

Model coupling with OpenMI – Introduction, basic concepts and live demonstration

Questions and answers of the Webinar

1. Which models (I mean software, generic models) can I couple via OpenMI?

See www.openmi.org --> OpenMI around the world for a list of OpenMI compliant software.

2. What about the computing times?

Basically, computing time adds up, because of the request and reply mechanism. OpenMI 2.0 provides a loop-driven control mechanism in addition to the pull driven (request-reply) control approach in OpenMI 1.4. Basically, the component (the model) is responsible for the overhead. See Buahin, C.A. and J.S. Horsburgh (2015) for more details on performance issues of coupling with OpenMI 2.0. Iterative coupling takes more time, because time steps are carried out repeatedly.

3. When do I have to apply iterative coupling, and when is external coupling sufficient?

Start with external coupling and analyze the results. We published a technical exercise "On the external and iterative coupling of multiple open channel flow models with OpenMI" (Becker & Talsma 2014) that can give some guidance.

4. Why does OpenMI not support simultaneous coupling?

Simultaneous coupling would mean to create one equation system for multiple models. This requires more than an interface for data exchange of boundary conditions and model results: the equation systems from the two models must be in line with each other. This means less flexibility for the components and will not be possible for legacy code in general.

5. I have a St Venant flow code. How long does it take to make my code OpenMI compliant?

It depends on experience in programming (C#, MSDN Platform Invoke), the structure of the code, and the complexity of the code how much time is needed. Count 3 months as a guess. I (Bernhard) needed for the FEFLOW OpenMI interface (Becker & Schüttrumpf 2010) more than a year, but the challenge was that I did not have the source code. RTC-Tools (Schwanenberg et al. 2015) took me a week to have the first version. I had IlmoFlood (Becker & Schüttrumpf 2010) OpenMI compliant one month after having developed some experience with FEFLOW.

6. Can I add spatial models to OpenMI?

Yes. OpenMI 1.4 requires a representation of time, OpenMI 2.0 does no longer. This was changed in order to support tools and converters. Spatial coordinates can be represented in both OpenMI 1.4 and 2.0.

7. I understand that SOBEK has a module for real-time control included, what is the added value for coupling with OpenMI?

Yes, SOBEK does have an RTC module. It is called D-RTC, and it uses RTC-Tools as computational core (Schwanenberg et al. 2015). So what we have presented in the webinar with OpenMI can also be done within SOBEK. Instead of OpenMI the DeltaShell manages the data exchange. But: not all features of RTC-Tools are accessible in SOBEK. The added value of OpenMI is that you can use additional features of RTC-Tools, for example RTC-Tools expressions. Before we developed D-RTC, we had RTC-Tools and the SOBEK channel flow module coupled via OpenMI. This illustrates another application case of OpenMI: prototyping of integrated modeling software.

8. Can OpenMI coupling schemes be applied in parallel environments over computer clusters?

Yes, but this must be handled within the OpenMI compliant component. For FEFLOW, I developed a FEFLOW controller, which is an OpenMI compliant component that transfers data to and from FEFLOW via remote procedure calls (Becker & Schüttrumpf 2010). With the right transfer protocol the data can be transferred across machines. A possible setting is to let the OpenMI composition and one model run on one machine, and a second model on a second machine. But OpenMI has no features that support parallel operations in particular.

9. Are OpenMI compliant models free or commercial?

This depends on the software provider. Both free and commercial software can be equipped with the Open Modelling Interface.

10. Was the model coupled with other models for modelling the impacts of flooding on critical infrastructures? Can we do that in OpenMI also?

Within the CIPRNet project, the inundation model was not coupled to critical infrastructure via OpenMI, because in the analyzed scenarios flooding and infrastructure are linked unidirectionally only, i.e. the flooding has an impact on the critical infrastructure, but the critical infrastructure does not affect flooding.

11. I have seen that SWAT has been made OpenMI compliant. What about we use the latest version of SWAT?

I cannot answer this question. This is a question to ask the software provider.

12. Is it a must to get the source code? To couple models, do we need to get the source codes? What level of coding knowledge is needed?

If you have two or more models that are OpenMI compliant, and the models offer the right exchange items, it is not necessary to deal with source code in order to run an OpenMI composition. You need the OpenMI configuration editor only.

However, if you need to add input or output exchange items, you need to code them and this means that you must be familiar with the source code of the model.

References

Becker, B.; Talsma, J. (2014): On The External and Iterative Coupling of Multiple Open Channel Flow Models with OpenMI. Presented at the HIC 2014 - 11th International Conference on Hydroinformatics; New York.

Becker, B. P.; Schüttrumpf, H. (2010): An OpenMI module for the groundwater flow simulation programme Feflow. Journal of Hydroinformatics 13 (1), 1–13. DOI 10.2166/hydro.2010.039

Buahin, C. A.; Horsburgh, J. S. (2015): Evaluating the simulation times and mass balance errors of component-based models: An application of OpenMI 2.0 to an urban stormwater system. Environmental Modelling & Software 72, 92–109. DOI 10.1016/j.envsoft.2015.07.003

Schwanenberg, D.; Becker, B. P. J.; Xu, M. (2015): The Open RTC-Tools Software framework for Modeling Real-Time Control in Water Resources Systems. Journal of Hydroinformatics 17 (1), 130–148. DOI 10.2166/hydro.2014.046