MATLAB/Simulink Introduction with Corsica Communication Interface

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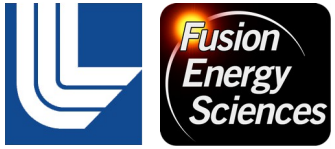

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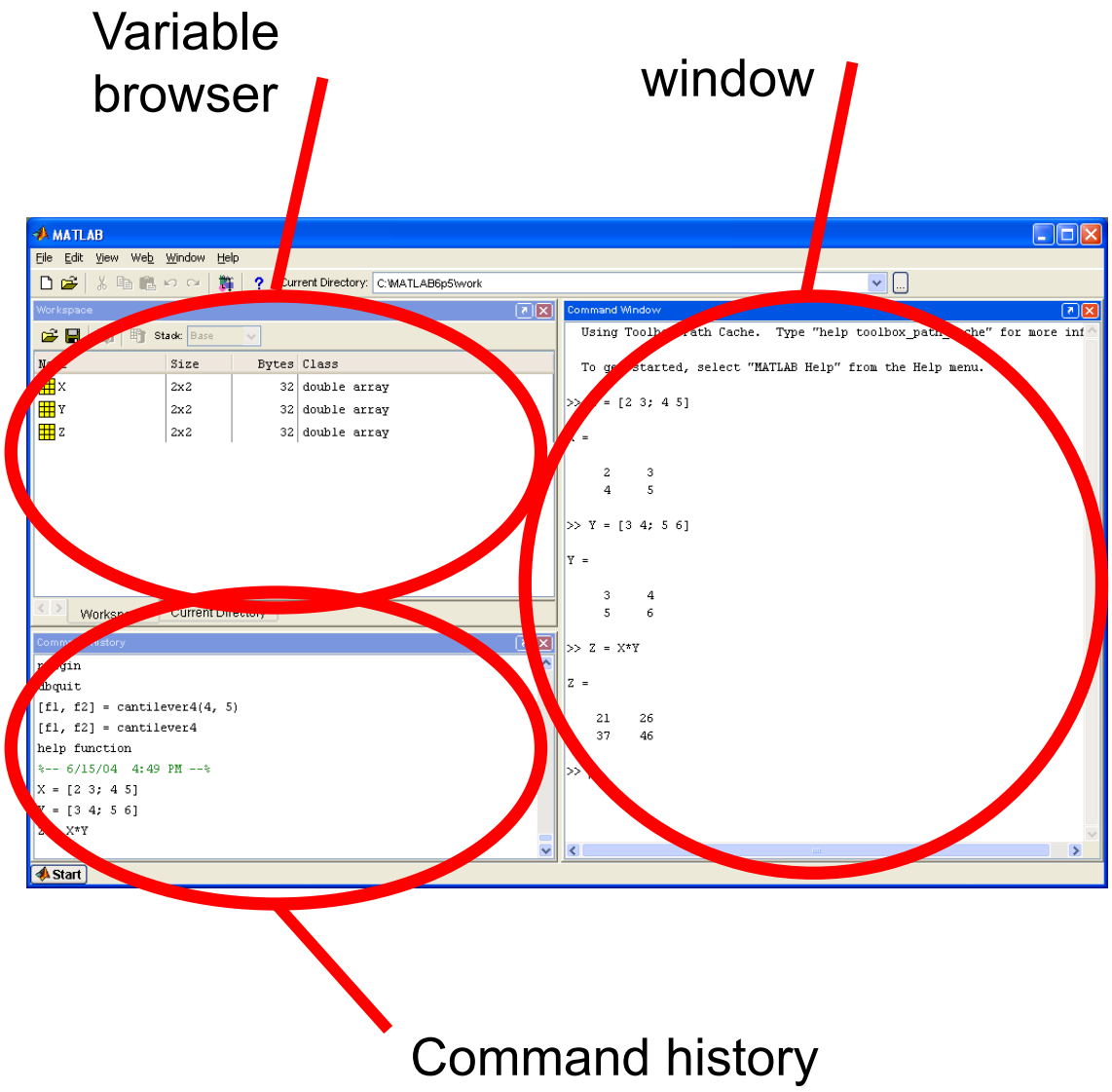
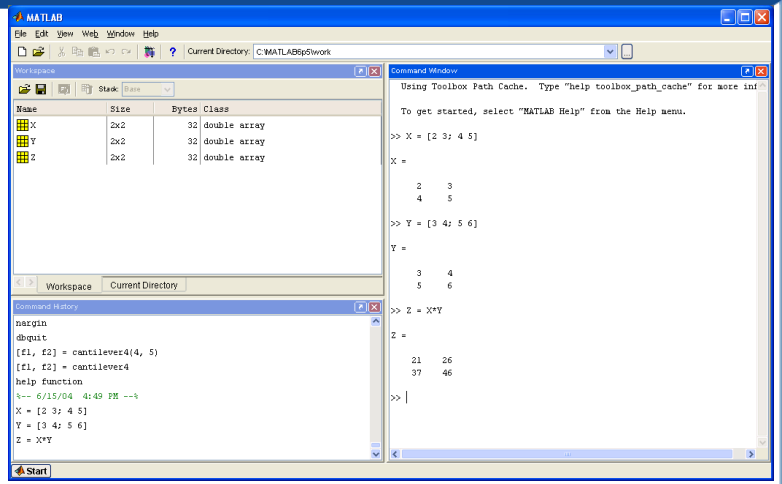
Introduction to Matlab

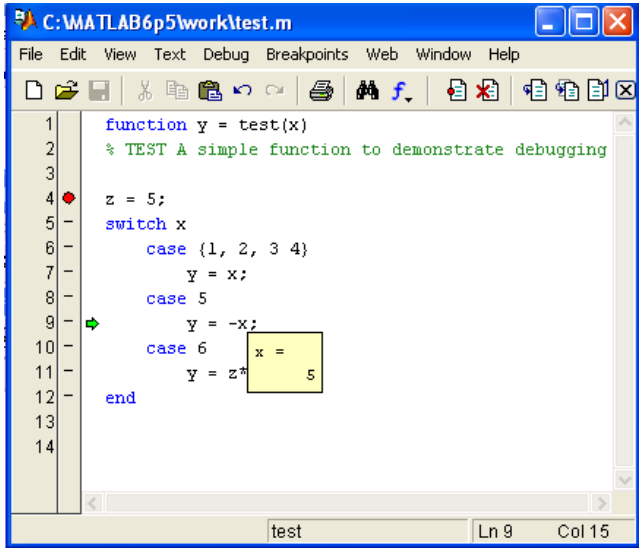
- Click on the Matlab icon/start menu initialises the Matlab environment:
- The main window is the dynamic command interpreter which allows the user to issue Matlab commands
- The variable browser shows which variables currently exist in the workspace



Matlab Programming Environment

- Matlab (Matrix Laboratory) is a **dynamic, interpreted**, environment for matrix/vector analysis
- Variables are created at run-time, matrices are dynamically re-sized, …
- User can build programs (in .m files or at command line) using a C/Java-like syntax
- Ideal environment for model building, system identification and control (both discrete and continuous time
- Wide variety of libraries (toolboxes) available





Numbers and variables and similar in Matlab

- Smallest positive floating point number *2.2251e-308*, and the highest is *1.7977e+308*.
- Spacing of floating point numbers (calculation precision) is 2.2204e-016.
- *1/0* gives infinite - *Inf*.
- *0/0* or *Inf-Inf* gives *NaN* – (not-a-number).
- Matlab is case sensitive; *a =10* is not equal to *A=10*.
- If the command is concluded with semicolon, the result will not be shown on the screen.
- For decimal numbers, dot is used, for example 2.45.
- Formats: format short, format long, fomat long e...format.
- *% Comment.*

Numbers and variables and similar in Matlab

- *2.4e-12 is* $2.4*10^{-12}$
- *pi* is the variable with defined name.
- *i* or *j* is complex unit (it can be overwritten).
- For trigonometric functions [rad] is used.
- *clear all,* clears all defined variables.
- *close all,* closes all graphical windows.
- *clear all, close all*, very usefull combination!
- *clc,* clears the screen, but nothing else.
- CRTL+C stop the execution of the program in Matlab.
- *dir*, current directory.
- *who*, list of all defined variables.

Basic mathematical operation

- +, - ,*, /,
- *sqrt* (a), square root,
- a^ b, power,
- *log(a),* natural algorithm,
- *exp(a)*, *log10(a),*
- *abs*(a), absolute value ,
- *cos(a)*, *sin(a)*, *acos(a)*, *asin(a)*,
- *sinh(a)*, *cosh(a)*, *tanh(a)*,
- *mod(a)*, Modulus after division,
- *rem(a)* Remainder after division,
- *floor(a), ceil(a), round(a),* Round towards ...

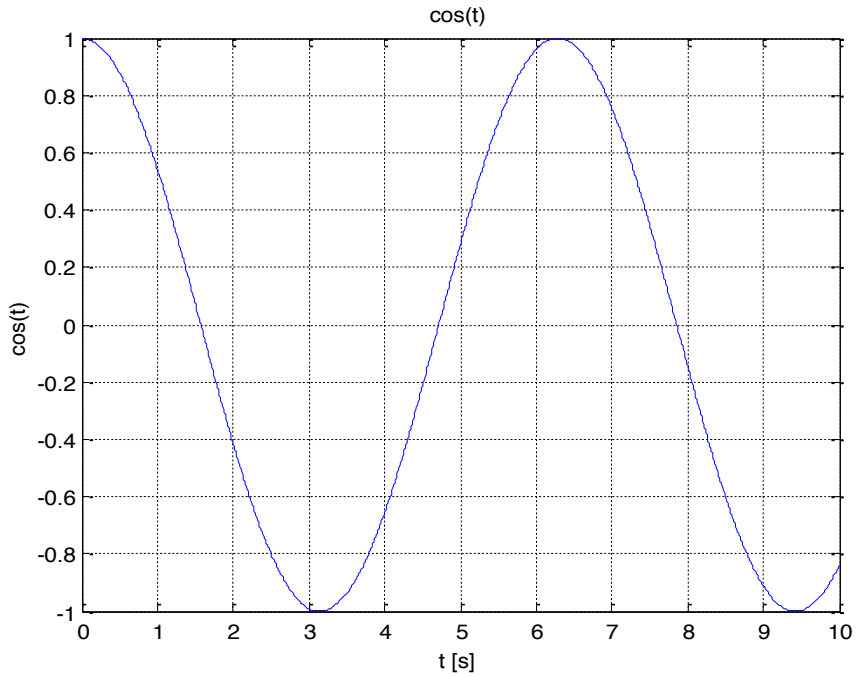
Matrixes and vectors

- *x = [1,2,3]* , vector-row,
- *y=[1;2;3]*, vector-column,
- *x=0:0.1:0.8* , vector *x=[0,0.1,0.2,0.3....0.8],*
- *A = [1,3,5;5,6,7;8,9,10]*, matrix,
- *A(1,2)*, element of matrix, 1. row, 2. column,
- *A(:,2)*, second column of matrix,
- *A(1,:)*, first row of matrix ,
- *C=[A;[10,20,30]]* matrix with additional row,
- *A(:,2)=[]*, deleting of second column,
- *B=A(2:3,1:2)*, part of matrix,
- *x'*, transpose.

Graphics

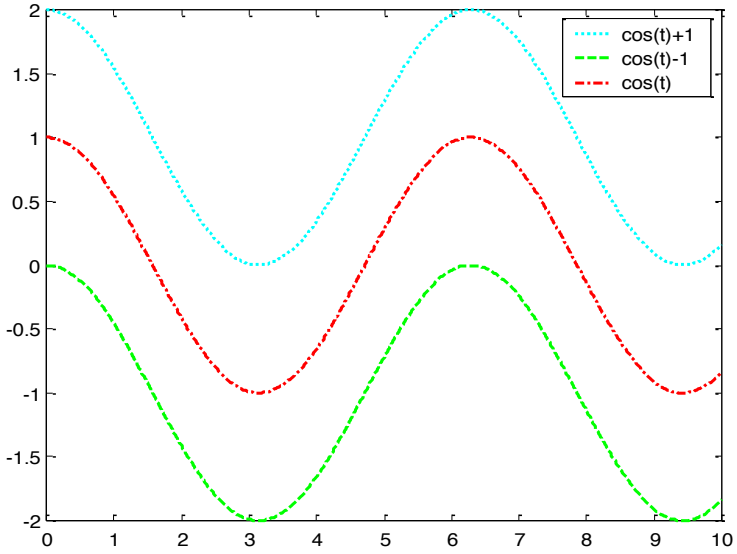
- *t=[0:0.01:10];*
- *figure(1), plot(t,cos(t))*
- *title('cos(t)')*
- *xlabel('t [s]'), ylabel('cos(t)')*
- *grid*

- Copy the figure:
  MENU: Edit->Copy Figure



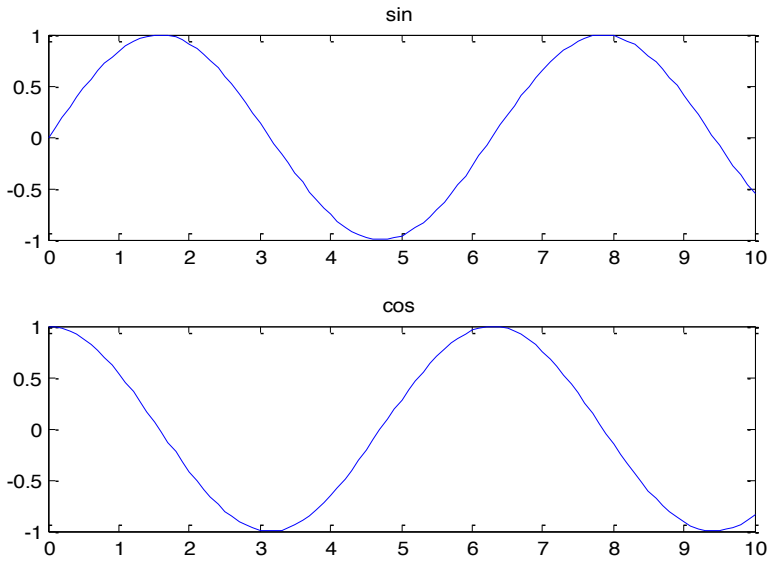
Graphics

- *figure(1), ahandle=plot(t,cos(t)+1,':c',t,cos(t)-1,'--g',t,cos(t),'-.r');*
- *set(ahandle,'LineWidth',[2]);*
- *legend('cos(t)+1','cos(t)-1','cos(t)');*



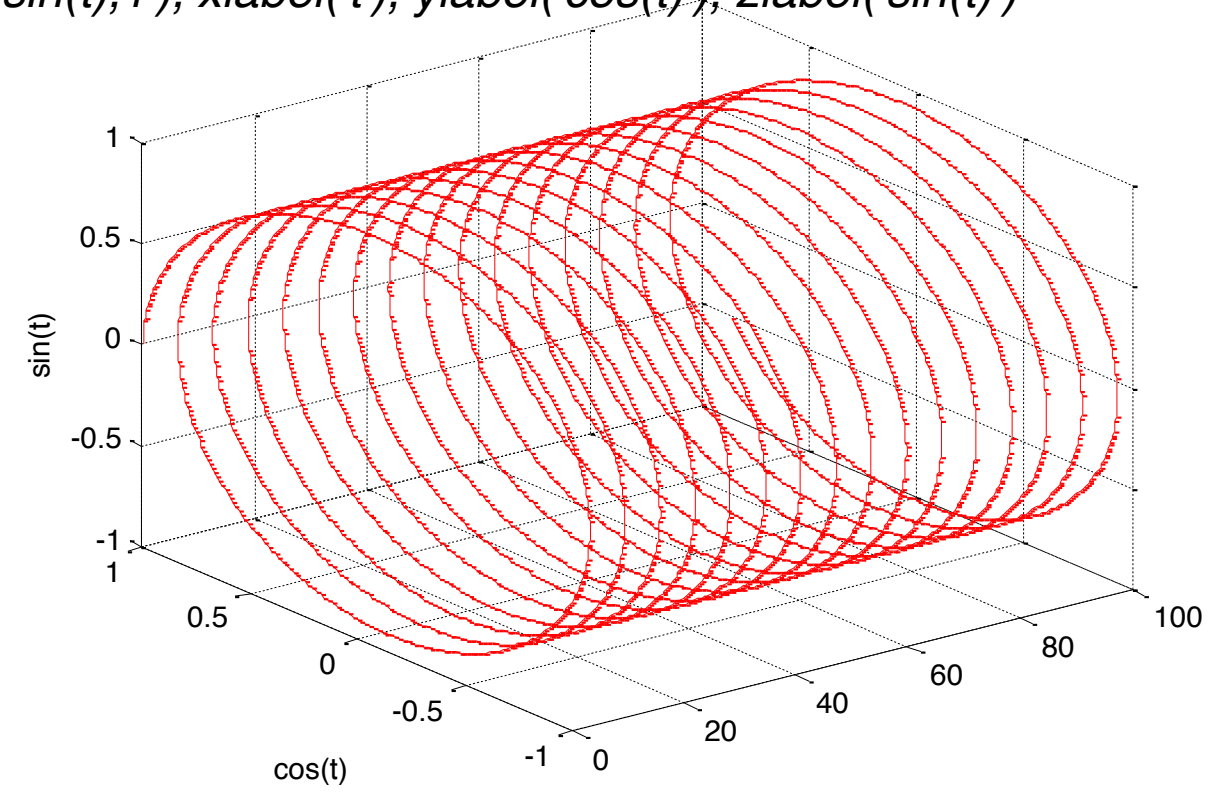
Graphics

- *t=[0:0.1:10];*
- *subplot(2,1,1),plot(t,sin(t)),title('sin')*
- *subplot(2,1,2),plot(t,cos(t)),title('cos')*



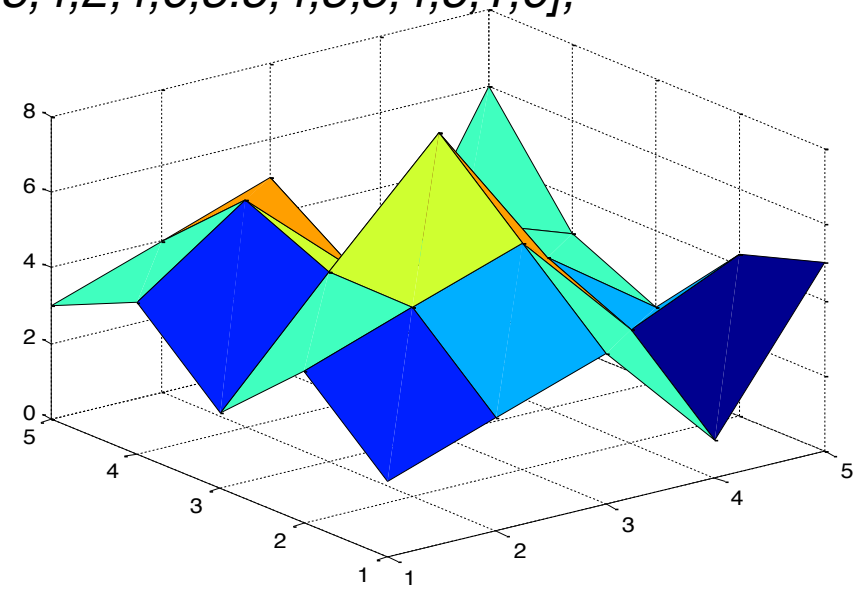
Graphics

- *t=[0:0.02:100];*
- *plot3(t,cos(t),sin(t),'r'), xlabel('t'), ylabel('cos(t)'), zlabel('sin(t)')*
- *grid*



Graphics

- *X=[1,2,3,4,5];*
- *Y=[1,2,3,4,5];*
- *Z=[2,3,4,1,5;4,5,6,3,4.3;2,5,8,4,2;4,6,3.5,4,3;3,4,5,1,6];*
- *surf(X,Y,Z)*



Program flow

- For loop

```
for I = 1:0.2:N,
        for J = 1:N,
            A(I,J) = 1/(I+J-1);
        end
end
```

Program flow

- While loop

```
while (a<b)
    c(a)=sin(a);
    a=a+1;
 end
```

Program flow

- If-else statement

```
if  I == J
        A(I,J) = 2;
elseif abs(I-J) == 1
        A(I,J) = -1;
else
        A(I,J) = 0;
end
```

Help in Matlab

- *help sqrt*, looking for known command,
- *lookfor algorithm*, looking for the key words,
- *help*, help topics are shown,
- *help*, interrogation point in menu, Mtalb help windows opens,
- *demo*, window with (many!) examples opens.

M-files

- Matlab files with program and/or definitions.
- Name of the files most be without special characters and spaces.
- Path to the directory with m-file must be set (if it is not *work* directory).
  - path(„<my directory“,path)
- To run, type the name of the file in the Command window or run directly from Matlab editor.
  - $CWD/startup.m run at startup
- New m-file is created in Matlab menu under *File/New/M-file*

MTConnect.m

Terminal

File Edit View Terminal Tabs Help

```
bash-3.2$ cat MTconnect.m

%
% This assumes that localhost (127.0.0.1) has been tunneled to
% Corsica. The local end of the tunnel is at port 1609
%
host = 'localhost'
port = 1606

cport = corsicaconnect(host,port)
corsicaparser('rpc chameleon simver="MTconnect"',cport)
corsicaparser('rpc real foobar= 0.0',cport)
corsicaparser('rpc real foobar2= 0.0',cport)
sim('SIMconnect')
corsicaparser('rpc.foobar2',cport)
corsicaparser('return')
exit


bash-3.2$
```

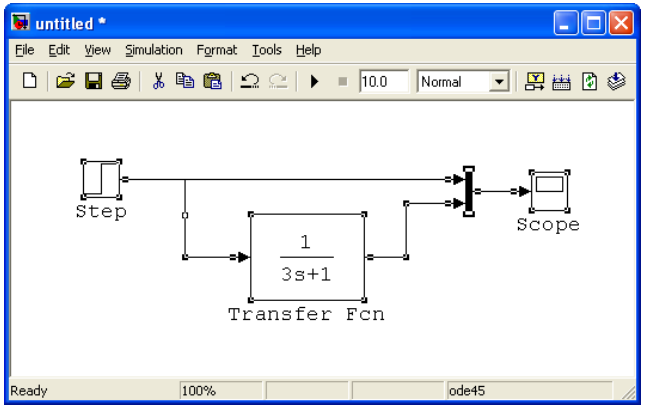
Corsicaconnect & corsicaparser part of corsica checkout

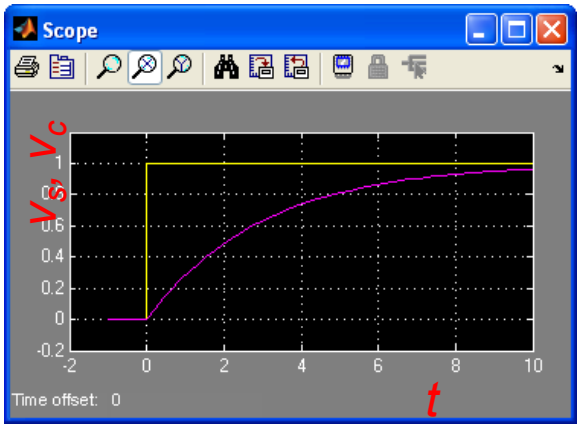
```
read ignorebegin
#
# This port number (1606) is arbitrary. It can be any number
# in the range 1025-65535 as long as long as it's not already
# in use by another application. Ports numbers <=1024 can only
# be used by processes run as the root user. Whatever is used
# it must match what is connected to from Matlab, or if tunneled,
# the local end of the tunnel must end up at this port.
#
#
rpcinit(1606)
read ignoreend
rpcserver

if ( simver <> "MTconnect") then
<< "Wrong Simulink simulation run: " << simver
endif
```

Corsica level_1 test MTconnect

Introduction to Simulink

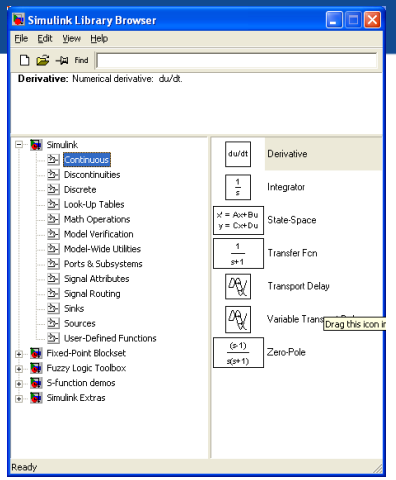
- Simulink is a graphical, “drag and drop” environment for building simple and complex signal and system dynamic simulations.
- It allows users to concentrate on the structure of the problem, rather than having to worry (too much) about a programming language.
- The parameters of each signal and system block is configured by the user (right click on block)
- Signals and systems are simulated over a particular time.



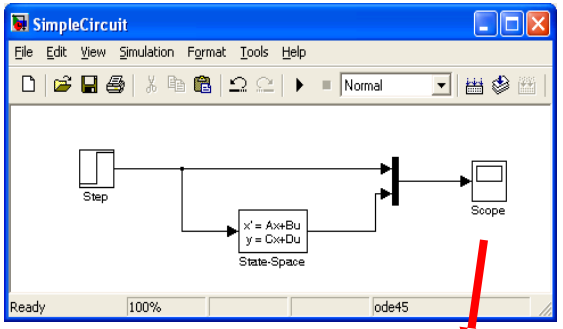


Starting and Running Simulink

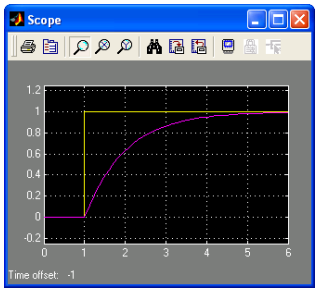
- Type the following at the Matlab command prompt
- >> simulink
- The **Simulink library** should appear



- Click File-New to create a new **workspace**, and drag and drop objects from the library onto the workspace.

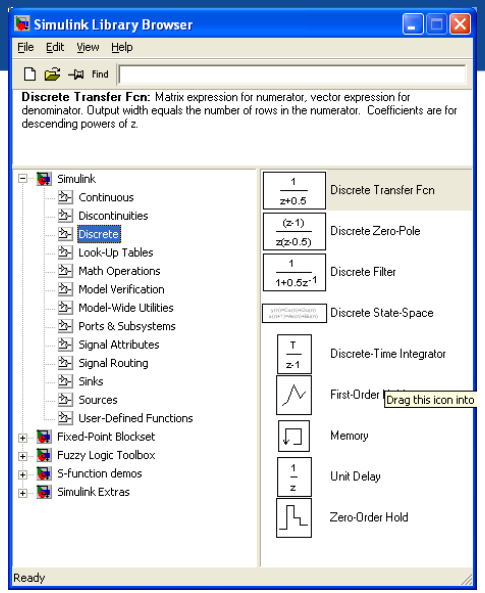


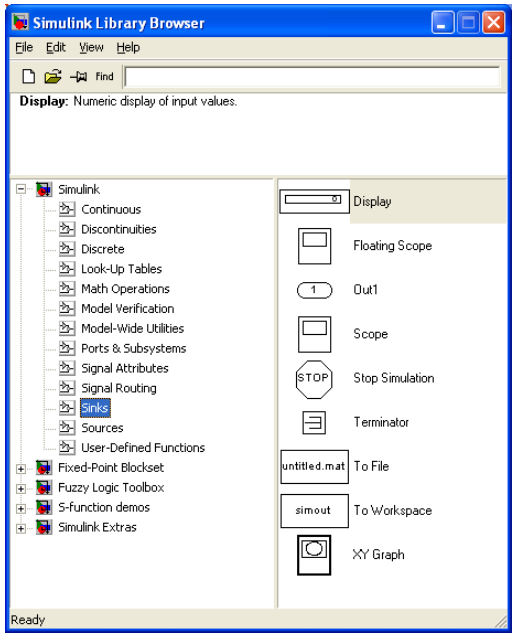
- Selecting **Simulation-Start** from the pull down menu will run the dynamic simulation. Click on the blocks to view the data or alter the run-time parameters

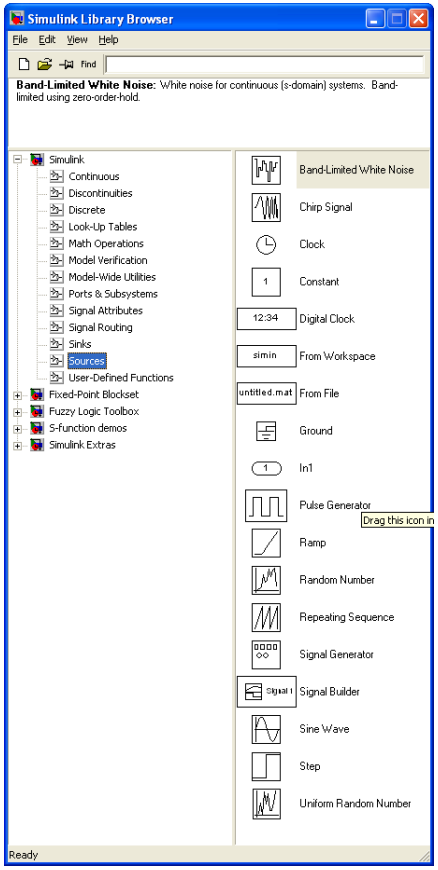


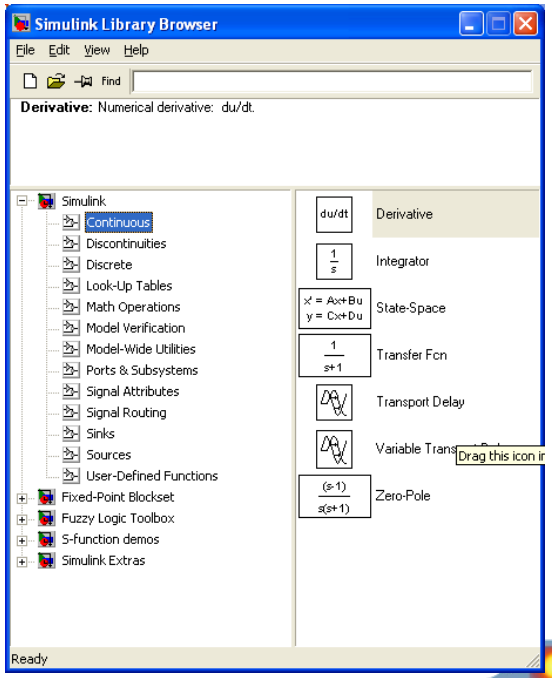
Signals and Systems in Simulink

- Two main sets of libraries for building simple simulations in Simulink:
- **Signals**: Sources and Sinks
- **Systems**: Continuous and Discrete







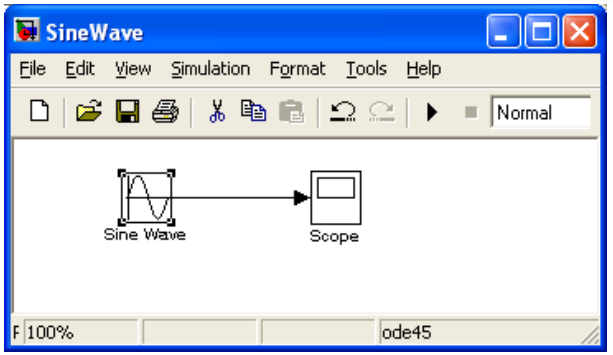


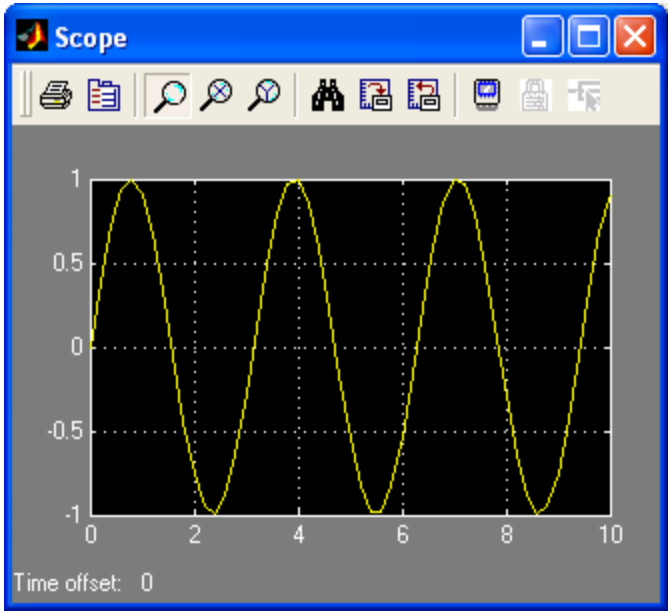
Simulink- libraries

- *Continuous*; integrator, transfer function..
- *Discrete*; discrete transfer function, unite delay, memory..
- *Math operations*; gain, product, sum, trigonometric functions..
- *Sinks*; blocks that have only input, scope, to worspace..
- *Sources*; blocks that have only output, generators, constant,...
- *User defined functions*: S-function, S-function builder,..

Basic Simulink Example

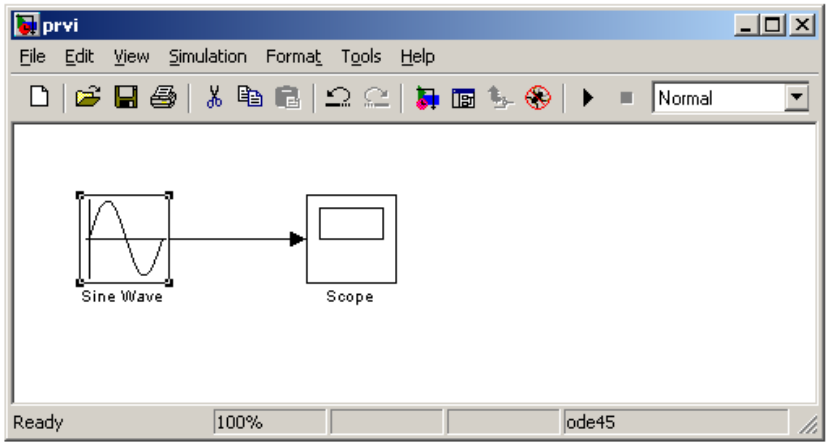
- Copy “sine wave” source and “scope” sink onto a new Simulink work space and connect.
- Set sine wave parameters modify to 2 rad/sec
- Run the simulation:
- Simulation - Start
- Open the scope and leave open while you change parameters (sin or simulation parameters) and re-run
- Many other Simulink demos …

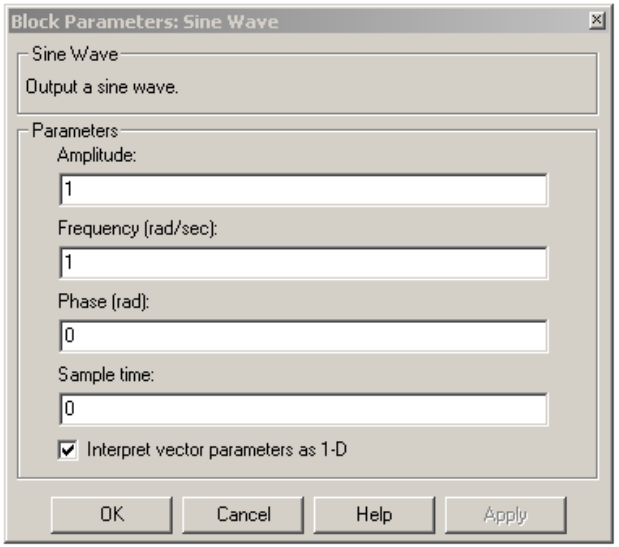




Simulink – creating a model

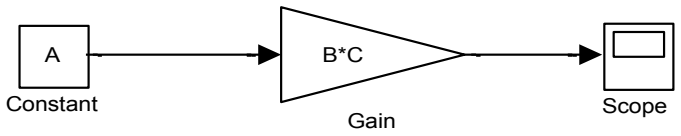
- Model is created by choosing the blocks from different libraries, dragging them to model window and linking them.
- The parameters of block (shown on picture, sine wave parameters), can be reached with double click on the block.





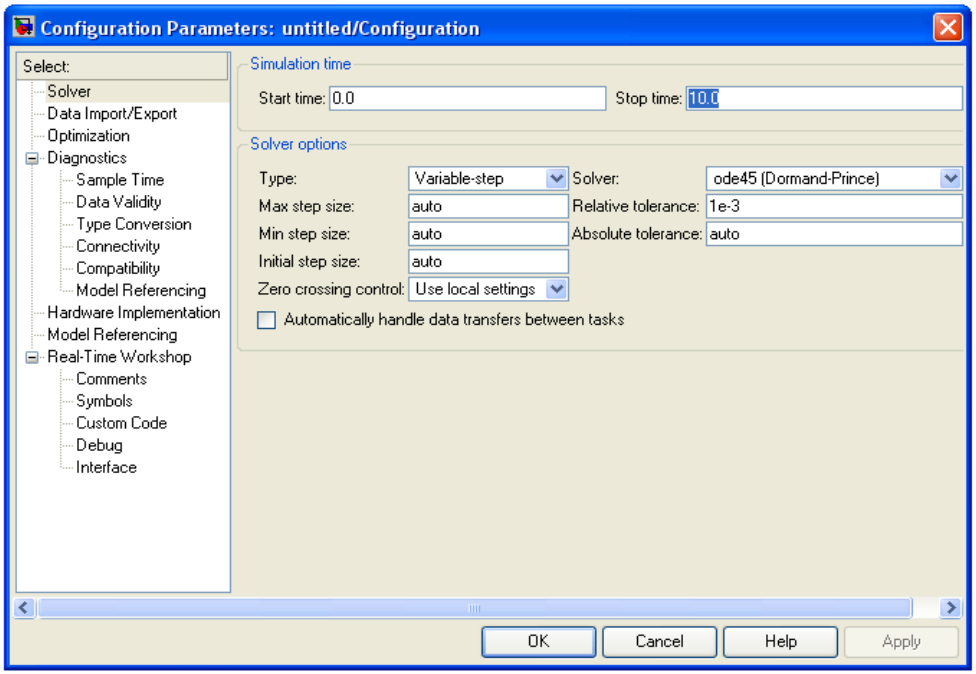
Simulink

- The parameters in the blocks can be variables, that are defined in m-file. M-file must be executed before simulation start, so that variables are defined in Command window, where Simulink can reach them.
- Never give the same name to Simulink model and m-file!
- Example: A, B and C must be defined with values in the Command window.

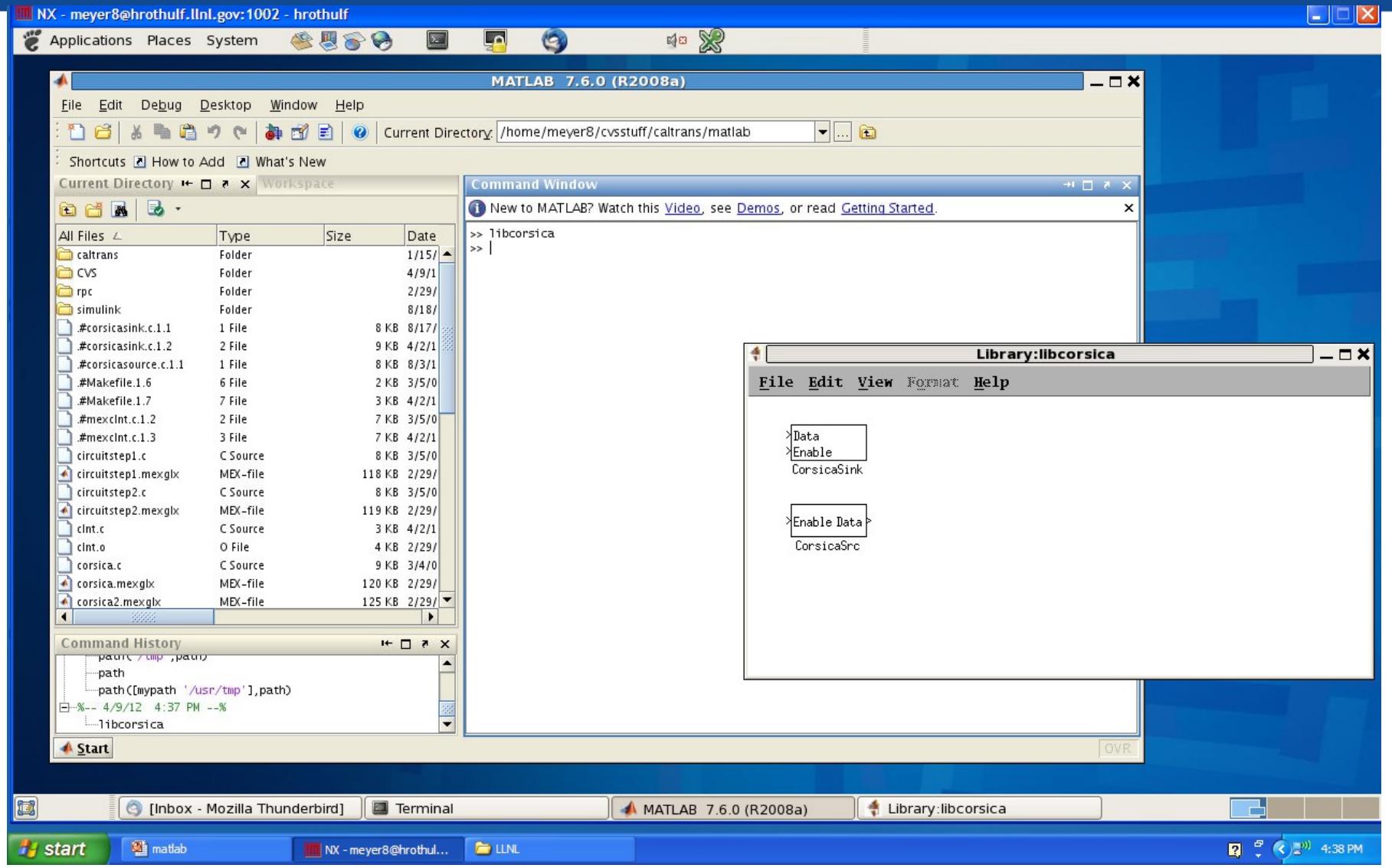


Simulink- configuration parameters

- Numerical solver method, start time, stop time (it can be also set directly)...

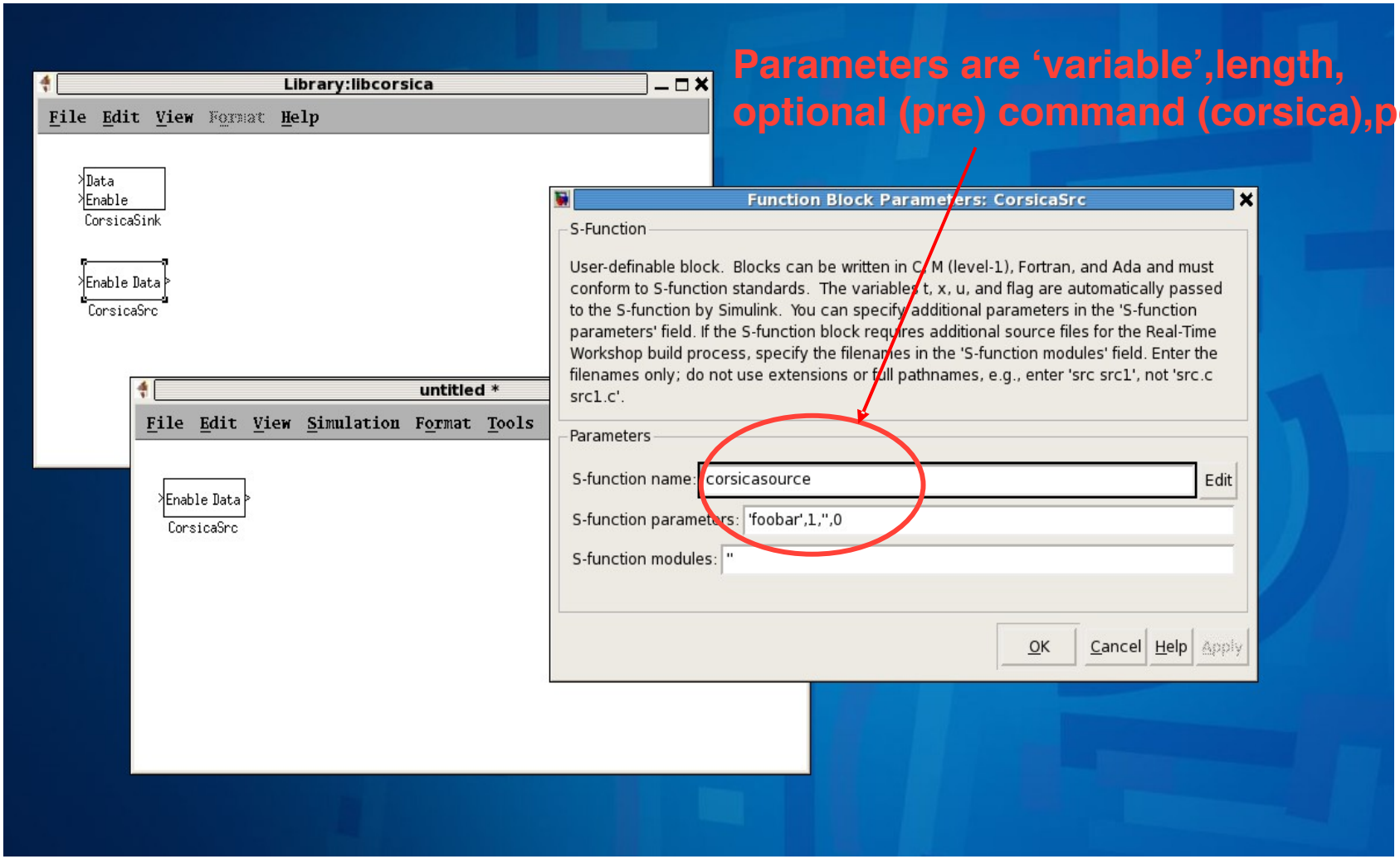


Simulink Library libcorsica.mdl



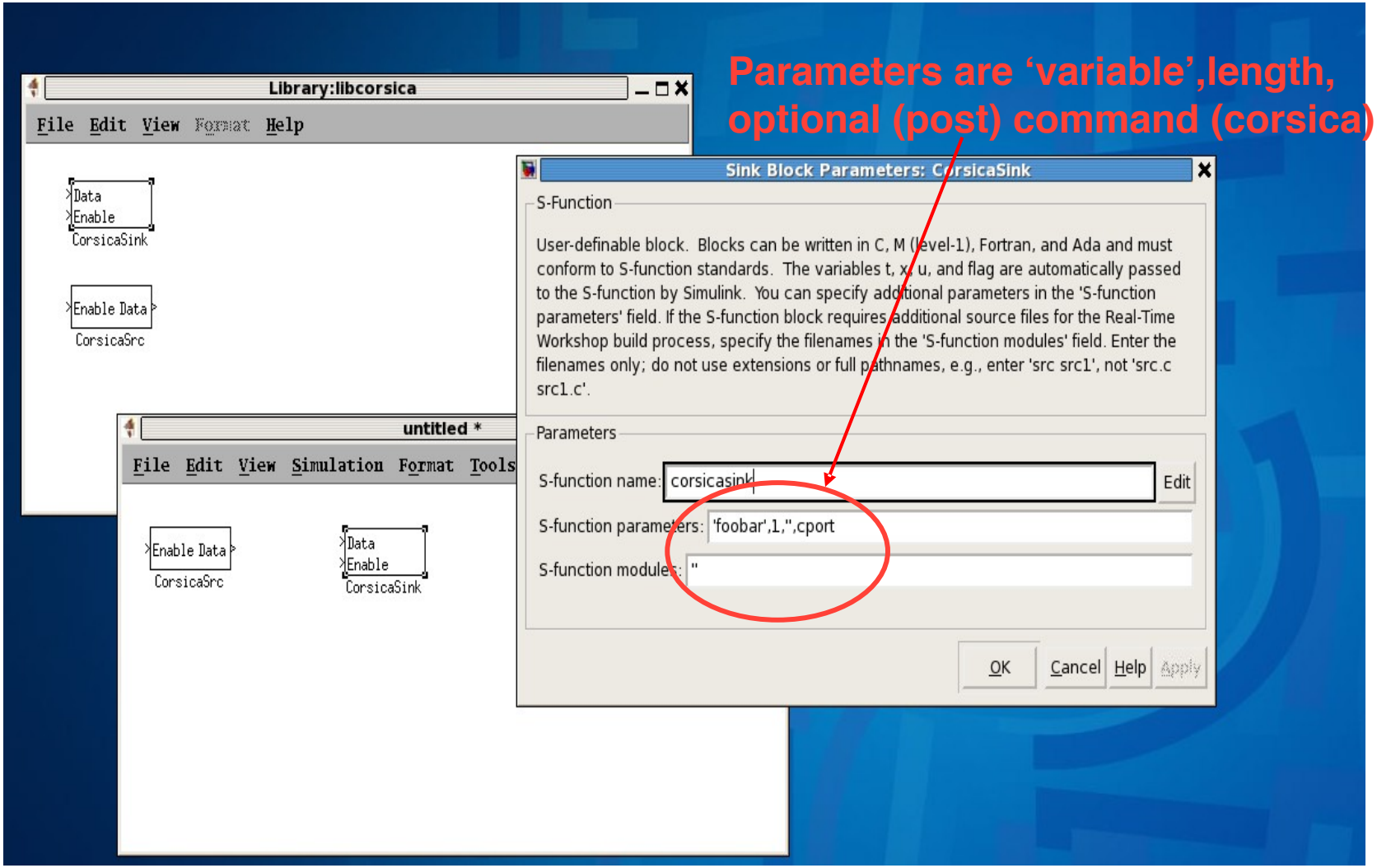
CorsicaSrc S-Function

- Insert data from Corsica into simulation



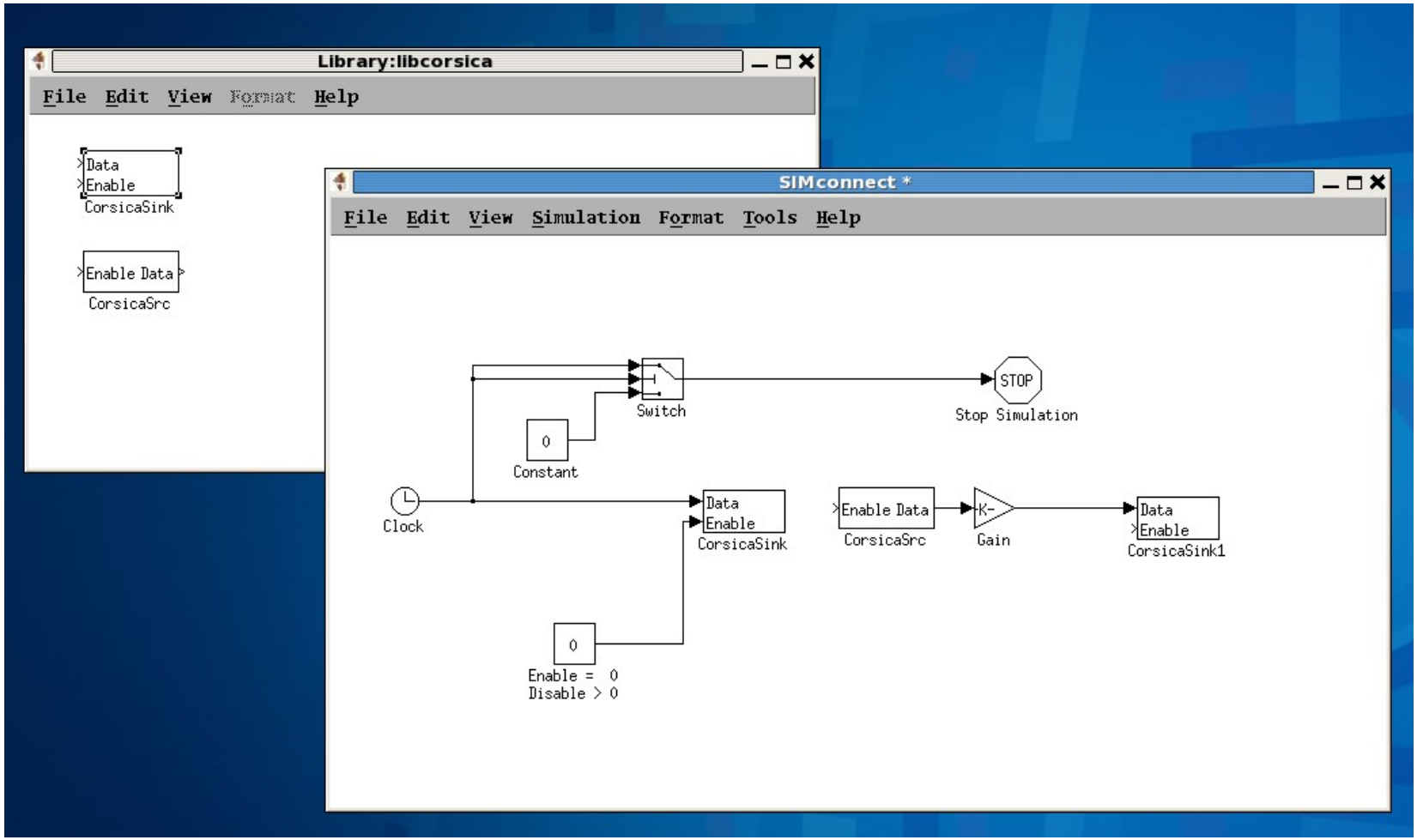
CorsicaSink S-Function

- Send data from simulation into Corsica

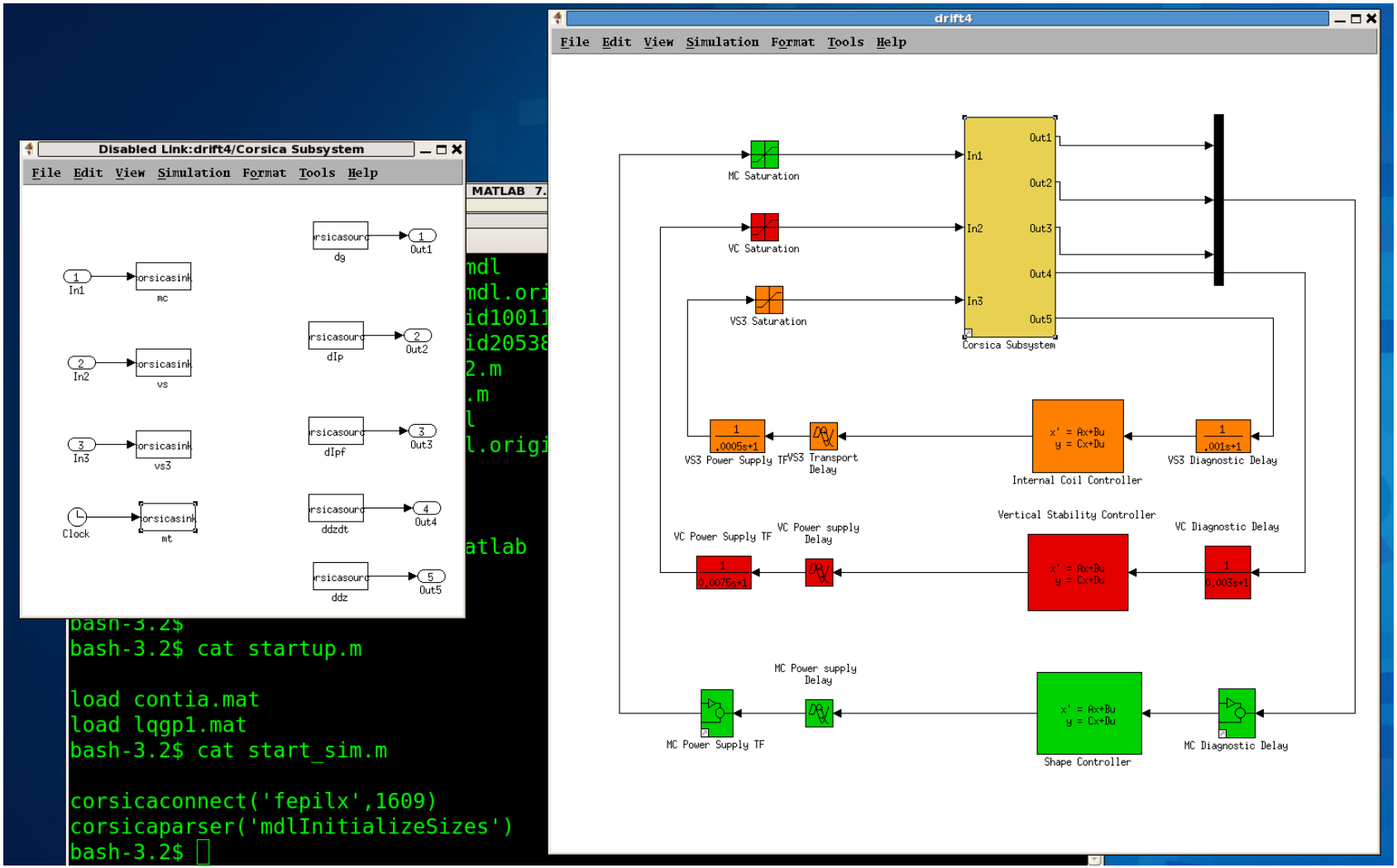


SIMConnect

- Checks communication with Corsica

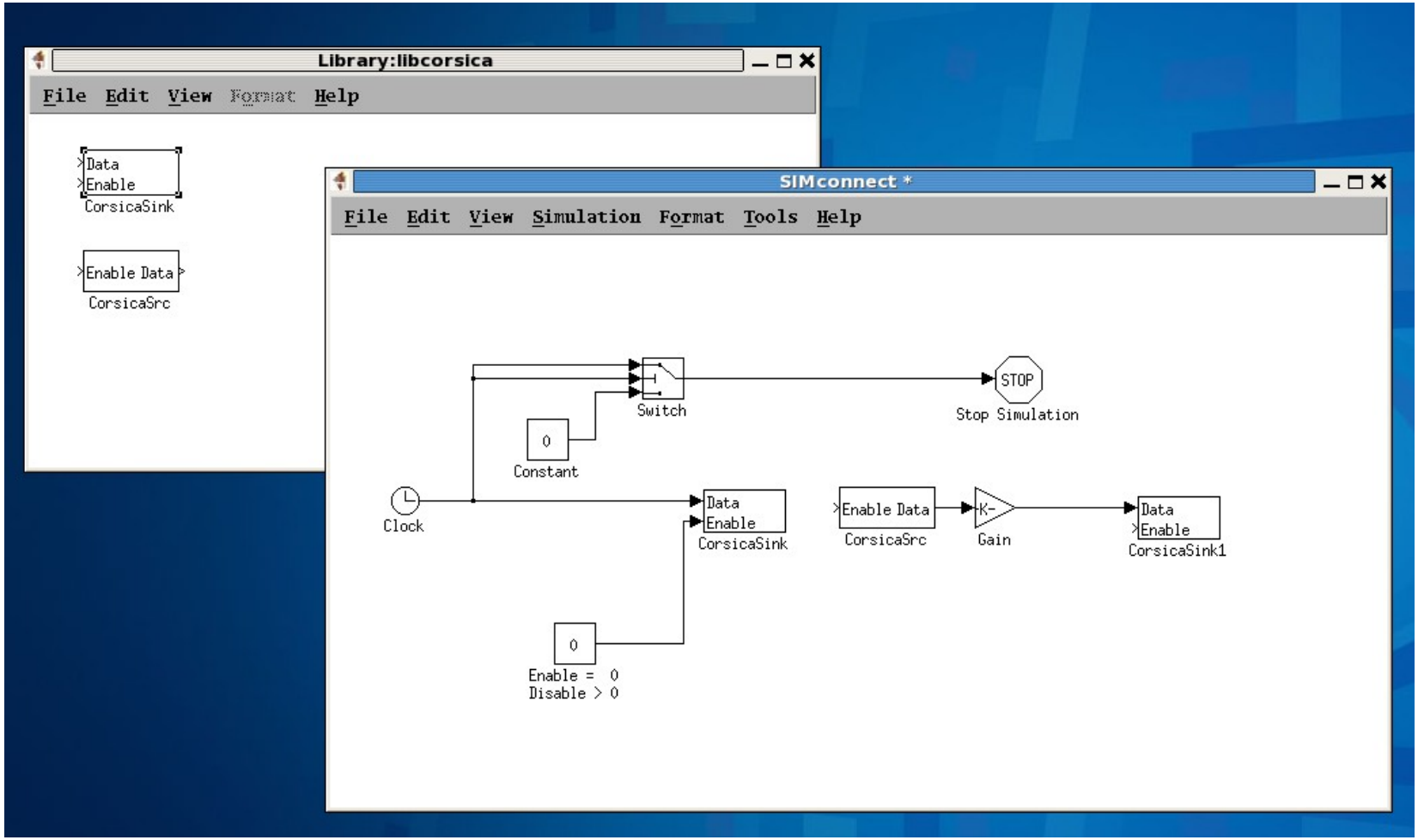


ITER Simulation

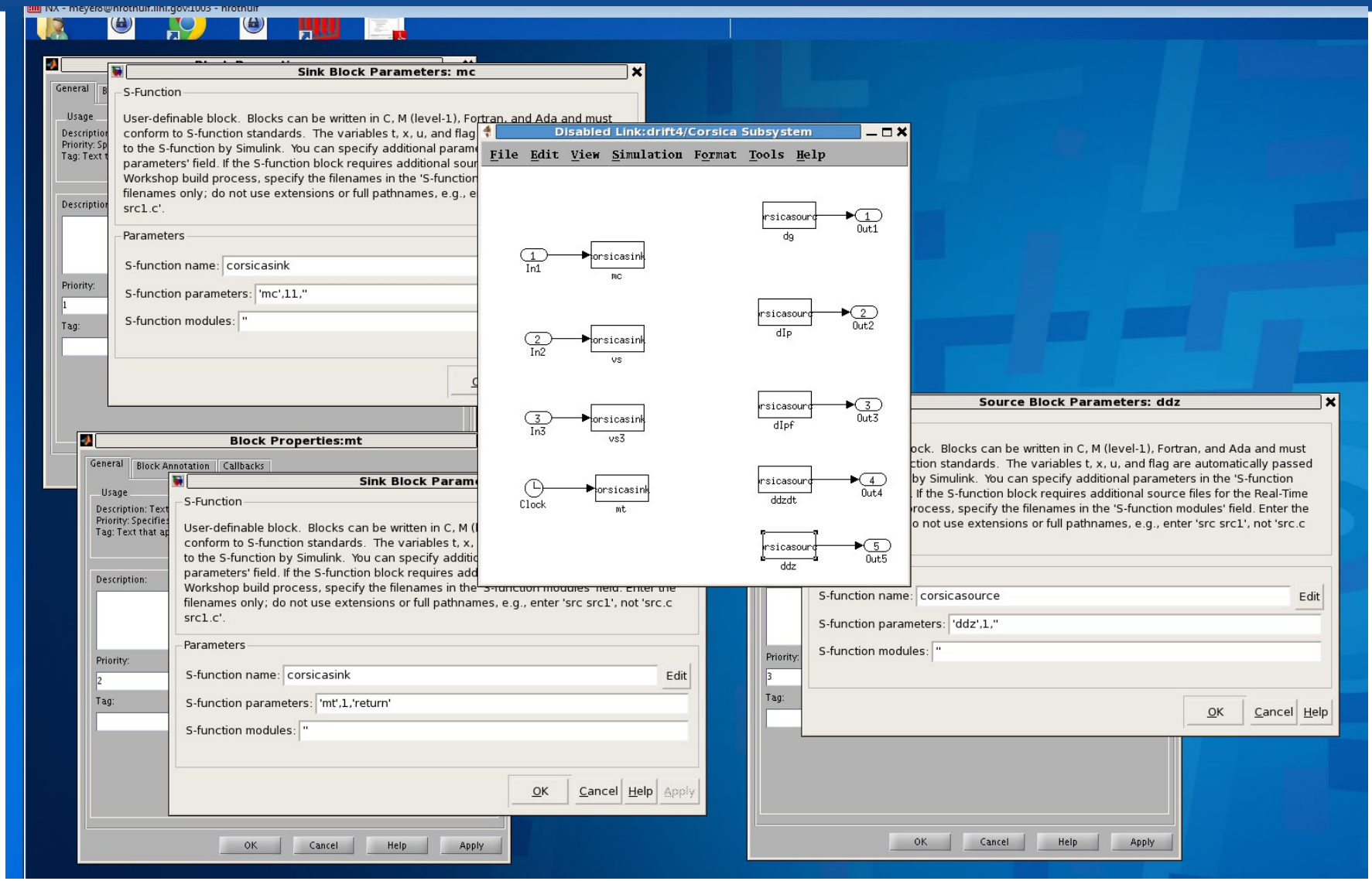


What is the value of CorsicaSink1 input?

- Clock->CorsicaSink(foobar),CorsicaSrc(foobar)->Gain->CosicaSink1(foobar2)
- What if CorsicaSrc->Gain->CorsicaSink1 executes before CorsicaSink



Corsica Subsystem Block Priorities



Matlab/Corsica Timing