Introduction to Matlab RTW and RTAI

This document gives a very short introduction on how Matlab Simulink can be used to do fast prototyping on Automations realtime platforms. Throughout this guide the following terms will be used:

- RTW
  Real Time Workshop. Addon to Matlab Simulink which makes it possible to generate stand alone c-code and executables from Simulink models.

- RTAI
  Realtime Application Interface for Linux. Open Source realtime extention which gives a standard Linux kernel realtime performance. (http://www.rtai.org/)

- RTAI-Lab
  Various tools which can be used to generate realtime code from block diagrams (for example Simulink diagrams) and to visualize the results.

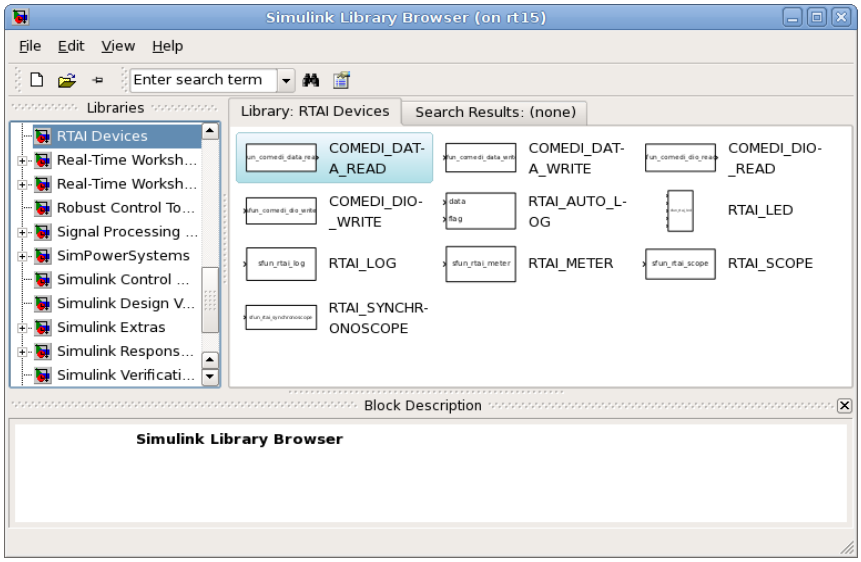
- Comedi
  Control and Measurement Interface. Open Source library and drivers for various data acquisition plug-in boards. (http://www.comedi.org/)

Usage example
The RTAI-Lab functionality is only available on realtime machines, therefore the first thing to do is to log in to one of Automations realtime platforms. This is done from a terminal or PuTTY, by executing

```
ssh rtX
```

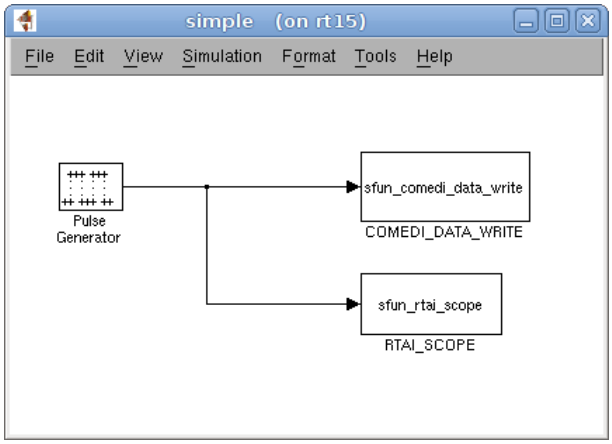
where X is the number of the realtime machine (For example rt15). Your home-directory is automatically mounted on the machine such that all your files are available.

Then start Matlab / simulink (Type “matlab” at the terminal).
Besides the usual Simulink blocks a new group called “RTAI devices” appear in the library browser.



This group contains all the blocks included in RTAI-Lab. The first four blocks are related to your data acquisition board trough the Comedi interface. The others are used to communicate with the visualisation program 'xrtailab' and are useful when debugging.

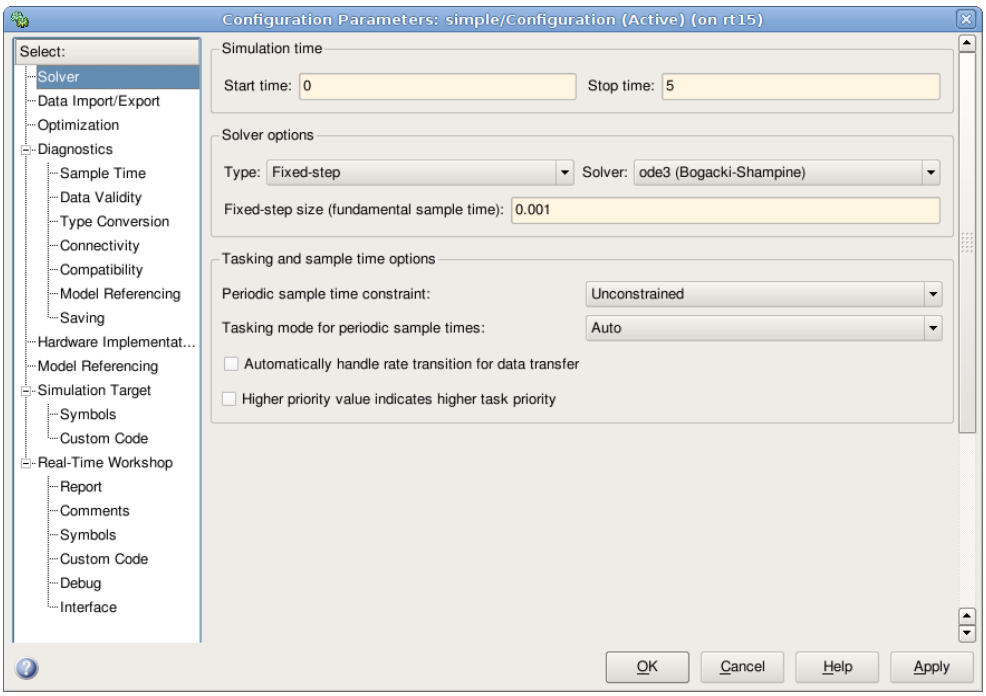
A very simple example on how to use the blocks are now given. It is assumed that the realtime machine has a Comedi DAC board connected like the PCI-DAS6025.
Start out by creating a new Simulink diagram as the one shown in the picture below.



The “Pulse Generator” is found in the Sources group. Open the “Pulse Generator”s parameters by double clicking the block. Choose “Pulse Type” to be “Sample Based”. Then save the block diagram.

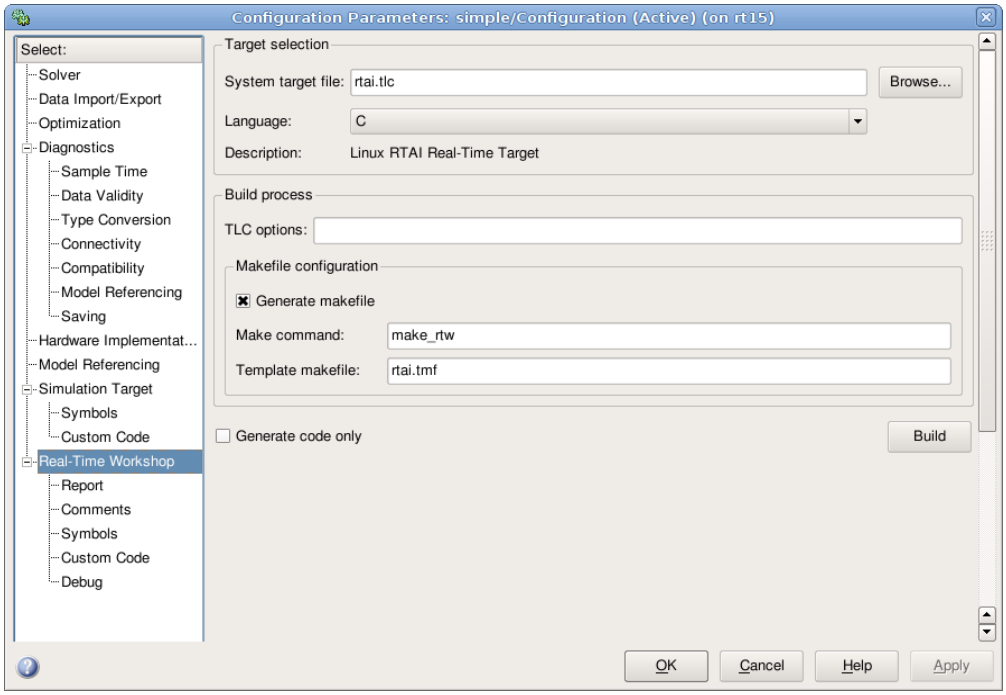
Note that all output to RTAI-Lab blocks must be in discrete time. If you need to output an analog signal it must be sampled first, eg. by a zero-order-hold network.

In order to invoke the RTW code generator one must open the “Configuration Parameters” panel in the “Simulation“ menu. This will open the following menu:



Choose “Solver options” → “Type” to be “Fixed-step”. Only discrete time solvers work with RTAI. Then choose a sample time (“Fixed-step size”) to suite your needs.

Next go to the “Real Time Workshop” panel in the left menu.



Set the “System target file” to be “rtai.tlc” and then press the “Build” button. This will start the compilation procedure and if everything goes well you should see a “Successful completion of Real-Time Workshop build procedure for model” in the Matlab window after a little while.

Now a Realtime program which corresponds to the block diagram has been created. To execute the program open a new terminal on the realtime computer. Go to the folder where you started Matlab. If the simulink model was saved under the named “simple”, you should see a file called “simple” and a folder called “simple_rtai”. The file is the program executable and the folder contains the c-files created by RTW. Execute the program by typing its name like this on the terminal:

```
./simple
```

The program can be stopped by hitting Ctrl+c. (Send SIGINT to the program).

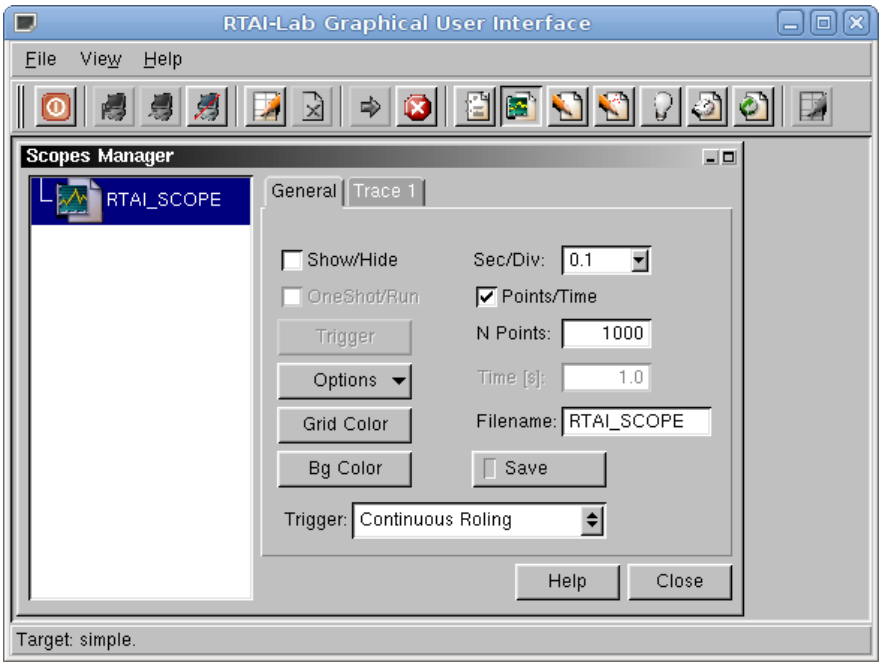
When the program is running try to measure on channel 0 of your data acquisition equipment with an oscilloscope. You should see the square pulse generated by the Simulink “Pulse Generator”. The channel used on the DAC board is set in the “COMEDI_DATA_WRITE” blocks parameters. Remember to choose a device and channel which are physically present on your system.

The signal can also be monitored on-line by using the RTAI-Lab program “xrtailab”. Open a new terminal on the realtime machine and type “xrtailab”. This should invoke the program. Choose connect from the file menu and type the IP address of the realtime machine. At Automation the IP addresses are 192.38.66.220 + X, where X is the number of your machine. For example rt15 has the IP address: 192.38.66.235.

A list of Automation realtime machines and their IP addresses can be found at:
http://timmy.elektro.dtu.dk/rse/wiki/index.php/Platform_list

For some unknown reason the program does not recognize the alias “rt15” so the full IP address must be typed.

When connected choose “View” → “Scopes”. This will open the scope manager where all scopes in the running program are listed.



Toggle the “Show/Hide” button to see the scope. When shown the scope should display the same signal as seen with the real oscilloscope.

Further exploration
The guide above show the general procedure in using RTW and RTAI. Of course these systems contains lots of other features which are not described here but since the tools are quite easy to use it is left to reader to explore these on his/her own.

Various information and mailing list are found at: http://www.rtai.org/