ARIA Radar Development Kit
User Manual

1 Document Version

Version	Date	Description
1.0	2024/09/04	Issued

2 Introduction

ARIA RDK (*Radar Development Kit*) is a complete suite to evaluate ARIA Radar Devices and/or to develop custom application algorithms to radar data. ARIA RDK allows for the simultaneous data acquisition from one or more ARIA radar devices. Consequently, users may exploit ARIA RDK to develop different applications, ranging from single-device evaluation, to customer's application development, and to advanced applications such as radar tomography.

3 Software Architecture

The system architecture is shown in Fig.1.

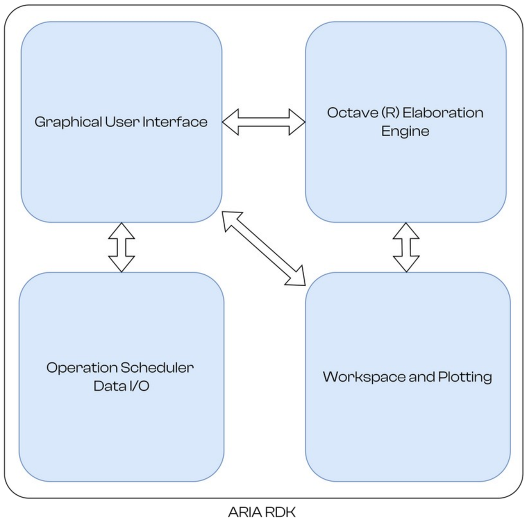


Fig. 1: ARIA RDK Main Architecture

ARIA RDK includes four main components:

1. A Graphical User Interface (Windows and Linux) to create custom projects

2. An interface component to the Scientific Programming Language Octave to run custom algorithms on radar data

3. A Scheduler & Data I/O component to coordinate radar acquisitions and execute user scripts

4. A data workspace management and plotting component

4 Prerequisites

ARIA RDK requires the following components to be compiled and installed in your system:

- Qt6 (>= 6.7.2)
- VTK: The Visualization Toolkit (https://vtk.org/)
- JKQTPlotter: an extensive Qt5 & Qt6 Plotter Framework (https://jkriege2.github.io/JKQtPlotter/index.html)
- Eigen: C++ template library for linear algebra (>= 3.4.0) (https://eigen.tuxfamily.org/)
- Octave (>=9.2.0): a scientific programming language environment

Please refer to respective build/install instruction.

ARIA-RDK is designed to be compiled with CMake®. Currently it has been compiled and tested under Clear Linux SO.

4.1 Building Instructions

The following instructions have been tested in Clear Linux SO, but it is expected full compatibility with other operating systems.

4.1.1 Qt

Install Qt through Qt-Creator self-installer program.

4.1.2 JKQTPlotter

- Download source code:

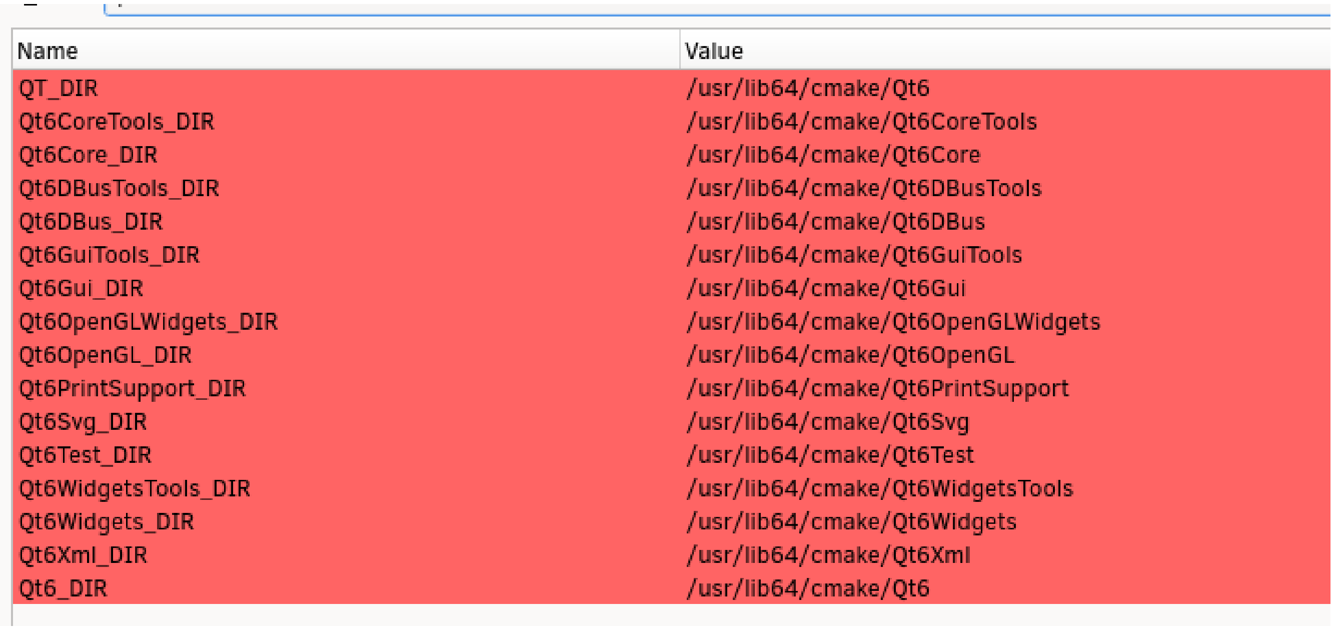
```
> git clone https://github.com/jkriege2/JKQtPlotter.git
> cd [folder where JKQTPlotter is downloaded]
> mkdir build
> cd build
```

- Start cmake-gui :

```
>cmake-gui ..
```

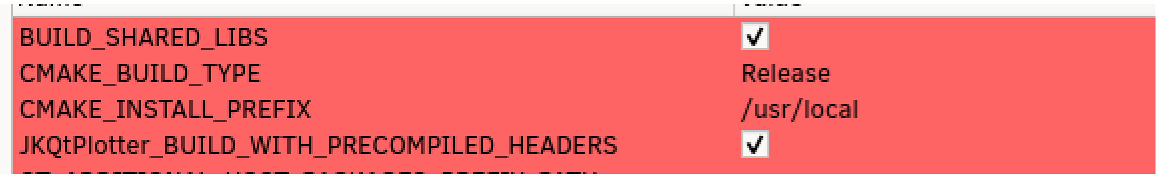
- Select the target compiler.

Start Configure and check that Qt6 is found:



Name	Value
QT_DIR	/usr/lib64/cmake/Qt6
Qt6CoreTools_DIR	/usr/lib64/cmake/Qt6CoreTools
Qt6Core_DIR	/usr/lib64/cmake/Qt6Core
Qt6DBusTools_DIR	/usr/lib64/cmake/Qt6DBusTools
Qt6DBus_DIR	/usr/lib64/cmake/Qt6DBus
Qt6GuiTools_DIR	/usr/lib64/cmake/Qt6GuiTools
Qt6Gui_DIR	/usr/lib64/cmake/Qt6Gui
Qt6OpenGLWidgets_DIR	/usr/lib64/cmake/Qt6OpenGLWidgets
Qt6OpenGL_DIR	/usr/lib64/cmake/Qt6OpenGL
Qt6PrintSupport_DIR	/usr/lib64/cmake/Qt6PrintSupport
Qt6Svg_DIR	/usr/lib64/cmake/Qt6Svg
Qt6Test_DIR	/usr/lib64/cmake/Qt6Test
Qt6WidgetsTools_DIR	/usr/lib64/cmake/Qt6WidgetsTools
Qt6Widgets_DIR	/usr/lib64/cmake/Qt6Widgets
Qt6Xml_DIR	/usr/lib64/cmake/Qt6Xml
Qt6_DIR	/usr/lib64/cmake/Qt6

- Verify that "CMAKE_BUILD_TYPE" is set to "Release"
- Set a proper installation folder, the installation folder has to be part of, or included into, OS search path.



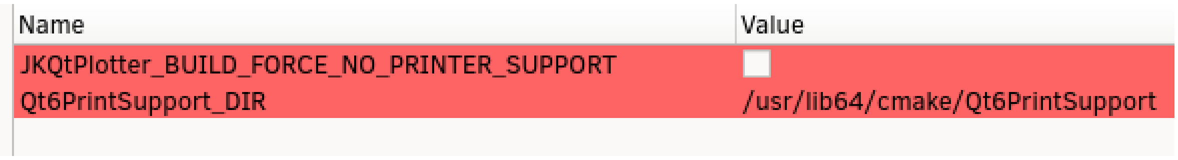
BUILD_SHARED_LIBS	☑
CMAKE_BUILD_TYPE	Release
CMAKE_INSTALL_PREFIX	/usr/local
JKQtPlotter_BUILD_WITH_PRECOMPILED_HEADERS	☑

- Run *Configure* and *Generate* and build & install:

```
> cmake  - - build .
> sudo cmake - - install .
```

NOTE: during compilation of ARIA-SDK, PrintSupport may not be found. In this case, the compilation is not successful.

To overcome this, check the following "JKQtPlotter_BUILD_FORCE_NO_PRINTER_SUPPORT"



Name	Value
JKQtPlotter_BUILD_FORCE_NO_PRINTER_SUPPORT	□
Qt6PrintSupport_DIR	/usr/lib64/cmake/Qt6PrintSupport

4.1.3 VTK

- Download source archive from https://vtk.org/download/.
- (Linux) Install the following packages

```
build-essential \
cmake-curses-gui \
mesa-common-dev \
mesa-utils \
freeglut3-dev \
```

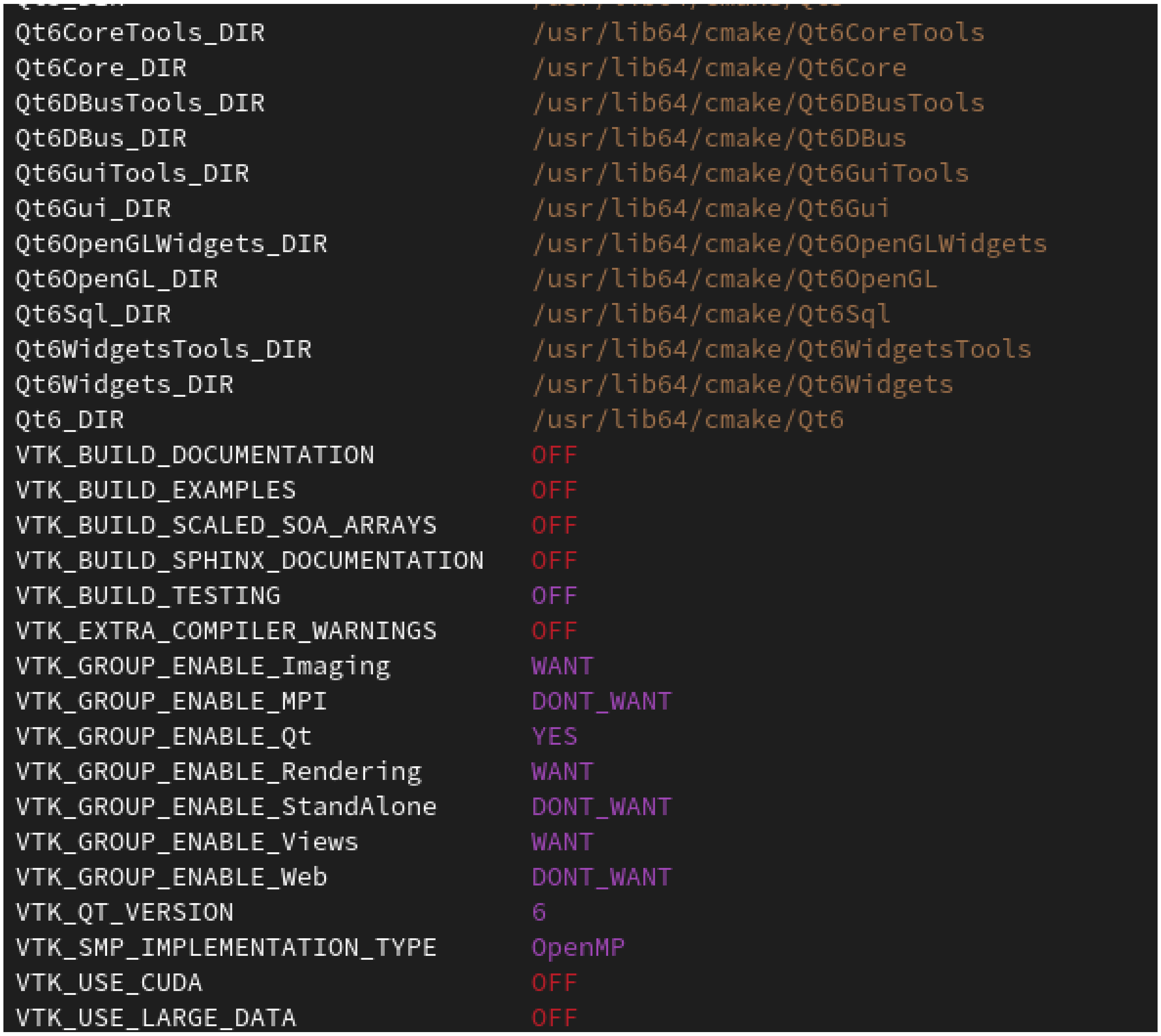
- Create a folder (e.g. ~/VTK) and unarchive the source code.
- Enter the new folder and mdkir build folder. Enter build folder

```
> cd [folder where VTK source code folder is extracted]
> mkdir build
> cd build
```

- Run the configuration ccmake

```
ccmake  -S path_to_vtk_source -B path_to_vtk_source/VTK-build
```

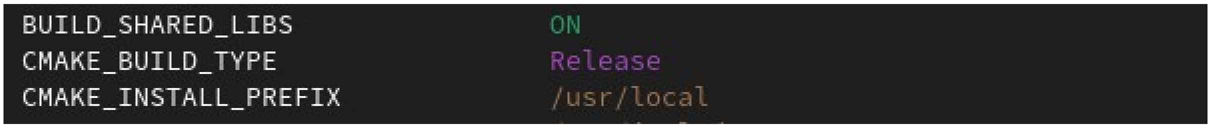
- Verify / set the following parameters



```
Qt6CoreTools_DIR                /usr/lib64/cmake/Qt6CoreTools
Qt6Core_DIR                     /usr/lib64/cmake/Qt6Core
Qt6DBusTools_DIR                /usr/lib64/cmake/Qt6DBusTools
Qt6DBus_DIR                     /usr/lib64/cmake/Qt6DBus
Qt6GuiTools_DIR                 /usr/lib64/cmake/Qt6GuiTools
Qt6Gui_DIR                      /usr/lib64/cmake/Qt6Gui
Qt6OpenGLWidgets_DIR            /usr/lib64/cmake/Qt6OpenGLWidgets
Qt6OpenGL_DIR                   /usr/lib64/cmake/Qt6OpenGL
Qt6Sql_DIR                      /usr/lib64/cmake/Qt6Sql
Qt6WidgetsTools_DIR             /usr/lib64/cmake/Qt6WidgetsTools
Qt6Widgets_DIR                  /usr/lib64/cmake/Qt6Widgets
Qt6_DIR                         /usr/lib64/cmake/Qt6
VTK_BUILD_DOCUMENTATION         OFF
VTK_BUILD_EXAMPLES              OFF
VTK_BUILD_SCALED_SOA_ARRAYS     OFF
VTK_BUILD_SPHINX_DOCUMENTATION  OFF
VTK_BUILD_TESTING               OFF
VTK_EXTRA_COMPILER_WARNINGS     OFF
VTK_GROUP_ENABLE_Imaging        WANT
VTK_GROUP_ENABLE_MPI            DONT_WANT
VTK_GROUP_ENABLE_Qt             YES
VTK_GROUP_ENABLE_Rendering      WANT
VTK_GROUP_ENABLE_StandAlone     DONT_WANT
VTK_GROUP_ENABLE_Views          WANT
VTK_GROUP_ENABLE_Web            DONT_WANT
VTK_QT_VERSION                  6
VTK_SMP_IMPLEMENTATION_TYPE     OpenMP
VTK_USE_CUDA                    OFF
VTK_USE_LARGE_DATA              OFF
```

(NB Actual Qt paths may be different)

- Verify that the installation prefix is set to a folder included in the search path, e.g.



```
BUILD_SHARED_LIBS                ON
CMAKE_BUILD_TYPE                 Release
CMAKE_INSTALL_PREFIX             /usr/local
```

- Press **c** to configure and **g** to generate
- Go into VTK source folder

```
cmake --build path_to_vtk_source/VTK-build
```

5 ARIA-RDK Main Concepts

5.1 Workspace

ARIA RDK introduces the concept of workspace, i.e. a folder structure where all the building blocks of a customer application project are defined.

A workspace contains the following elements:

- A set of radar modules definitions: a radar module is a description of one specific UWB module, with the firmware it runs, and its interface with the PC (Fig. 2);
- A set of elaboration scripts: a script is a set of instructions to run customer applications and algorithms. Currently ARIA-RDK support the Octave scientific-programming language;
- A set of radar devices: a device is a physical board attached to the PC. Each device must have its corresponding module definition properly loaded.
- One or more schedulers (handlers): one scheduler is responsible to synchronize more devices to run at the same time, to enable multi-radar acquisition.

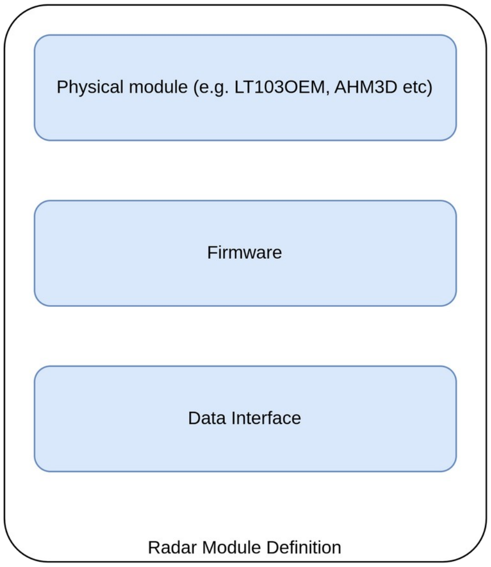


Fig. 2: Radar Module Definition

These components are described in the following sections.

6 Radar Modules

One "radar module" is the definition of a peculiar family of radar devices. Each module is uniquely identified by the following data:

1. Its name;
2. A set of parameters which are the radar variables exposed to the PC. They vary according to the radar module and the installed FW. For instance, a module with "basic" FW would provide only the radar's raw-data while the same module with a more advanced FW (e.g. to detect and locate people) would provide the results of the elaboration (e.g. the presence detection outcome and the position of the detected person);
3. Optional: the definition of the antenna array, with the antennas models and their position to evaluate the beamforming capability;
4. The scripts that are to be executed at start-up, before and after each data acquisition;
5. The configuration of the serial port.

6.1 Radar Devices

A radar device is the physical device connected to the PC. It is identified by a radar module definition, from which the parameters are inherited, and a set of scripts that are executed

- at start-up (i.e. before the 1st acquisition cycle)
- before any acquisition cycle
- after any acquisition cycle

See below for details on radar acquisition cycles.

6.1.1.1 Radar Cycle

A radar cycle is made of 4 steps:

1. init phase: all initialization scripts and variables are set

2.pre-acquisition: all parameters that affect next acquisition are set

3. post-acquisition: this is where customer post-acquisition algorithms are expected

4. frame-rate synchronization

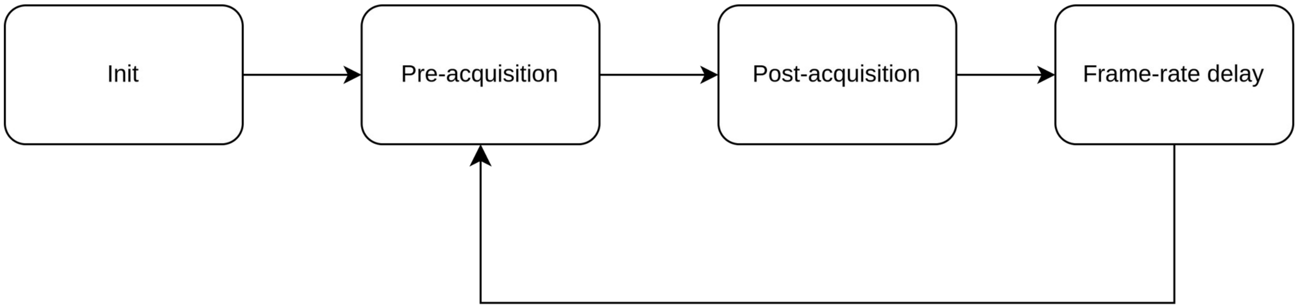


Fig. 3: Basic Radar Cycle

In Fig. 3, the basic radar cycle is shown: after a setup phase ("init"), each acquisition cycle is made of a pre-acquisition phase where the selected scripts are executed and, then, the corresponding parameters are fed into the physical device. When the radar device is able to provide data to the PC and the transfer of the selected parameters is complete, another optional set of scripts is executed (post-acquisition). Please note that the proper acquisition is made by the firmware running into the physical device, so from the RDK perspective we have just two different "moments": before starting an acquisition and after the acquisition has been completed.

If this process (pre-acquisition, acquisition, post-acquisition) is faster than the required refresh rate, a delay is added to maintain the required refresh-rate.

If, instead, the process is longer than the refresh-rate, the behavior of the system is defined into the *scheduler* options. See *Schedulers* for further details.

6.1.2 Parameters

A parameter is a variable that is exposed from the physical device / firmware. ARIA RDK can therefore inquiry for actual value(s) of a parameter, or set its desired value(s).

Parameters may be of different types, these types are enlisted as follows:

6.2 Policy during init, pre_acquisition and post_acquisition

All phases are further split in 3 different steps:

1. Inquiry of output params and

2. Execution of the scripts related to

3. Update of the params that are Input, I/O and that are modified by Octave

6.2.1 Radar Flow of Operations

6.2.1.1 Parameter Update

1. When a parameter is updated, the sw object send the data and it updates the value according to the corresponding return value. This is done in the *radarInstance::set_value* method.

When *transmit_param* is set, the transmission process is started too.

6.2.2

7

8 License

ARIA-RDK is distributed with a LGPL-3.0 License.

ARIA-RDK can be is distributed for the evaluation of algorithms based on ARIA UWB Radars SoCs and Modules. It can be used freely, but WITHOUT ANY WARRANTY; without even the implied warranty of FITNESS FOR A PARTICULAR PURPOSE.