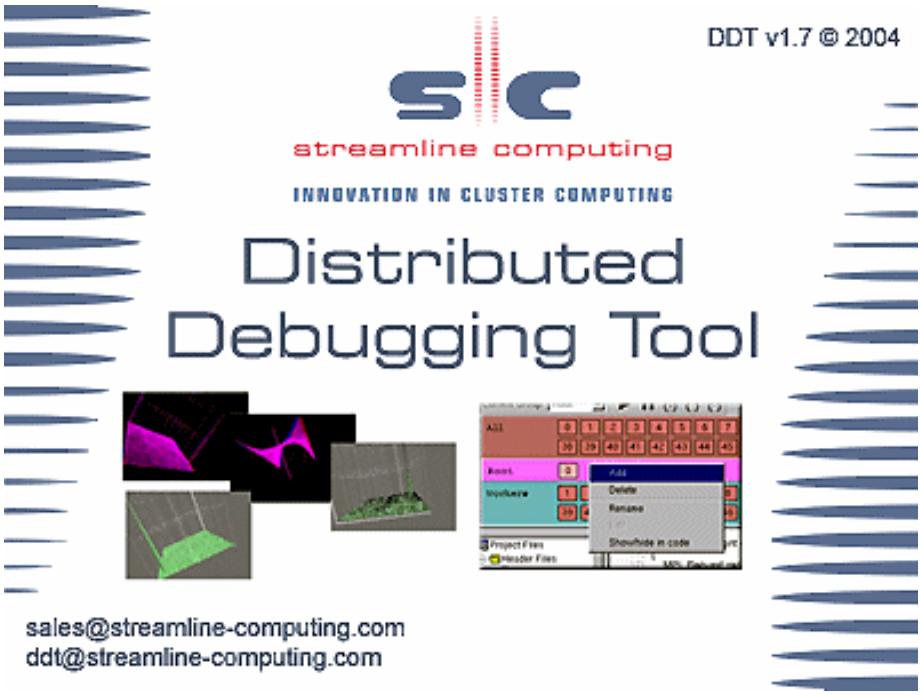
The Distributed Debugging Tool



Quickstart Guide
(F77 programs)

streamline computing

Contents

1. Introduction

In this document you will use the example program provided with DDT to gain an overview of DDT and it's features. You will see how DDT can be used to debug a fortran 77 program using the basic features found within DDT. After following this guide you should be able to start a program, control your processes, examine data, set breakpoints and learn how to find and recover from errors in your programs.

2. Starting A Session

By now you should have installed DDT successfully. In your DDT directory you will find the examples subdirectory. We will now compile this:

```
[examples]$ make -f fmake.makefile
mpif77 -g -O0 -o hellof77 hello.f
[examples]$
```

To verify that you have MPI working correctly, run the example without DDT first.

```
[examples]$ mpirun -np 4 ./hellof77
```

On termination, the hello program will, if your MPI supports I/O (input/output) from remote processors, have produced output that ends:

```
[....]
All done... 3
All done... 0
[examples]$
```

We now start DDT debugging this program:

```
[examples]$ $DDT ./hellof77 &
```

DDT will present a dialog box; you should now ensure that the right number of processors are selected as well as the correct debugger interface for your compilers and the correct MPI implementation.

If you are unsure which MPI implementation to choose, look in the FAQ for more help. The most common MPI is “generic”.

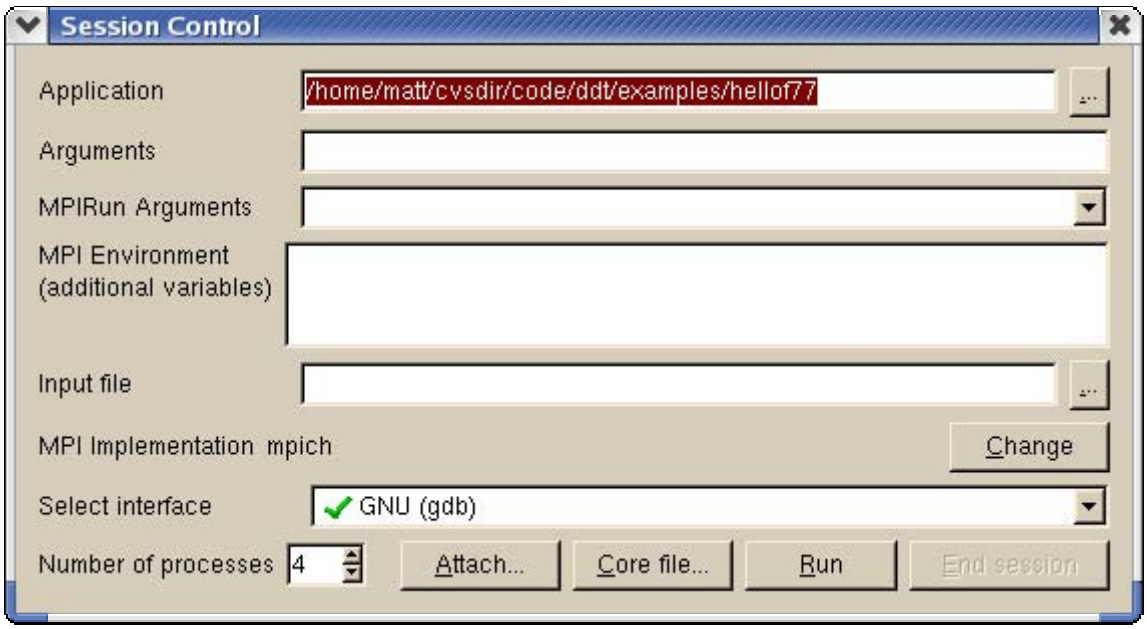


Fig.1 The session control window

You should now see the DDT session control window as in Fig.1. Select "Run" and DDT will connect to your processes, load your source files and take you into the main DDT window, ready to begin your debugging.

Checking Your Program Status

After loading the example program into DDT as described above your main DDT window should look like the one seen in Fig.2. The source files that have been found are shown, and the current file, that from which MPI_Init is called, will be loaded and shown. You can examine any of your source files at any time by selecting it from the list.

At the top of the screen is a collection of coloured numbered boxes, and three lines: "All", "Root" and "Workers". These are process groups. Process groups are used to control your processes *en-masse*. Each numbered box represents a process. One of the lines will be brighter than the others, and one of the boxes may be brighter and have a dotted border. These are the current group and the current process (if one is selected) respectively.

The process boxes are either red or green. A green process is running, and a red process is stopped, it could be paused or it may have terminated.

You should see a red bar on the line containing MPI_Init. This indicates that some processes in the red process group are on that line, and the red process group is the current group. If the line is bright, this also means that the currently selected process is on that line. Hover your mouse pointer over this line and DDT will tell you which processes are at that point. Select a different process group by clicking on "Workers". The red line will change to the colour of the Workers group.

Information about which line a processor is on is updated every time the program is paused.

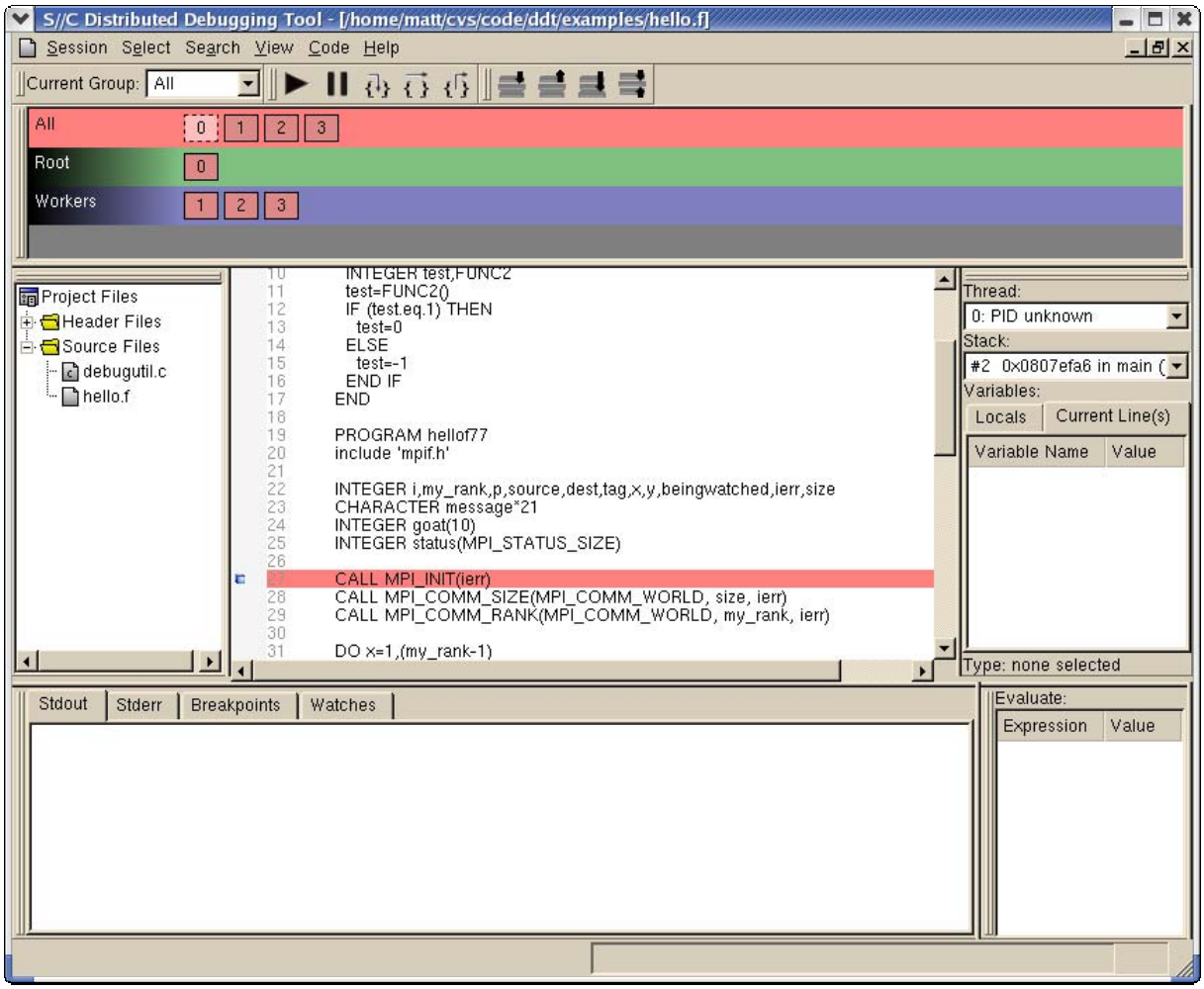


Fig.2 DDT main window

3. Controlling Your Processes

Process groups as described above are used to control most of the operations you will wish to perform on your processes. If you wish to make all processes stop at a point in your code, or all processes move a single step, the "All" process group would be selected. Alternatively, if none of the predefined groups are exactly right for you, by right clicking in the process group area, you can create your own using drag and drop moves.

The next step in our exercise will be to advance all the processes through the code. We will be using the process operation buttons found in the toolbar just below the process groups (see Fig.3). These buttons are (from left to right): Play, Pause, Step In, Step Over, and Step Out.

Fig.3 Process operation buttons

Advancing Processes Forward By A Line

Select the "All" process group using the mouse, and then press the `Step Over` button. The red line in your code will advance one line, your processes may also briefly turn green whilst they perform the step, returning to red when they have finished working.

In the example, press step over again - until the processes are at the line: "CALL FUNC1()".

Stepping Into A Function

Suppose we now wish to see what happens inside FUNC1(). Press the `Step Into` button, and the code window leaps to the relevant part of the source code. The processes have now moved into FUNC1().

Do this again to enter FUNC().

Stepping Out Of A Function

You should now be seeing the definition of FUNC2() and it looks uninteresting so lets go back up to FUNC1() and see what happens there. Click the `Step Out` button. The processes will now continue until they reach the end of FUNC2() and then return to FUNC1().

After this the processors are still shown as being on the line of FUNC1() that calls FUNC2(); this is because it hasn't finished executing the last part of this line, which is where the return value of FUNC2() is assigned to test.

Following If Branches

Probably the most important part of FUNC1() is the if statement and we'd like to watch what happens in there; which path is taken. By stepping over we can watch what happens as the program proceeds. Use the `Step Over` button to do this until you leave FUNC1().

Pausing Processes At A Breakpoint

You could keep using `Step Over` until you have reached a point in your code that is important to you, but this would be time consuming. It's also possible that some processes may take more instructions to reach a point of interest than others, leading to different processes being on different lines of code. A better idea is to cause your processors to stop at a breakpoint.

We'd like to see what is happening during an MPI operation - where process 0 is receiving data from all of the other processes. Select the process group "Workers" and then click on the line containing MPI_Send; line 54. Click the right mouse button and choose "Add breakpoint", this will add a breakpoint for the currently selected group.

Now select the "All" process group, and press play to resume execution. After a short period of computation, you will see that process 0 is Green, still running, and processes 1, 2 and 3 have reached the breakpoint.

You can have as many breakpoints as you like, each breakpoint you set will be active for the currently selected process group. You can see all the breakpoints that are set by clicking on the breakpoints tab at the bottom of the window.

Manually Pausing Processes

Process 0 is still running, but we can guess that it will be waiting to receive data and is not actually "working". By selecting either the "Root" or the "All" group if neither is selected, and then pressing `Pause`, process 0 can now be stopped.

Select process 0 and you will see the stack, located to the right side of the code. This can be viewed by clicking the mouse over the stack display window, which will currently be displaying the top of the stack.

If you double click on process 0 the code window will jump to the point in the code where process 0 has paused and will bring the stack frame up to the correct stack to view the currently highlighted line in the code, and it's associated variables.

All of the process operation buttons, and the setting of breakpoints work on the currently selected process group. The ability to configure and save your own groups is a very powerful feature making it much easier to debug your programs using DDT.

4. Viewing Data

Now that you know how to control processes in DDT, we are now ready to look at the data or contents of the processes.

Current Line

By clicking on any of the paused processes, we can examine the data on the current line of code. If we choose any of the processes that have just executed a send procedure we can view the message that is about to be sent to process 0. First select process 1 (using a double click) and then click on the "Current Line" tab, to the right of the window.

The current line panel shows the variables that used on the current line of code for the currently selected process. In this case we can see the "message" variable, and the dest and tag variables. We can see that the dest and tag variables are integers with a value of 0. We can also tell from looking at the "message" variable that it is an array, as we can see there is a "+" on the left of the variable name.

You can see more than the currently selected line by dragging the mouse around the lines of interest in the code window.

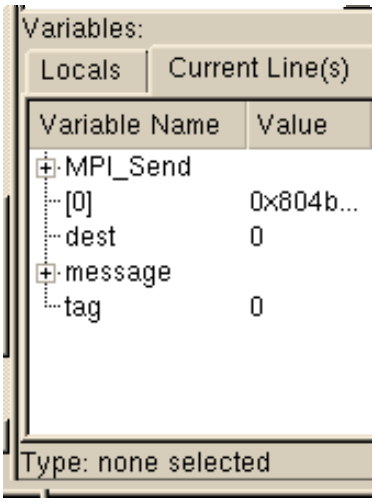


Fig.4 Current line for process 1

Local Data

The variables known as "locals", those in scope in your current function, and in the case of Fortran most other global variables; can be seen by clicking the locals tab.

Keeping An Expression In View

It would be useful to keep a particular eye on the values in "ierr", in order to know if our mpi calls are throwing errors or not; we'd like to watch this as we proceed. We can do this by putting expressions into the evaluate window. This is found below the current line/locals window.

You can drag “ierr” from the locals window into the expression window using mouse drop and drop techniques, or you can type it in directly by right clicking in the evaluate window and selecting “Evaluate expression”.

We’ll now make processors 1, 2 and 3 send the data. Press `Step Over` whilst the “Workers” group is selected. Now examine the value of ierr for each of the 3 processes and it should still be 0. On some MPIs the buffering may not be sufficient to let all three communications occur without first setting process 0 running, you will be able to use the process operation buttons talked about in the previous section to find this out if your processes do not stop and instead are running but waiting on I/O.

Finding And Fixing An Error

The “hello” program was designed to break. If the program is started with exactly 8 processes it will abort with an error. Lets try to find and fix this error.

We can restart “hello” by selecting `Session` and then the `Restart` option from the tool bar. Then click on `End Session`.

In the session control dialog, change the number of processes to 8. Now commence the program as before. When DDT is ready, press play to start everything going.

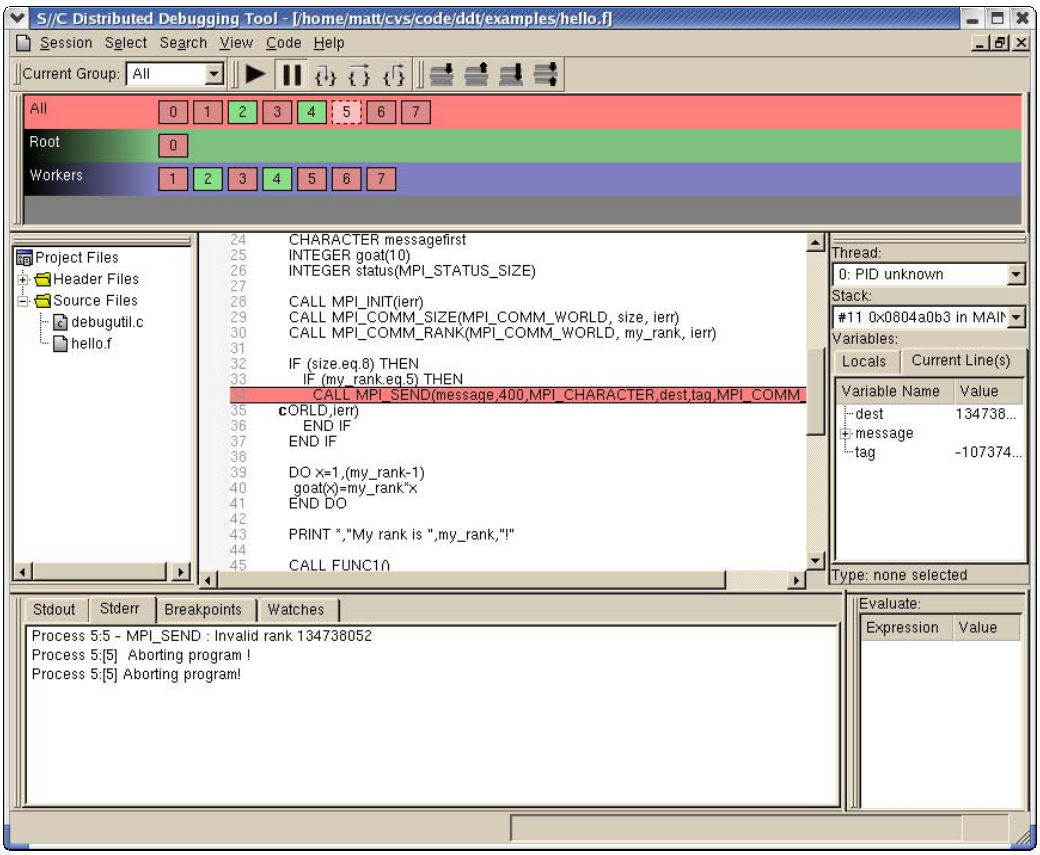


Fig.5 Error output in DDT

Some of the processes will appear to end and some will appear to continue running. Click on the `All` group and then pause the remaining processes using the `pause`

button. Change the output window at the bottom so that you are viewing the `stderr` queue.

You will see that process 5 has aborted with an invalid rank error. If you now double click on process 5 your code window will jump to the line on which it has broken.

It is now obvious to see that you are trying to call an MPI_Send without first initializing the variable “dest”.

In this way it is possible to find errors and faults in your code and locate where they are and what the problem is.

Hint: You will also have noticed a p4_error output in the `stdout` window, this is often a sign that some memory allocation problem has occurred and is a good first guide to the fact that you have a problem in your program. See Fig.6 for an example of this.

Fig.6 Errors in the Stdout window

5. Conclusion

You have now mastered the basic operations of DDT for debugging a fortran 77 program. For a more in depth look at the possibilities with DDT you can attempt one of the two tutorials (tutorial-1 or tutorial-2) supplied with DDT.

Note: These tutorials deal with c programs.

Alternatively you can take a look at the quick start guide and tutorials for C, to learn how to use DDT's powerful features on standard C code.

For more help on the features of DDT see the supplied Userguide.