Variable time step: Constant improvements for FLUX to Simulink Technology.

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"Coupled for the best " was the title of the article presenting the linking technology between FLUX and SIMULINK. It dates back to September 2002. Say it was just the engagement. One year and a half later, they are getting married!
After the first FLUX to SIMULINK Technology that brought the only co-simulation of its kind, CEDRAT releases the new version of this technology: FLUX to SIMULINK Technology VS (as Variable time Step).

The success of the linking technology and the comments of the users led us to improve it and add new functionnalities.

The engagement

In order to complete a full system analysis, it became possible to join the power of FLUX for electromagnetic transient simulation and SIMULINK for drive and control.
It enabled to analyse full electromagnetic systems including its drive and accounting for saturation, eddy currents, motion... without using an approximate equivalent diagram.
It is used in any application that requires a high level of drive: switched reluctance machines (see figure 1) are one of the most obvious example.
It is also used to model inductances (see FLUX Magazine N°41) transformers or linear actuators.

The wedding

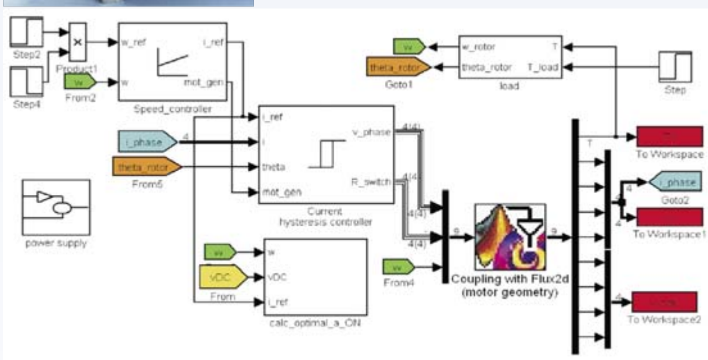
To go forward and answer its customers requests, CEDRAT developed for this version the possibility to include a variable time step. We decided also to make everything possible to speed the simulation up. Our solution? Enable SIMULINK to run several computation while FLUX does only one!

- The dowry

Being able to control the time step easily was the major request we had for this co-simulation technology. Indeed, being able to adapt the time step during the simulation is often a good solution to reduce the computation time without changing the accuracy on the results.
As example, in the following simple case (see figure 2), we study the current in two cables fed with sinusoidal voltage and triangular voltage respectively. As those two cables are close to each other, the current is expected not to be sinusoidal (for the first cable) nor triangular (for the second cable).
The time step depends on the value of the output current. If the current' s magnitude is upper than 50 Amps, the time step is 1 ms; if it is lower, the time step is 0.3 ms. We can then see that the time step varies indeed as we expected (see figure 4): the dots on the line represent every computation instant. They are closer when the current is lower than 50 Amps.

As you may notice in figure 3, the time step is defined in the parameter list. But it can also be defined in the box "FLUX local time step". What is the difference?

Figure 1: SRM and its drive modelled with FLUX to SIMULINK Technology (courtesy of HWV, Belgium).



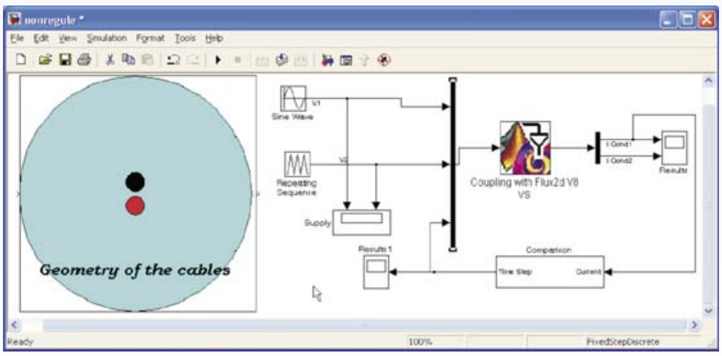


Figure 2: SIMULINK model where the time step is defined as function of the current in one conductor.

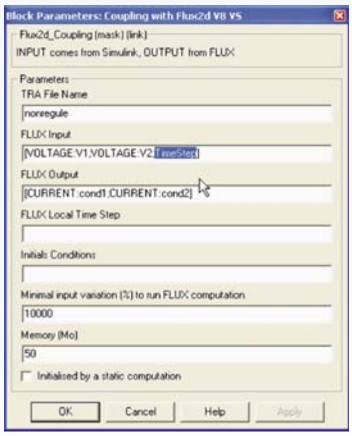


Figure 3: FLUX to SIMULINK block, with the Time Step defined as a parameter.

(continued on page 3)

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This later definition corresponds in fact to the previous version, with a constant value of the time step.

- The wedding ring

The previous FLUX to SIMULINK Technology had one main drawback: for each SIMULINK computation, there were one FLUX computation. And it could lead sometimes to quite long computation.
Controlling the value of the time step will now reduce the computation time. And a new option will also help you to save time: the possibility to run several SIMULINK computation for one FLUX computation. SIMULINK computations are shorter than FLUX's. The principle is then to prevent from doing a FLUX computation if it is not needed.
And how do we define when it is needed? Using this little magic box called "Minimal input variation (%) to run FLUX computation". Say we decide to set this value to 10. Each time the input values are computed, they are compared to the value used for the last FLUX computation. If the difference is lower than 10 %, then no FLUX computation is done. If it is greater, FLUX computes the corresponding time step.
As we may see in figure 5, the value of the current does not vary much for a minimal input variation between 0% (all SIMULINK computation lead to a FLUX computation) and 20%.
This method may reduce dramatically the simulation time, mainly if the system does not vary much during long period of time.

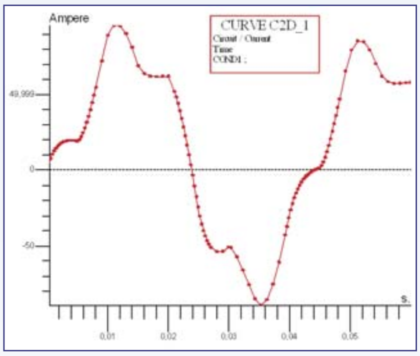

Figure 4: Curve of the current in the sine fed cable. We can see that the time step varies.

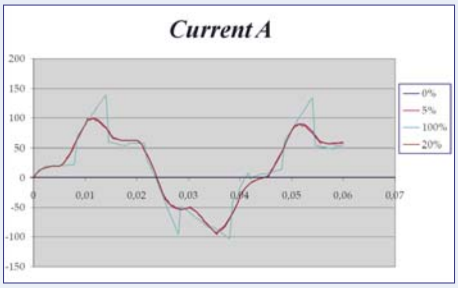

Figure 5: Current in the first conductor for varying value of the minimal input variation.

And more...

By the way, before the ceremony finishes, FLUX to SIMULINK is mainly dedicated to drive and control. So for our cables, with those strange currents, we add a simple PID controller (only proportional actually), and we can smooth the current enough so that it is nearly sinusoidal (see figure 6.)

CEDRAT loves good stories with happy ends...

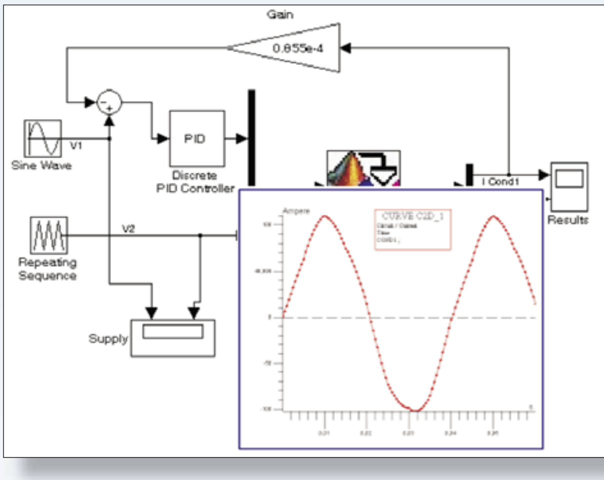

Figure 6 : Control of the output current using PID controller and result.

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