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CIPRNet

Critical Infrastructure Preparedness and Resilience Research Network

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D8.213 CIPRNet cooperation meeting OpenMI

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Deltares

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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1 Rationale of the document

In the CIPRNet WP8 called “Dissemination and spreading of excellence”, the second task has the objective to promote and organise cooperation workshops on CIP and CIP MS&A with other partners [DoW].

The OpenMI Association provides OpenMI as a coupling standard for water-related models. The joint cooperation meeting has been held on 31. October 2014 in Delft, the Netherlands within the frame of the Delft software days.

In the following we give an introduction on OpenMI and the OpenMI Association and report on the joint coordination meeting itself.

2 What is OpenMI?

The OpenMI (Open Modelling Interface, see www.openmi.org) Standard is a software component interface definition. It was originally conceived to facilitate the simulation of interacting processes, particularly environmental processes. It did so by enabling independent models of the processes to exchange data as they ran, time step by time step. However, it was quickly realised that OpenMI could be made into a generic solution to the problem of data exchange between any models, not just environmental models, and soon after that not just models but software components. Hence, it could be applied to linking any combination of models, databases and analytical and visualisation tools.

When the standard is implemented, OpenMI compliant components can

- be configured to exchange data during computation (at run-time)
- run simultaneously and share information at each timestep making model integration feasible at the operational level.

Linked components may come from different suppliers, represent data and processes from different domains, be based on different concepts, have different spatial and temporal resolutions and representations (including no temporal or spatial representation).

The standard supports two-way links where involved models mutually depend on calculation results from each other. Linked models may run asynchronously with respect to timesteps, and data represented on different geometries (grids) can be exchanged seamlessly.

The OpenMI standard is defined by a set of software interfaces that a compliant component must implement. Reference implementations for these interfaces are available both in C# and Java, but other implementations can be developed as well.

The OpenMI is distributed by the OpenMI Association. The objectives of the Association are to promote the development, use, management and maintenance of the Open Modelling Interface (the OpenMI), a standard for the runtime exchange of data between software components for environmental management.

The Association seeks to achieve this goal by, among other things:

- Promoting information exchange and discussion among likeminded organisations and individuals
- Sustaining the maintenance and development of the OpenMI Standard and its supporting software
- Facilitating the advancement of integrated modelling by promoting the use of the OpenMI.

3 Joint cooperation meeting CIPRNet and the OpenMI Association

3.1 Organisation

The joint cooperation meeting has been organised as a one-day symposium with presentations from both user groups. In the morning session technical issues and the relation of OpenMI to other model coupling standards, in particular those used for critical infrastructure modelling, were discussed. The afternoon session was dedicated to OpenMI applications.

The symposium has been organised as OpenMI Symposium within the frame of the Delft Software Days and has been hosted by the project partner Deltares.

Table 1: Programme of the OpenMI Symposium

Time	Event
08:30 - 09:00	**Welcome & Registration**
09:00 - 09:15	**Welcome and opening** **Quillon Harpham/Roger Moore (OpenMI Association)**
09:15 - 10:30	**Morning Session OpenMI Symposium - Part 1**
09:15 - 09:30	CIPRNet and OpenMI Erich Rome (Fraunhofer)
09:30 - 10:00	Federated modelling of Critical Infrastructure (DIESIS project) Erich Rome (Fraunhofer)
10:00 - 10:30	OpenMI and other model coupling standards Bert Jagers and Stef Hummel (Deltares)
10:30 - 11:00	**Coffee break**
11:00 - 12:30	**Morning Session OpenMI Symposium - Part 2**
11:00 - 11:25	Standards for critical infrastructure modelling: HLA Wim Huiskamp (TNO)
11:25 - 11:50	Standards for critical infrastructure modelling: i2Sim Antonio Di Pietro (ENEA)
11:50 - 12:30	Discussion: What can we learn from each other? Andreas Burzel (Deltares) and audience
12:30 - 14:00	**Lunch break**
14:00 - 15:30	**Afternoon session OpenMI Symposium - Part 1**
14:00 - 14:15	OpenMI applications and tools 1 Roger Moore/Quillon Harpham (OpenMI Association)
14:15 - 14:40	FluidEarth and OpenMI 2.0 Quillon Harpham (HR Wallingford)
14:40 - 15:05	A selection of water-related applications of OpenMI Bernhard Becker and Geert Prinsen (Deltares)
15:05 - 15:30	An OpenMI composition with channel flow and real-time control modelling for a Dutch polder system Niels de Hulster (Arcadis), Siebe Bosch (Hydroconsult) and Klaas-Jan van Heeringen (Deltares)
15:30 - 16:00	**Coffee break**
16:00 - 16:50	**Afternoon session OpenMI Symposium - part 2**
16:00 - 16:25	Integrated Environmental Modelling applied to the Thames Basin, UK: Linking models using OpenMI to allow multi-scale simulation of groundwater processes Andrew Hughes (British Geological Survey)
16:25 - 16:50	An operational forecasting system for subsurface floods in the city of Cologne Moritz Kreyenschulte (RWTH Aachen), Daniel Bachmann (Deltares)
17:15 - 17:30	**Closure** **OpenMI Association/CIPRNet**
17:30 - 18:30	**Drinks**

3.2 Outcomes of the cooperation meeting

3.2.1 Presentations

Presentations are available online on http://www.dsd-int.nl/symposia/openmi-symposium/.

A newsletter item has been published on the website of the OpenMI Association: http://www.openmi.org/announcements/openmisymposium2014

3.2.2 Conclusions from presentations and the discussions

3.2.2.1 Different backgrounds

Different user groups use different terms for similar things. An example is the term "integrated modelling", which in the OpenMI community is used for conjunctive modelling of different processes with different codes, while in CIPRNet this term denotes modelling different processes in one code. CIPRNet uses "federated modelling" for conjunctive modelling of different processes with different codes. This term is not used in OpenMI, although OpenMI supports federated modelling as coupling standard.

3.2.2.2 Availability

Pros and cons of open source have been discussed. For the water domain it has been very important to have a freely available coupling standard to bridge gaps between institutions. For CIPRNet this issue appeared to be less relevant. The HLA standard is one example for a non-open source standard which is a commercial product.

3.2.2.3 End user training

Applying coupled modelling is not yet a standard task. End-user training is very important. Within CIPRNet this is addressed also for OpenMI.

3.2.2.4 Applications

The DIESIS simulator (see http://www.diesis-project.eu/) integrates three infrastructure models and an inundation model which represents a thread to the critical infrastructure. A coupling in one direction is sufficient for integrating the inundation model, because the critical infrastructure does not feed back on the inundation. Integration of inundation could also be realised by boundary conditions. The infrastructure components are coupled in two directions because of the interaction.

The i2Sim models (see http://www.i2sim.ca/) dependencies between infrastructures.

Water-related applications with OpenMI focus on physics. The relation to critical infrastructure is given by the fact that most modelling studies that have been presented are driven by flood modelling or operational flood forecasting.

Iterations per time step are not necessary in many cases for accuracy.

3.2.2.5 Other coupling standards

A lot of coupling methods are available to couple models, all have been developed from different backgrounds.

Different applications, for example human behaviour (decision making), infrastructure (traffic, including failure) and physics (water flow, electricity) require different coupling methods. OpenMI is designed for modelling physical processes and most applications focus on physical processes. HLA (see http://www.pitch.se/hlatutorial) is both used for modelling human behaviour (military) and physics (DIESIS project).

3.3 Conclusions

There are many different standards for model coupling available all over the world. Participants agree on the fact that different purposes require different approaches and that it will be not feasible to have one standard that satisfies all requirements. This conclusion is supported by the different cases that were presented during the symposium.

Many show cases from different backgrounds have been presented on the symposium, and the questions that were posed have shown that people are willing to learn from each other. Discussions during the breaks were inspiring and brought people to new ideas. Although different terms are used in different communities, people were able to discuss on a scientific level and understood each other. Model coupling is not trivial. It needs specialists to develop coupled systems, and end-user training with the coupled systems is a very important issue.

A valuable outcome of the OpenMI cooperation workshop also was the informal exchange between the OpenMI chairs and the CIPRNet coordinator. The OpenMI association has successfully managed to sustain its operation for much more than ten years. The knowledge of this best practice example could help CIPRNet in its plans to sustain the operation of its Virtual Centre of Competence and Expertise in CIP. A benefit for OpenMI was CIPRNet's in-depth presentation of the coupled cross-sector simulations that are being employed for research and applications in Critical Infrastructure Protection.

3.4 Participants

Table 2: Registrations to the OpenMI Symposium

No.	First name	Family name	Affiliation	Country
1	Nuryazmeen Farhan	Haron	Universiti Teknologi MARA,Selangor, Malaysia	Malaysia
2	Marco	Tesei	Università Campus Bio-Medico di Roma	Italy
3	Erich	Rome	Fraunhofer IAIS	Germany
4	Son	Truong	Delft University of Technology	Netherlands
5	Tarasinta	Perwitasari	Deltares	Netherlands
6	Aleksandr	Diachenko	Institute for Water and Environmental Problems of SB RAS (IWEP SB RAS)	Russia
7	Andreas	Burzel	Deltares	Netherlands
8	Jianfeng	Tao	Hohai University	China
9	Stef	Hummel	Deltares	Netherlands
10	Bert	Jagers	Deltares	Netherlands
11	Quillon	Harpham	HR Wallingford	UK
12	Darell	Meertins	Darellsoffice BV	Netherlands
13	Werner	Kramer	VORtech BV	Netherlands
14	Bernhard	Becker	Deltares	Netherlands
15	Johanna N.P.	Huang	Delft University of Technology	Netherlands
16	Hassan	Mashriqui	National Weather Service (NOAA-NWS)	USA
17	Geert	Prinsen	Deltares	Netherlands
18	Elena	Lazovik	TNO	Netherlands
19	Bulut	Akkol	Deltares	Netherlands
20	Abhishek	Saha	National University of Singapore (NUS)	Singapore
21	Daniel	Bachmann	Deltares	Netherlands
22	Roger	Moore	British Geological Survey (BGS)	UK
23	Wim	Huiskamp	TNO	Netherlands
24	Antonio	Di Pietro	ENEA	Italy
25	Niels de	Hulster	ARCADIS	Netherlands
26	Siebe	Bosch	Siebe Bosch Hydroconsult	Netherlands
27	Klaas-Jan	van Heeringen	Deltares	Netherlands
28	Andrew	Hughes	British Geological Survey (BGS)	UK
29	Moritz	Kreyenschulte	RWTH Aachen University	Germany
30	Pieter	Haaring	Rijkswaterstaat	Netherlands

Figure 1: **Photo from the OpenMI Symposium (not all participants are on the photo)**