STM32CubeIDE ST-LINK GDB server

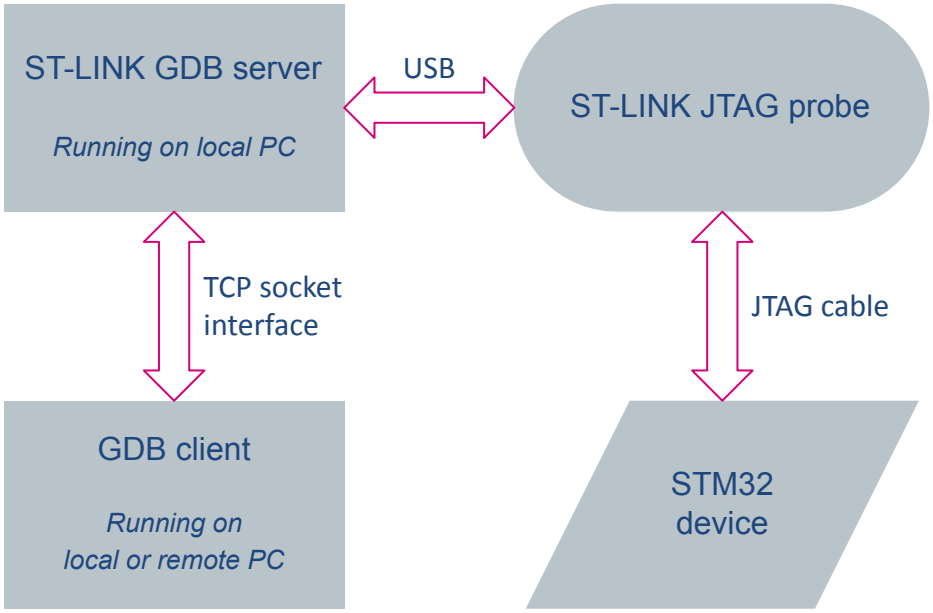
Introduction

The STM32CubeIDE ST-LINK GDB server, also referred to as the GDB server, is a command-line application that runs on a PC connected to the Arm® Cortex®-M target via the ST-LINK JTAG probe.

At start-up, the ST-LINK GDB server connects to the STM32 Arm® Cortex®-M target using the ST-LINK JTAG. After establishing the target-side communication, it waits for the client to connect to its TCP-listen socket. Once the client is connected to the TCP-listen socket, the ST-LINK GDB server processes the Remote Serial Protocol (RSP) messages sent by the client, performs the appropriate target-side actions, and sends RSP replies back to the client.

Figure 1 shows a typical debug session using the ST-LINK GDB server to debug an Arm® Cortex®-M target using STMicroelectronic ST-LINK probe.

Figure 1. Overview of a debug setup



The figure shows how the GDB client connects to the ST-LINK GDB server via a TCP-socket interface in order to debug the Arm® Cortex®-M target connected via the ST-LINK JTAG.

1 GDB server usage

The STM32CubeIDE ST-LINK GDB server is a command-line application, which can be started by

- entering a set of command-line options
- instructing the GDB server to load the options from a configuration file

If no options are specified, the GDB server starts up with pre-configured default options. The start-up options and the default values corresponding to each of them are listed in Section 1.1 GDB server start-up options.

The STM32CubeIDE ST-LINK GDB server uses STM32CubeProgrammer (STM32CubeProg) to flash the device that shall be debugged. The STM32CubeProgrammer software is automatically used by the GDB server when a `load` command is issued by gdb.

Note: For cases where advanced device control is needed such as Flash erase or setting of Option Bytes, STM32CubeProgrammer (STM32CubeProg) can be used. It is included in STM32CubeIDE and can be also downloaded independently from the STMicroelectronics website at www.st.com.

STM32CubeIDE supports STM32 32-bit products based on the Arm® Cortex® processor.

Note: Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

1.1 GDB server start-up options

The GDB server is started up with the following command:

```
ST-LINK_gdbserver.exe [options]
```

Most options are available in a short and long form. The set of options, which the GDB server supports, are described below with default modes and configurations in bold:

- `-h`, `--help`

  Causes the `ST-LINK_gdbserver` to display usage information.

- `--halt`

  Halts all cores during reset.

  [Use this option with multi-core devices to halt all.]

- `-c <config file>`, `--config-file <config file>`

  Instructs the GDB server to read the options from the configuration file. A sample configuration file illustrating the syntax is provided in Appendix B.

- `-f <log file>`, `--log-file <log file>`

  Specifies the name of the log file. The default name is **`debug_log.txt`**.

- `-l <log level>`, `--log-level <log level>`

  Specifies the logging level. The logging level is between 0 and 31. Specifying a logging level of 0 turns the logging off, whereas specifying a logging level of 31 enables the full logging. The default logging level is **31**. The logging level can be set as per the following list:

  – = 0: Disables logging.
  – ≥ 1: Enables the logging of error messages.
  – ≥ 2: Adds warning messages.
  – ≥ 4: Adds communication-specific messages.
  – ≥ 8: Adds all information messages.
  – ≥ 16: Adds all HW-specific messages.

  Hence, if the options `-f` and `-l` are not specified, the server starts up with a default logging level of 31 (full logging) and the default log file is `debug_log.txt`.

- `-p <port number>`, `--port-number <port number>`

  Specifies the TCP port number at which the server listens for client connection. The default port number at which the server listens is **61234**.

- `-v, --verbose`

  Specifying `-v` in the command line enables the verbose mode; which, in addition, also prints on the standard output the debug log of the server. By default, the verbose mode is **disabled**.

- `-r <refresh delay>, --refresh-delay <refresh delay>`

  Specifies the interval, in seconds, at which the hardware status is updated in the debug log file. Note that updating the status at very small intervals bloats the debug log file. The default status refresh delay is **5 seconds**.

- `-s, --verify`

  Turns on the verification of the Flash download.

- `-e, --persistant`

  Specifying the option `-e` starts the server in persistent mode. By default, the persistent mode is disabled, meaning that the server starts in **non-persistent** mode.

- `-d, --swd`

  Enables the Serial Wire Debug (SWD) mode. Specifies that SWD is used instead of JTAG.

  [Use this option for SWV.]

- `-z <port number>, --swo-port <port number>`

  Specifies the TCP port number at which the server outputs raw SWO data.

  [Use this option for SWV.]

- `-a <cpu clock>, --cpu-clock <cpu clock>`

  Specifies the clock speed of the CPU in Hz.

  [Use this option for SWV.]

- `-b <SWO CLOCKDIV>, --swo-clock-div <SWO CLOCKDIV>`

  Specifies the SWO clock divider. This operates on the CPU clock speed given by the `-a` option.

  [Use this option for SWV.]

  Use the `-z`, `-a`, and `-b` options together to specify the speed of the SWO. For example, if the core runs at 168 MHz and the target SWO at 1 MHz, configure these options as follows: `-z 61235 -a 168000000 -b 168`. For a core running at 72 MHz and SWO at 125 kHz, use `-z 61235 -a 72000000 -b 576`.

- `-k, --initialize-reset`

  Initializes the device while under reset condition.

- `-q, --debuggers`

  List connected debuggers, ST-LINK serial numbers.

- `-i <ST-LINK S/N>, --serial-number <ST-LINK S/N>`

  Specifies the ST-LINK serial numbers the server shall connect to.

- `--frequency <max freq kHz>`

  Specifies the ST-LINK communication frequency in kHz, such as 5, 25, 100, 240, 950, 1800, 4000, 8000, 24000 kHz.

- `-m <apID>, --apid <apID>`

  Defines the apID to debug.

  [Use this option for muti-core.]

- `-g, --attach`

  Attaches to the running target.

  Attach is aimed to be used to connect to a running program in the device without doing a reset or downloading a new program.

  [`STM32_Programmer_CLI` is always started with "`mode=UR reset=hwRst`" so that a device reset is done when loading a new program independent of this option. This guarantees that the flashing of the device is made correctly.]

- `-t, --shared`

  Allows two or more programs to connect to the same device simultaneously using one single ST-LINK probe.

  [Use this option for the ST-LINK server.]

- `--erase-all`
  Erases all the memories.
- `--memory-map <device id>`
  Shows the memory map for the given device identifier, such as 0x410.
- `--ext-memory-loaders`
  Provides the list of the available external memory loaders.
- `-el <file_path>`, `--extload <file_path>`
  Selects a custom external memory-loader.
- `-cp <path>`, `--stm32cubeprogrammer-path <path>`
  Path to the STM32CubeProgrammer (STM32CubeProg) installation.
- `--temp-path <path>`
  Temporary files for starting a debug session are stored at the path provided.
- `--preserve-temps`
  Temporary files are not removed.
- `--licenses`
  Provides the list of the tools and licenses used.
- `--`, `--ignore-rest`
  Ignores the rest of the labeled arguments following this flag.
- `--version`
  Displays version information and exits.

1.2 GDB server modes of operation

The server can be run either in persistent or non-persistent mode depending upon the configuration options. In persistent mode, the server continues to run even after the client disconnects, and waits for new connections, whereas in non-persistent mode the server exits when the client closes the connection. However, as an exception, if the server encounters errors in the target communication, it closes all connections and shuts down, regardless of the mode.

1.3 Starting the GDB server

The GDB server can be started in a command window in the following way:

1. `cd C:\ST\STM32CubeIDE_1.0.0.19w12patch\STM32CubeIDE\plugins\com.st.stm32cube.ide.mcu.externaltools.stlink-gdb-server.win32_1.0.0.201903011553\tools\bin\ST-LINK_gdbserver`
2. Start the GDB server using `-cp` with the path to `STM32_Programmer_CLI.exe`
   For instance: `ST-LINK_gdbserver.exe -d -v -cp "C:\ST\STM32CubeIDE_1.0.0.19w12patch\STM32CubeIDE\plugins\com.st.stm32cube.ide.mcu.externaltools.cubeprogrammer.win32_1.0.0.201903011553\tools\bin"`
3. Then, the GDB server connects to the STM32 device using the ST-LINK JTAG and waits for commands from a GDB debug session.

2 Debugging with GDB

This section describes a minimal set of GDB commands, which are needed to debug a program via a GDB client. A full list of commands can be obtained by typing `help` at the GDB command prompt. Alternatively, the GDB user manual is available in the STM32CubeIDE information center.

The ST-LINK GDB server is tested against versions v7.0, and 8.1 of the GDB client.

2.1 Launching GDB

A command-line GDB client is started by the command

```
>arm-none-eabi-gdb <program.elf>
```

where `<program.elf>` is the program to be debugged.

2.2 Connecting to the server

The server can be started in either persistent or non-persistent mode:

- If the server is started in non-persistent mode, the client must connect to the server using the command

  ```
  >target remote <ip-address>:<port-number>
  ```

  When the client connects to the server in non-persistent mode using this command, the debug session cannot be restarted without closing both client and server.
- If the server is started in persistent mode, the client must connect to the server using the command

  ```
  >target extended-remote <ip-address>:<port-number>
  ```

  When the client connects to the server in persistent mode using this command, the user has the facility to restart the debug session without closing the server or client. In this mode of operation for client and server, the debug session can be repeatedly restarted.

2.3 Loading the program on the target

The executable program is loaded on the target using the GDB-command

```
>load <program.elf>
```

This command loads the program on the target. If the code segment of the program lies in the Flash ROM, then the respective pages of the Flash are erased before the new code is written.

Note: The Flash programming (the code download into the Flash memory) is handled by the GDB server and is transparent to the user.

2.4 Setting breakpoints

Breakpoints are placed using the GDB `break` command

```
> break [LOCATION]
```

where, `LOCATION` is a line number, function name, or "`*`" followed by an address. If a line is specified, GDB breaks at the start of the code for that line. If a function is specified, GDB breaks at the start of the code for that function. If an address is specified, GDB breaks at the exact address.

The `break` command places a software breakpoint at the specified location. This is valid if the code segment lies in RAM. However, if the code segment lies in the Flash ROM, then the `hbreak` command should be used instead of the `break` command. The arguments for the `hbreak` command are the same as those of the `break` command.

Note: The maximum number of hardware breakpoints that can be simultaneously placed depends on the debugged STM32 device. Note that there is no such limit on software breakpoints.

2.5 Setting watch-points

Variable read, write, and access operations are tracked with the commands

`>rwatch <variable-name>`, which halts the program if the variable is read,

`>watch <variable-name>`, which halts the program if the variable is written to,

`>awatch <variable-name>`, which halts the program if an access to the variable occurs.

Note: The maximum number of watch-points that can be simultaneously placed depends on the hardware configuration.

2.6 Running the program

Once the program is loaded, the debugger starts execution through the command

`>continue`

Note: There is no mechanism for specifying command-line parameters to the program.

The user can halt the program by pressing `Ctrl-C` while it is running. The user can step over a statement by using the `next` command. The user can also step inside a function by using the `step` command.

2.7 Exiting a debug session

The user exits the debug session by issuing the GDB command `quit`.

2.8 Debugging on the target STM32 board

The ST-LINK GDB server supports the debug of STM32 Arm® Cortex®-M-based devices. Both debugging in RAM and Flash are supported. Flash breakpoints are supported by the Arm® Cortex®-M hardware breakpoints. Application code can be compiled to run from either the RAM or Flash. No special commands are needed to distinguish between RAM- and Flash-mode codes as GDB handles this internally.

For the debug of code in RAM or Flash on an Arm® Cortex®-M microcontroller, the stack pointer (SP, R13) and program counter (PC, R15) must be initialized correctly:

- If the code to be debugged is located in the Flash, the SP is read from 0x0 and PC from 0x4.
- If the code to be debugged is located in the RAM, typically the start of the vector is the start of the RAM area used for download. On most devices, this is 0x20000000. This means that the initial value of the stack pointer (SP) can be read from 0x20000000 and the initial value of the PC can be read from 0x20000004.

Use the command

`>monitor reset`

after downloading the code in order to set the SP and PC correctly. STM32CubeIDE issues this command automatically after downloading the code to the target device.

2.9 Monitor commands

The GDB monitor commands are supported and implement target-specific features, especially for performing Flash controller specific commands.

The following commands are the monitor commands supported for the ST-LINK GDB server:

- `>monitor help`

  Prints information about the supported monitor commands.
- `>monitor reset`

  Resets the target device.
- `>monitor flash mass_erase`

  Used to erase all the pages of the Flash device. Care needs to be taken when using this command since it causes all data stored in the Flash to be lost.
- `>monitor ReadAP <register index>`

  Read CoreSight AP register.

The following commands are not yet supported and always return OK:

- `>monitor ReadDP <register index>`

  Read CoreSight DP register.
- `>monitor WriteAP <register index> <data32>`

  Write CoreSight AP register.
- `>monitor WriteDP <register index> <data32>`

  Write CoreSight DP register.

3 Troubleshooting

In case the server hangs or fails to start up, follow these steps:

1. Shutdown the GDB server and any client attached to the server.
2. Power off the target board.
3. Disconnect the ST-LINK JTAG USB cable.
4. Re-connect the ST-LINK JTAG USB cable.
5. Power on the target board.
6. Check the debug configuration settings, such as the SWD/JTAG interface
7. Start the GDB server, preferably using a different port number.

A good practice is to attemps the debug of another project to eliminate the possibility of a project-specific problem with the project configuration or start-up code.

We also recommend to try and debug with another USB cable, ST-LINK or STM32 hardware to exclude hardware failures as the reason for the debug problems.

It is also advised to try and connect to the target using some other tool from STMicroelectronics, such as the STM32CubeProgrammer (STM32CubeProg). If STM32CubeProgrammer can connect to the target, try to:

1. Erase the Flash with STM32CubeProgrammer.
2. Program a new program with STM32CubeProgrammer.
3. If the programming is successful, erase the Flash again with STM32CubeProgrammer.
4. Disconnect STM32CubeProgrammer from the target.
5. Try and debug the program using `ST-LINK_gdbserver`.

Appendix A Return/error code information

Table 1. ST-LINK GDB server return/error codes

Code	Definition	Description
0	TARGET_SUCCESS	OK.
1	TARGET_CONNECT_ERR	Port is in use, something is already connected to the board, such as STM32CubeProgrammer.
2	TARGET_DLL_ERR	No ST-LINK connected.
3	TARGET_USB_COMM_ERR	USB communication error.
4	TARGET_NO_DEVICE	ST-LINK is connected but no board is connected
5	TARGET_UNKNOWN_MCU_TARGET	For instance, not using option `-d` when only SWD pins are connected to the HW.
6	TARGET_FIRMWARE_OLD	Old ST-LINK_firmware.
7	TARGET_RESET_ERR	Reset error.
8	TARGET_HELD_UNDER_RESET	Reset button on board pressed.
9	TARGET_NOT_HALTED	Target could not be halted.
10	TARGET_CMD_ERR	Command error.
11	TARGET_APP_RESET_ERR	Application reset error.
12	TARGET_VERSION_ERR	Version error.
13	TARGET_GET_STATUS_ERR	Get status error.
14	TARGET_FORCE_HALT_ERR	Force halt error.
16	TARGET_STLINK_SELECT_REQ	Several boards are connected. Need to specify `-i <ST-LINK S/N>`.
17	TARGET_STLINK_SERIAL_NOT_FOUND	The ST-LINK serial number cannot be found when using the `-i` option.
18	TARGET_DEVICE_UNKNOWN_VENDOR	The vendor information cannot be verified.
255	TARGET_UNKNOWN_ERR	Unknown error.

Appendix B Configuration file format

This appendix describes the configuration file format for starting the ST-LINK GDB server from a configuration file. The configuration file format is briefly depicted by the following rules:

- Each line starting with a # is treated as a comment.
- Each configuration option (refer to Section 1.1 GDB server start-up options) is specified in a single line.

A sample configuration file is shown below:

```
####################################################################
#### Sample Configuration File
####################################################################

####################################################################
#  -e                  : Enables persistent mode
####################################################################
-e

####################################################################
#    -f <Log-File>      : Name of log file.
####################################################################
-f debug_log_v0.txt

####################################################################
#   -l <Log-Level>     : Logging level between 0 & 31
####################################################################
-l 31

####################################################################
#   -p <Port-Number>   : TCP-Listen Port-Number.
####################################################################
-p 61234

####################################################################
#  -v                  : Enables verbose mode
####################################################################
-v

####################################################################
#    -r <refresh-delay-sec> : Maximum Delay in status refresh
####################################################################
-r 1
```

Revision history

Table 2. **Document revision history**

Date	Version	Changes
18-Apr-2019	1	Initial release.
11-Oct-2019	2	Updated Section 1.1 GDB server start-up options with more options.

Contents

1 GDB server usage 2
1.1 GDB server start-up options 2
1.2 GDB server modes of operation 4
1.3 Starting the GDB server 4
2 Debugging with GDB 5
2.1 Launching GDB 5
2.2 Connecting to the server 5
2.3 Loading the program on the target 5
2.4 Setting breakpoints 5
2.5 Setting watch-points 6
2.6 Running the program 6
2.7 Exiting a debug session 6
2.8 Debugging on the target STM32 board 6
2.9 Monitor commands 7
3 Troubleshooting 8
Appendix A Return/error code information 9
Appendix B Configuration file format 10
Revision history 11
Contents 12
List of tables 13
List of figures 14

List of tables

Table 1. ST-LINK GDB server return/error codes 9
Table 2. Document revision history 11

List of figures

Figure 1. Overview of a debug setup 1