

RDC Command Line Tool (rdci)

A command-line tool to invoke all the features of the RDC tool. This CLI can be run locally or remotely.

ROCm-SMI library

A stateless system management library provides low-level interfaces to access GPU information.

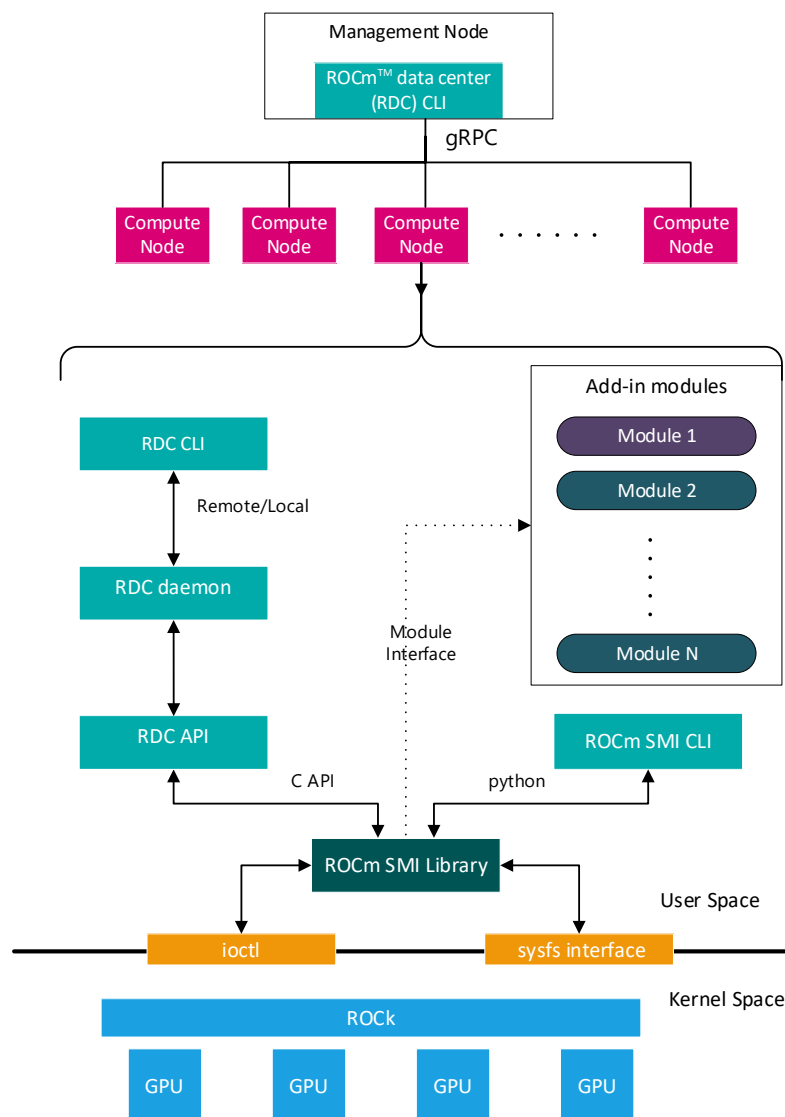


Figure 1 High-level diagram of RDC components

2.4 Starting ROCm Data Center Tool

The ROCm Data Center (RDC) Tool™ can be run in the following two modes. Note, the feature set is similar in both cases. Users have the flexibility to choose the right option that best fits their environment.

- Stand-alone
- Embedded mode

The capability in each mode depends on the privileges the *user* has for starting RDC. A normal *user* will have access only to monitor (access to GPU telemetry) capabilities. A *privileged user* can run the tool with full capability. In the full capability mode, GPU configuration features can be invoked. This may or may not affect all the users and processes sharing the GPU.

2.4.1 Standalone mode

This is the preferred mode of operation as it does not have any external dependencies. To start RDC in stand-alone mode, RDC Server Daemon (rdcd) must run on each compute node. You can start RDC daemon (rdcd) as a systemd service or from directly from the command-line.

2.4.1.1 Start RDC using systemd

The capability of RDC can be configured by modifying the rdc.service system configuration file. Use the *systemctl* command to start *rdcd*.

```
$ systemctl start rdc
```

By default, *rdcd* starts with full capability. To change to monitor only comment out the following two lines.

```
$ sudo vi /lib/systemd/system/rdc.service
# CapabilityBoundingSet=CAP_DAC_OVERRIDE
# AmbientCapabilities=CAP_DAC_OVERRIDE
```

NOTE: *rdcd* can be started by using the *systemctl* command

```
$ systemctl start rdc
```

2.4.1.2 Start ROCm Data Center Tool™ from command-line

While *systemctl* is the preferred way to start *rdcd*, you can also start directly from the command-line. The installation scripts will create a default user - “*rdc*”. Users have the option to edit the profile file (*rdc.service* installed at */lib/systemd/system*) and change these lines accordingly:

```
[Service]
User=rdc
Group=rdc
```

```
#Start as user rdc
$ sudo -u rdc rdcd

# Start as root
$ sudo rdcd
```

From the command-line, start *rdcd* as a *user* (for example, *rdc*) or *root*.

Note, in this use case, the *rdc.service* file mentioned in the previous section is not involved. Here, the capability of RDC is determined by the privilege of the user starting *rdcd*. If *rdcd* is running under a normal user account, then it has the Monitor-only capability. If *rdcd* is running as root, then *rdcd* has Full capability.

NOTE: If a user other than *rdc* or *root* starts the *rdcd* daemon, the file ownership of the SSL keys mentioned in the [Authentication](#) section must be modified to allow read and write access.

2.4.1.3 Troubleshooting rdcd

When *rdcd* is started using *systemctl*, the logs can be viewed using the following command.

```
$ journalctl -u rdc
```

These messages provide useful status and debugging information. The logs can also help debug problems like *rdcd* failing to start, communication issues with a client, and others.

2.4.2 Embedded mode

The embedded mode is useful if the end user has a monitoring agent running on the compute node. The monitoring agent can directly use the RDC library and will have a finer grain control on how and when RDC features are invoked. For example, if the monitoring agent has a facility to synchronize across multiple nodes, then it can synchronize GPU telemetry across these nodes.

The RDC daemon *rdcd* can be used as a reference code for this purpose. The dependency on gRPC is also eliminated if the RDC library is directly used.

CAUTION: RDC command-line `rdci` will not function in this mode. Third-party monitoring software is responsible for providing the user interface and remote access/monitoring. Refer *ROCm™ Data Center API Guide (Alpha Release)* for API details and pseudocode.

Chapter 3 Feature Overview

Note, ROCm™ Data Center Tool™ is in active development. This section highlights the current feature set.

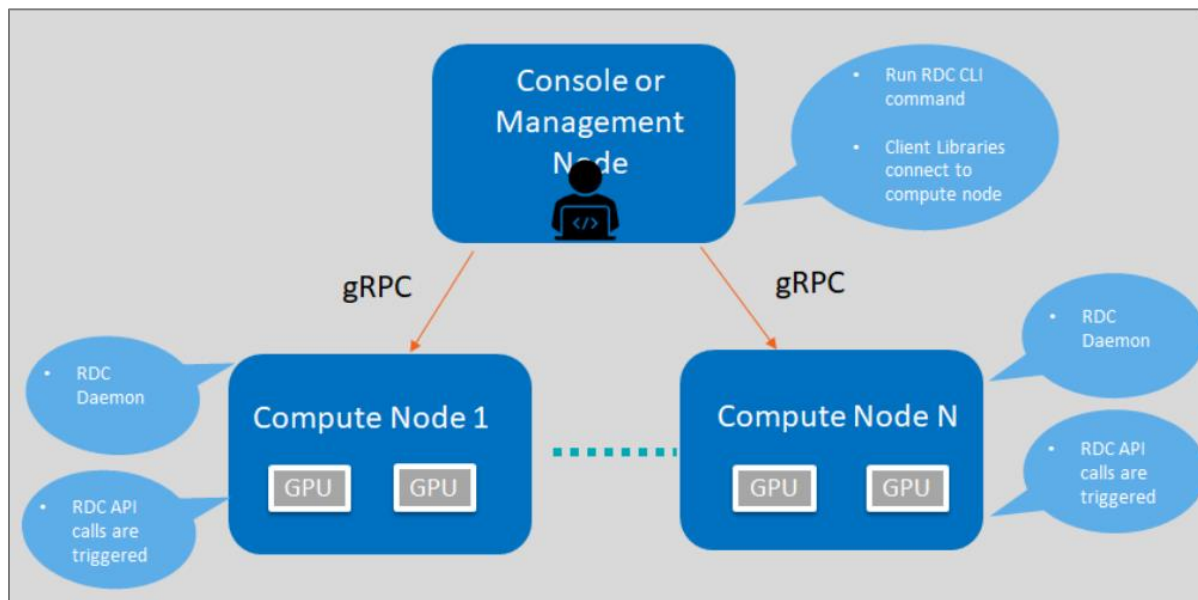


Figure 2 Shows RDC components and framework for describing features

3.1 Discovery

The Discovery feature enables you to locate and display information of GPUs present in the compute node. For example,

```

$ rdci discovery <host_name> -l

2 GPUs found

GPU Index | Device Information
-----|-----
0 | Name: AMD Radeon Instinct™ MI50 Accelerator
1 | Name: AMD Radeon Instinct™ MI50 Accelerator

$ rdci -l : list available GPUs
$ rdci -u: No SSL authentication
  
```

3.2 Groups

3.2.1 GPU Groups

With the GPU groups feature, you can create, delete, and list logical groups of GPU.

```
$ rdci group -c GPU_GROUP
Successfully created a group with a group ID 1

$ rdci group -g 1 -a 0,1
Successfully added the GPU 0,1 to group 1

$ rdci group -l

1 group found
```

Group ID	Group Name	GPU Index
1	GPU_GROUP	0,1

```
$ rdci group -d 1
Successfully removed group 1

-c create; -g group id; -a add GPU index; -l list; -d delete group
```

3.2.2 Field Groups

The Field groups feature provides you the options to create, delete, and list field groups.

```
$ rdci fieldgroup -c <fgroup> -f 150,155
Successfully created a field group with a group ID 1

$ rdci fieldgroup -l

1 group found
```

Group ID	Group Name	Field Ids
1	fgroup	150,155

```
$ rdci fieldgroup -d 1
Successfully removed field group 1

rdci dmon -l
Supported fields Ids:
100 RDC_FI_GPU_CLOCK:      Current GPU clock freq.
150 RDC_FI_GPU_TEMP:       GPU temp. in milli Celsius.
```

```
155 RDC_FI_POWER_USAGE:      Power usage in microwatts.
203 RDC_FI_GPU_UTIL:         GPU busy percentage.
525 RDC_FI_GPU_MEMORY_USAGE: VRAM Memory usage in bytes

-c create; -g group id; -a add GPU index; -l list; -d delete group
```

3.2.2.1 Monitoring Errors

You can define the *RDC_FI_ECC_CORRECT_TOTAL* or *RDC_FI_ECC_UNCORRECT_TOTAL* field to get the RAS Error-Correcting Code (ECC) counter:

- 312 RDC_FI_ECC_CORRECT_TOTAL: Accumulated correctable ECC errors
- 313 RDC_FI_ECC_UNCORRECT_TOTAL: Accumulated uncorrectable ECC errors

3.2.3 Device Monitoring

The ROCm Data Center tool™ enables you to monitor GPU fields.

```
$ rdci dmon -f <field_group> -g <gpu_group> -c 5 -d 1000
```

```
1 group found
```

GPU Index	TEMP (m°C)	POWER (µW)
0	25000	520500
0	25000	520500
0	25000	520500
0	25000	520500

```
rdci dmon -l
```

```
Supported fields Ids:
```

```
100 RDC_FI_GPU_CLOCK:      Current GPU clock freq.
150 RDC_FI_GPU_TEMP:       GPU temp. in milli Celsius.
155 RDC_FI_POWER_USAGE:    Power usage in microwatts.
203 RDC_FI_GPU_UTIL:       GPU busy percentage.
525 RDC_FI_GPU_MEMORY_USAGE: VRAM Memory usage in bytes
```

```
-e field ids; -i GPU index; -c count; -d delay; -l list; -f fieldgroup id
```

3.2.4 Job Stats

You can display GPU statistics for any given workload.

```
$ rdci stats -s 2 -g 1
```

```
Successfully started recording job 2 with a group ID 1

$ rdci stats -j 2
```

Summary	
Executive Status	
Start time	1586795401
End time	1586795445
Total execution time	44
Energy Consumed (Joules)	21682
Power Usage (Watts)	Max: 49 Min: 13 Avg: 34
GPU Clock (MHz)	Max: 1000 Min: 300 Avg: 903
GPU Utilization (%)	Max: 69 Min: 0 Avg: 2
Max GPU Memory Used (bytes)	524320768
Memory Utilization (%)	Max: 12 Min: 11 Avg: 12

```

$ rdci stats -x 2
Successfully stopped recording job 2

-s start recording on job id; -g group id; -j display job stats; -x stop
recording
```

3.2.4.1 Job stats use case

A common use case is to record GPU statistics associated with any job or workload. The following example shows how all these features can be put together for this use case.

	rdci commands
	<pre>\$ rdci group -c group1 Successfully created a group with a group ID 1 \$ rdci group -g 1 -a 0,1 GPU 0,1 is added to group 1 successfully</pre>
	<pre>rdci stats -s 123 -g 1 job 123 recorded successfully with the group ID</pre>
	<pre>rdci stats -x 123 Job 123 stops recording successfully</pre>

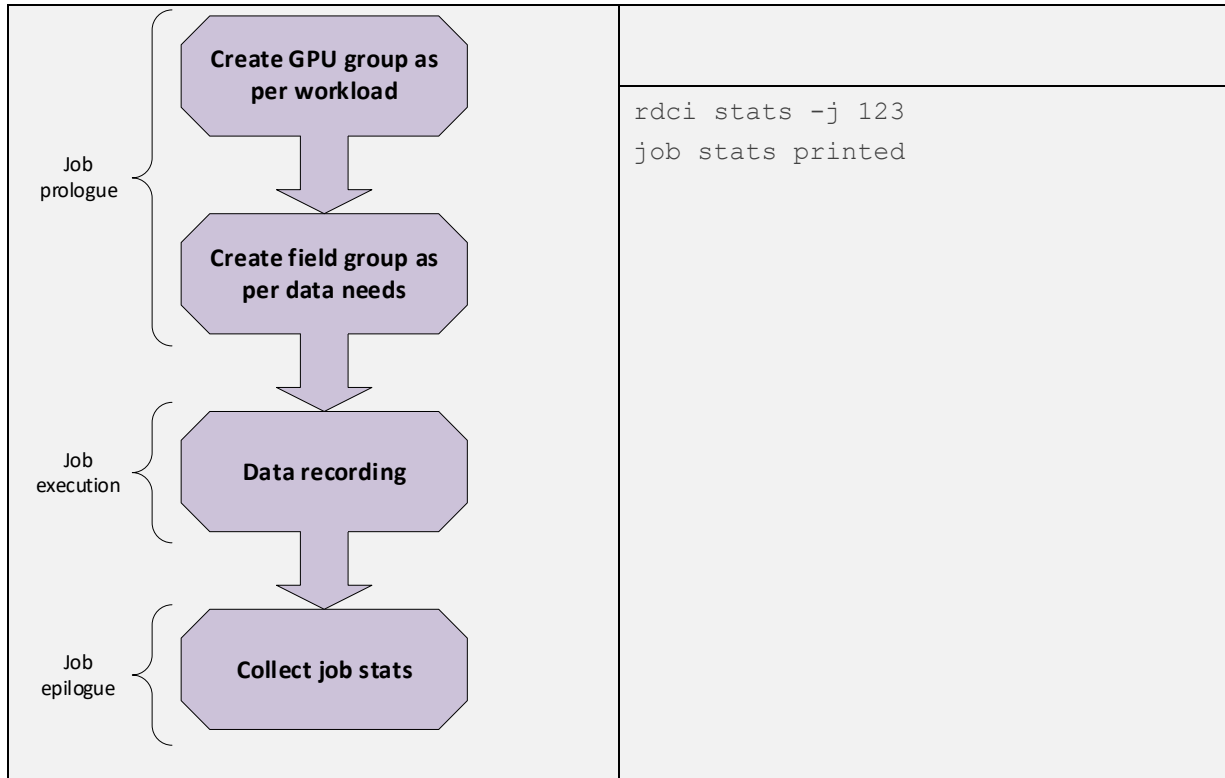


Table 1 An example showing how job statistics can be recorded

3.2.4.2 Error-Correcting Code Output

In the job stats output, this feature prints out the Error-Correcting Code (ECC) errors while running the job.

Chapter 4 Third-Party Integration

4.1.1 Python¹ Bindings

The ROCm™ Data Center Tool™ (RDC) provides a generic python class *RdcReader* to simplify telemetry gathering. *RdcReader* simplifies usage by providing the following functionalities.

- The user only needs to specify telemetry fields. *RdcReader* will create the necessary groups and fieldgroups, watch the fields, and fetch the fields.
- The *RdcReader* can support embedded and standalone mode. The standalone can be with or without authentication.
- In standalone mode, the *RdcReader* can automatically reconnect to *rdcd* if the connection is lost.
- When *rdcd* is restarted, the previously created group and fieldgroup may be lost. The *RdcReader* can re-create them and watch the fields after reconnecting.
- If the client is restarted, *RdcReader* can detect the groups and fieldgroups created before and avoid re-creating them.
- A custom unit converter can be passed to *RdcReader* to override the default RDC unit.

See below for a sample program to monitor the power and GPU utilization using the *RdcReader*.

```
from RdcReader import RdcReader
from RdcUtil import RdcUtil
from rdc_bootstrap import *

default_field_ids = [
    rdc_field_t.RDC_FI_POWER_USAGE,
    rdc_field_t.RDC_FI_GPU_UTIL
]

class SimpleRdcReader(RdcReader):
    def __init__(self):
        RdcReader.__init__(self, ip_port=None, field_ids = default_field_ids,
update_freq=1000000)
    def handle_field(self, gpu_index, value):
        field_name = self.rdc_util.field_id_string(value.field_id).lower()
        print("%d %d:%s %d" % (value.ts, gpu_index, field_name, value.value.l
_int))
```

¹ "Python" is a registered trademark of Python Software Foundation

```

if __name__ == '__main__':
    reader = SimpleRdcReader()
    while True:
        time.sleep(1)
        reader.process()

```

In the sample program,

- class *SimpleRdcReader* is derived from the *RdcReader*.
- The field "ip_port=None" in *RdcReader* dictates that the ROCm Data Center tool runs in the embedded mode.
- *SimpleRdcReader::process()*, then, fetches fields specified in *default_field_ids*. *RdcReader.py* can be found in the *python_binding* folder located at RDC install path.

To run the example, use

```

# Ensure that RDC shared libraries are in the library path and
# RdcReader.py is Python will look for modules.

$ python SimpleReader.py

```

4.1.2 Prometheus Plugin

4.1.2.1 Installing and Running Prometheus Plugin

The ROCm™ Data Center Tool™ (RDC) Prometheus plugin *rdc_prometheus.py* can be found in the *python_binding* folder.

NOTE: Ensure the *Prometheus client* is installed before the Prometheus plugin installation process.

```
$ pip install prometheus_client
```

The options the plugin provides can be viewed with *-help*.

```

% python rdc_prometheus.py --help
usage: rdc_prometheus.py [-h] [--listen_port LISTEN_PORT] [--rdc_embedded]
                        [--rdc_ip_port RDC_IP_PORT] [--rdc_unauth]
                        [--rdc_update_freq RDC_UPDATE_FREQ]
                        [--rdc_max_keep_age RDC_MAX_KEEP_AGE]
                        [--rdc_max_keep_samples RDC_MAX_KEEP_SAMPLES]

```

```

        [--rdc_fields RDC_FIELDS [RDC_FIELDS ...]]
        [--rdc_fields_file RDC_FIELDS_FILE]
        [--rdc_gpu_indexes RDC_GPU_INDEXES [RDC_GPU_INDEXES ...]]
        [--enable_plugin_monitoring]

RDC Prometheus plugin.

optional arguments:
  -h, --help                show this help message and exit
  --listen_port LISTEN_PORT
                           The listen port of the plugin (default: 5000)
  --rdc_embedded            Run RDC in embedded mode (default: standalone mode)
  --rdc_ip_port RDC_IP_PORT
                           The rdcd IP and port in standalone mode (default:
                           localhost:50051)
  --rdc_unauth             Set this option if the rdcd is running with unauth in
                           standalone mode (default: false)
  --rdc_update_freq RDC_UPDATE_FREQ
                           The fields update frequency in seconds (default: 10))
  --rdc_max_keep_age RDC_MAX_KEEP_AGE
                           The max keep age of the fields in seconds (default:
                           3600)
  --rdc_max_keep_samples RDC_MAX_KEEP_SAMPLES
                           The max samples to keep for each field in the cache
                           (default: 1000)
  --rdc_fields RDC_FIELDS [RDC_FIELDS ...]
                           The list of fields name needs to be watched, for
                           example, " --rdc_fields RDC_FI_GPU_TEMP
                           RDC_FI_POWER_USAGE " (default: fields in the
                           plugin)
  --rdc_fields_file RDC_FIELDS_FILE
                           The list of fields name can also be read from a file
                           with each field name in a separated line (default:
                           None)
  --rdc_gpu_indexes RDC_GPU_INDEXES [RDC_GPU_INDEXES ...]
                           The list of GPUs to be watched (default: All GPUs)
  --enable_plugin_monitoring
                           Set this option to collect process metrics of the
                           plugin itself (default: false)

```

By default, the plugin runs in the **Error! Reference source not found.** and will connect to *rdcd* at localhost:50051 to fetch fields. The plugin should use the same authentication mode as *rdcd* i.e. if *rdcd* is running with *-u/--unauth* flag, then *--rdc_unauth* flag should be used by the plugin. The plugin can be used in the **Error! Reference source not found.** without *rdcd* by setting *--rdc_embedded* flag.

To override the default fields that are monitored, the *--rdc_fields* option can be used to specify the list of fields. If the fields list is long, then the *--rdc_fields_file* option provides a convenient way to fetch fields list from a file. The *max_keep_age* and *max_keep_samples* can be used to control how the fields are cached.

The plugin can provide the metrics of the plugin itself, including the plugin process CPU, memory, file descriptor usage, and native threads count, including the process start and up times. This can be enabled using `--enable_plugin_monitoring`.

You can test the plugin with the default settings.

```
# Ensure that rdc is running on the same machine
$ python rdc_prometheus.py

# Check the plugin using curl
$ curl localhost:5000
# HELP gpu_util gpu_util
# TYPE gpu_util gauge
gpu_util{gpu_index="0"} 0.0
# HELP gpu_clock gpu_clock
# TYPE gpu_clock gauge
gpu_clock{gpu_index="0"} 300.0
# HELP gpu_memory_total gpu_memory_total
# TYPE gpu_memory_total gauge
gpu_memory_total{gpu_index="0"} 4294.0
# HELP gpu_temp gpu_temp
# TYPE gpu_temp gauge
# HELP power_usage power_usage
# TYPE power_usage gauge
power_usage{gpu_index="0"} 9.0
# HELP gpu_memory_usage gpu_memory_usage
# TYPE gpu_memory_usage gauge
gpu_memory_usage{gpu_index="0"} 134.0
```

4.1.2.2 Steps to integrate with Prometheus

1. Download and install Prometheus in the management mode.
2. Use the example configuration file `rdc_prometheus_example.yml` in the `python_binding` folder. This file can be used in its original state, however, note that this file refers to `prometheus_targets.json`. Ensure this is modified to point to the correct compute nodes.

```
// Sample file: prometheus_targets.json

// Replace rdc_test*.amd.com to point the correct compute nodes

// Add as many compute nodes as necessary

[
  {
```

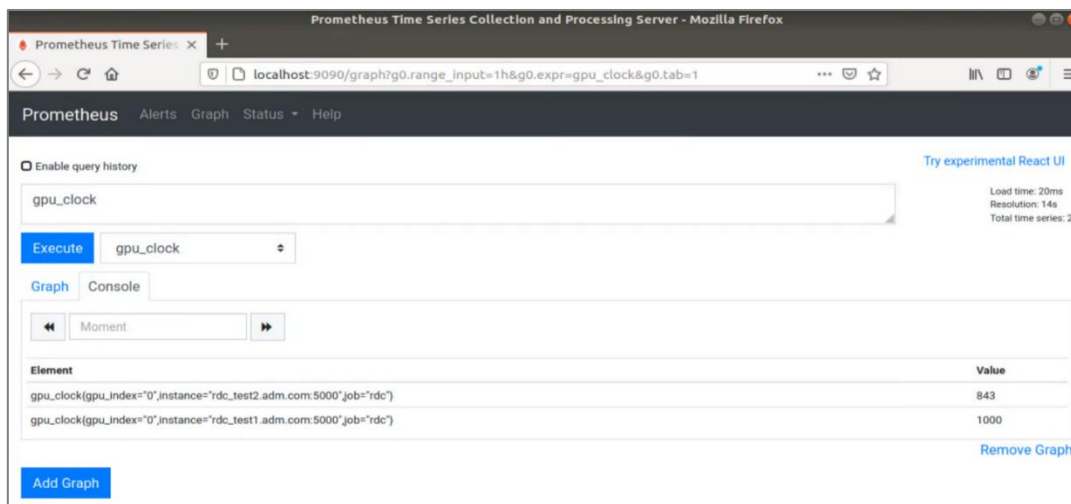
```
"targets": [  
    "rdc_test1.amd.com:5000",  
    "rdc_test2.amd.com:5000"  
]  
}  
]
```

NOTE: In the above example, there are two compute nodes *rdc_test1.adm.com* and *rdc_test2.adm.com*. Ensure the Prometheus plugin is running on those compute nodes.

3. Start the Prometheus plugin.

```
% prometheus --config.file=<full path of the  
rdc_prometheus_example.yml>
```

4. From the management node, using a browser, open the URL <http://localhost:9090>.
5. Select one of the available metrics. For example, `gpu_clock`



The Prometheus image shows the GPU clock for both *rdc_test1* and *rdc_test2*.

Chapter 5 Developer Handbook

The ROCm™ Data Center Tool™ (RDC) is open source and available under the MIT License. This section is targeted at open source developers. Third-party integrators may also use the section.

5.1.1 Prerequisites for building RDC

NOTE: The ROCm Data Center Tool is tested on the following software versions. Earlier versions may not work.

- CMake 3.15
- g++ (5.4.0)
- AMD ROCm which includes AMD ROCm SMI Library
- gRPC and protoc (Refer 2.2.1)

The following components are required to build the latest documentation:

- Doxygen (1.8.11)
- Latex (pdfTeX 3.14159265-2.6-1.40.16)

```
$ sudo apt install libcap-dev  
$ sudo apt install -y doxygen
```

5.1.2 Building and Installing RDC

Clone the RDC source code from GitHub and use CMake to build and install.

```
$ git clone <GitHub for RDC>  
$ cd rdc  
$ mkdir -p build; cd build  
$ cmake -DROCM_DIR=/opt/rocm2 -DGRPC_ROOT="$GRPC_PROTOC_ROOT"..  
$ make  
  
#Install library file and header and the default location is /opt/rocm  
$ make install
```

² location of ROCm install root. By default, it is /opt/rocm

5.1.3 Building documentation

You can generate PDF documentation after a successful build. The reference manual, `refman.pdf`, appears in the `latex` directory.

```
$ make doc
$ cd latex
$ make
```

5.1.4 Build unit tests for ROCm Data Center Tool™

```
$ cd rdc/tests/rdc_tests
$ mkdir -p build; cd build
$ cmake -DROCM_DIR=/opt/rocm -DGRPC_ROOT="$GRPC_PROTOC_ROOT"..
$ make

# To run the tests

$ cd build/rdctst_tests
$ ./rdctst
```

5.1.5 Test

```
# Run rdcd daemon
$ LD_LIBRARY_PATH=$PWD/rdc_libs/ ./server/rdcd -u

# In another console run RDC command-line
$ LD_LIBRARY_PATH=$PWD/rdc_libs/ ./rdci/rdci discovery -l -u
```

5.2 Authentication

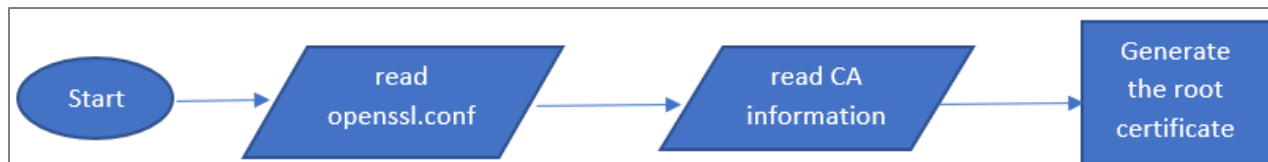
5.2.1 Generating Files for Authentication

The ROCm Data Center Tool™ supports encrypted communications between clients and servers. The communication can be configured to be authenticated or not authenticated. By default, authentication is enabled.

To disable authentication, when starting the server, use the "`--unauth_comm`" flag (or "`-u`" for short). You must also use "`-u`" in `rdci` to access `unauth rdcd`. The `/lib/systemd/system/rdc.service` file can be edited to pass arguments to `rdcd` on starting. On the client side, when calling `rdc_channel_create()`, the "secure" argument must be set to `False`.

5.2.1.1 Scripts

RDC users manage their own keys and certificates. However, some scripts generate self-signed certificates in the RDC source tree in the authentication directory for test purposes. The following flowchart depicts how to generate the root certificates using the *openssl* command in `01gen_root_cert.sh`:



The section where the default responses to *openssl* questions can be specified is included in *openssl.conf*. To locate the section, look for the following comment line:

```
# < ** REPLACE VALUES IN THIS SECTION WITH APPROPRIATE VALUES FOR YOUR ORG.  
**>
```

It is helpful to modify this section with values appropriate for your organization if you expect to call this script many times. Additionally, you must replace the dummy values and update the `alt_names` section for your environment.

To generate the keys and certificates using these scripts, make the following calls:

```
$ 01gen_root_cert.sh  
# provide answers to posed questions  
$ 02gen_ssl_artifacts.sh  
# provide answers to posed questions
```

At this point, the keys and certificates are in the newly-created "CA/artifacts" directory. This directory must be deleted if you need to rerun the scripts.

To install the keys and certificates, access the artifacts directory, and run the `install.sh` script as root, specifying the install location. By default, RDC expects this to be in `/etc/rdc`:

```
$ cd CA/artifacts  
$ sudo install_<client|server>.sh /etc/rdc
```

These files must be copied to and installed on all client and server machines that are expected to communicate with one another.

5.2.1.2 Known Limitation

The ROCm Data Center Tool™ has the following authentication limitation.

The client and server are hardcoded to look for the *openssl* certificate and key files in */etc/rdc*. There is no workaround available currently.

5.2.2 Verifying Files for Authentication

Several SSL keys and certificates must be generated and installed on clients and servers for authentication to work properly. By default, the RDC server will look in the */etc/rdc* folder for the following keys and certificates:

5.2.2.1 Client

```
$ sudo tree /etc/rdc

/etc/rdc

|-- client

    |-- certs

        |-- rdc_cacert.pem

        |-- rdc_client_cert.pem

    |-- private

|-- rdc_client_cert.key
```

NOTE: Machines that are clients and servers will consist of both directory structures.

5.2.2.2 Server

```
$ sudo tree /etc/rdc
/etc/rdc
|-- server
    |-- certs
        |-- rdc_cacert.pem
        |-- rdc_server_cert.pem
    |-- private
|-- rdc_server_cert.key
```

Chapter 6 ROCm™ Data Center API (Alpha Release)

Disclaimer: This is the alpha version of ROCm Data Center (RDC) API™ and is subject to change without notice. The primary purpose of this API is to solicit feedback. AMD accepts no responsibility for any software breakage caused by API changes.

6.1 RDC API

The ROCm™ Data Center Tool™ API is the core library that provides all the RDC features. This section focuses on how RDC API can be used by third-party software.

The RDC includes the following libraries:

- `librdc_bootstrap.so`: Loads during runtime one of the two libraries by detecting the mode
- `librdc_client.so`: Exposes RDC functionality using gRPC client
- `librdc.so`: RDC API. This depends on `librocm_smi.so`
- `librocm_smi.so`: Stateless low overhead access to GPU data

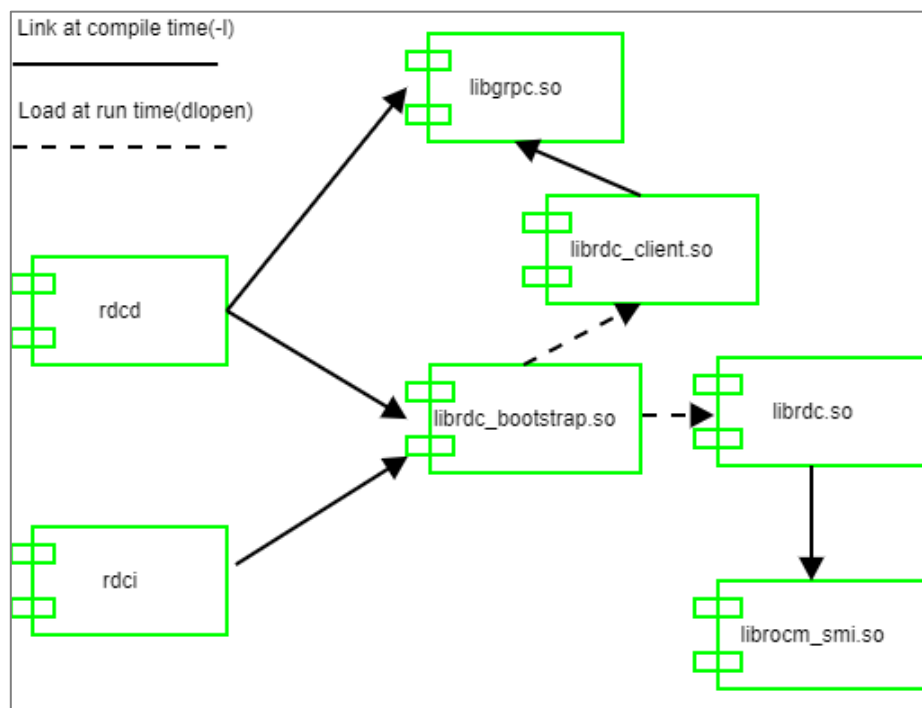


Figure 3 Different libraries and how they are linked

Note that `librdc_bootstrap.so` loads different libraries based on the modes. For e.g.

- `rdci`: `librdc_bootstrap.so` loads `librdc_client.so`
- `rdcd`: `librdc_bootstrap.so` loads `librdc.so`

For more information, see the *ROCm™ Data Center Tool API Guide (Alpha Release)*.

6.2 Job stats use case

The following pseudocode shows how ROCm Data Center (RDC) API™ can be directly used to record GPU statistics associated with any job or workload. Refer to the example code provided with RDC on how to build it.

For more information, see [Job Stats](#)

```
//Initialize the RDC
rdc_handle_t rdc_handle;
rdc_status_t result=rdc_init(0);

//Dynamically choose to run in standalone or embedded mode
bool standalone = false;
std::cin>> standalone;
if (standalone)
    result = rdc_connect("127.0.0.1:50051", &rdc_handle, nullptr, nullptr,
    nullptr); //It will connect to the daemon
else
    result = rdc_start_embedded(RDC_OPERATION_MODE_MANUAL, &rdc_handle);
//call library directly, here we run embedded in manual mode

//Now we can use the same API for both standalone and embedded
// (1) create group
rdc_gpu_group_t groupId;
result = rdc_group_gpu_create(rdc_handle, RDC_GROUP_EMPTY, "MyGroup1",
&groupId);

// (2) Add the GPUs to the group
result = rdc_group_gpu_add(rdc_handle, groupId, 0); //Add GPU 0
result = rdc_group_gpu_add(rdc_handle, groupId, 1); //Add GPU 1

// (3) start the recording the Slurm job 123. Set the sample frequency to once
per second
result = rdc_job_start_stats(rdc_handle, group_id,
    "123", 1000000);

//For standalone mode, the daemon will update and cache the samples
//In manual mode, we must call rdc_field_update_all periodically to take
samples
if (!standalone) { //embedded manual mode
    for (int i=5; i>0; i--) { //As an example, we will take 5 samples
```

```
        result = rdc_field_update_all(rdc_handle, 0);
        usleep(1000000);
    }
} else { //standalone mode, do nothing
    usleep(5000000); //sleep 5 seconds before fetch the stats
}

//(4) stop the Slurm job 123, which will stop the watch
// Note: we do not have to stop the job to get stats. The rdc_job_get_stats
can be called at any time before stop
result = rdc_job_stop_stats(rdc_handle, "123");

//(5) Get the stats
rdc_job_info_t job_info;
result = rdc_job_get_stats(rdc_handle, "123", &job_info);
std::cout<<"Average Memory Utilization: "
<<job_info.summary.memoryUtilization.average <<std::endl;

//The cleanup and shutdown ....
```