OPENMODELICA WORKSHOP, 06.02.2016

Industrial Applications of OpenModelica

Challenges and Pitfalls

Industrial Automation Power Generation, ABB AG

Agenda

Use cases of Modelica

Importance of Standards

Example: ABB OPTIMAX PowerFit

Challenges and Pitfalls with OpenModelica

Use cases of Modelica and usability of OpenModelica

Major use case: Engineering Design Simulation

Engineering Design Simulation (-)

- Ambitious expert users
- Hard: cf. License cost for best in class tool vs. Engineering cost for additional hours spent with OpenModelica

Education (+)

- Don’t require all Modelica features
- Licensing enables flexible use, e.g. in class rooms, on campuses, …
- Openness is advantageous for deep investigations

Generate controller code for advanced model-based applications (++)

- Openness, including also development process and testing, improve code quality
- Licensing enables flexible use, e.g. installation on customer machines
- Can customize yourself to industrial needs (e.g. C++ runtime)

Industrial applications: Mitigate risks with standards

Modelica and FMI

Traditional approach

- Each tool defines its own proprietary interfaces and formats
- Possible problems show up late
- Tool changes or even upgrades become very expensive

Exploitation of standards

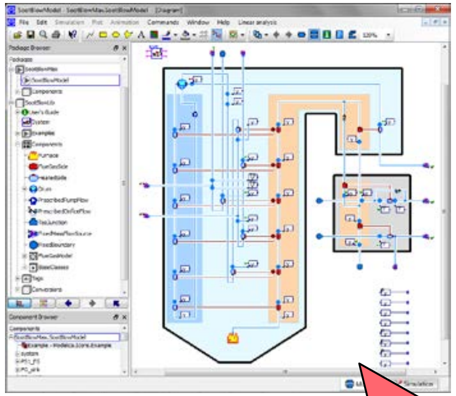
- Modelica saves investments into model development
- FMI saves investments into runtime software development

Low barrier for start using a new Modelica tool, like OpenModelica

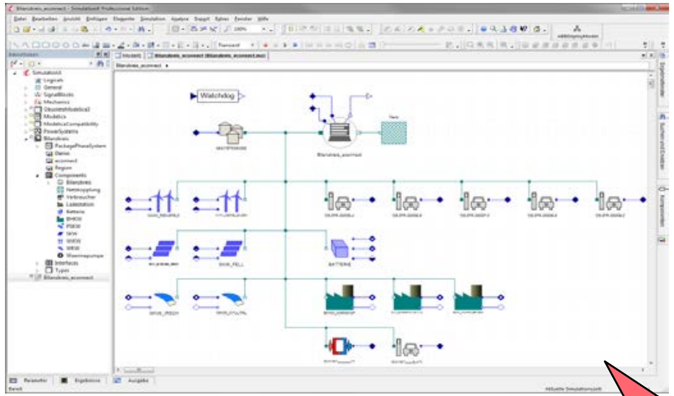
ABB Dynamic Optimization – standardized model-based applications

Basis for several OPTIMAX application, e.g. SootBlowMax and PowerFit

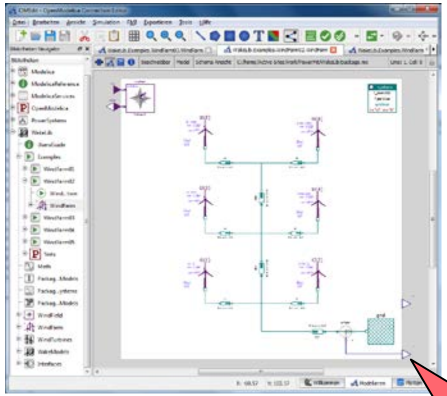
Modelica for application engineering (www.modelica.org)



SootBlowMax



PowerFit



WakeMax

FMI (Functional Model Interface) for deployment (www.fmi-standard.org)

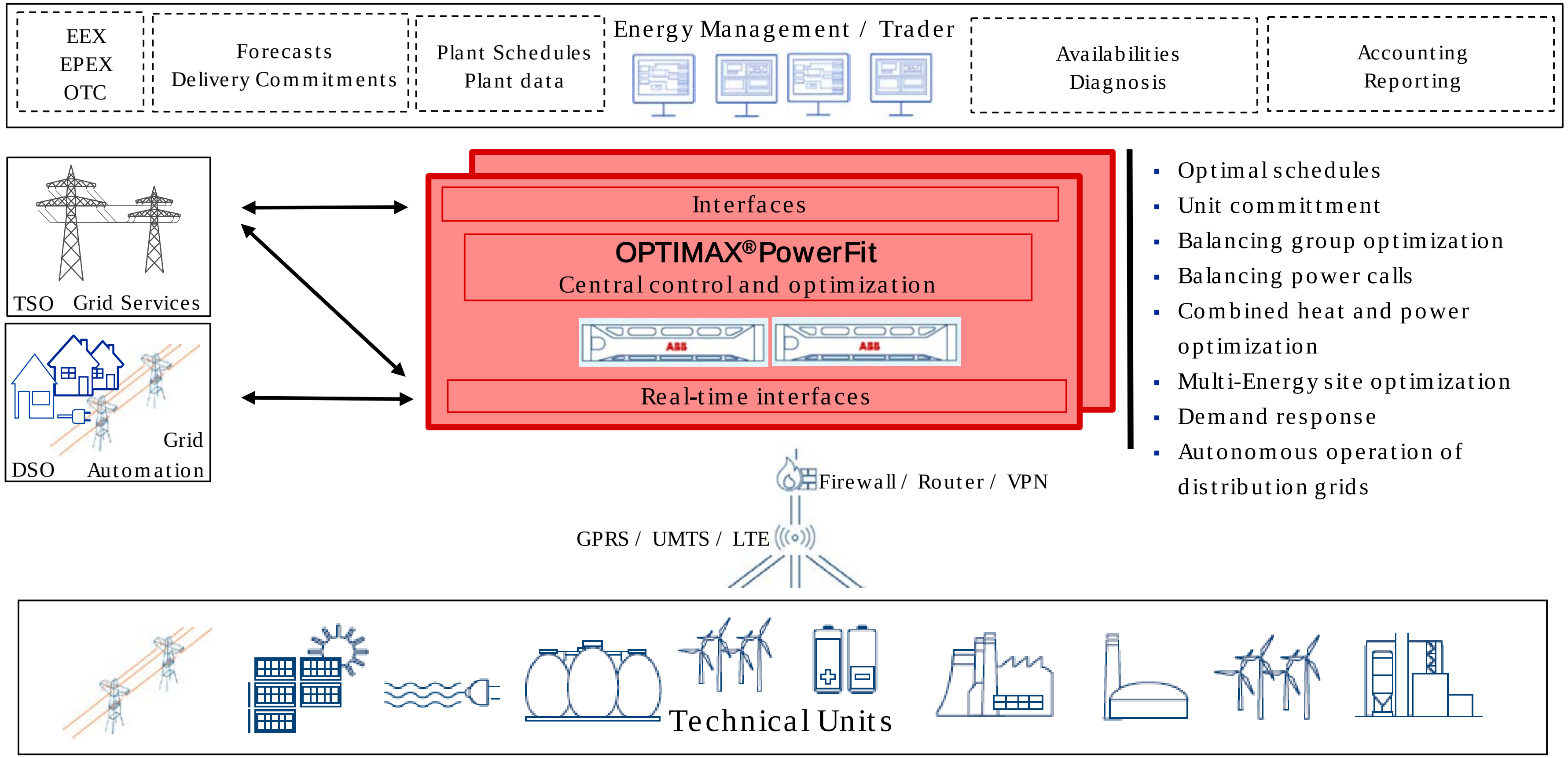
Embedded

Server

Cloud

ABB OPTIMAX PowerFit

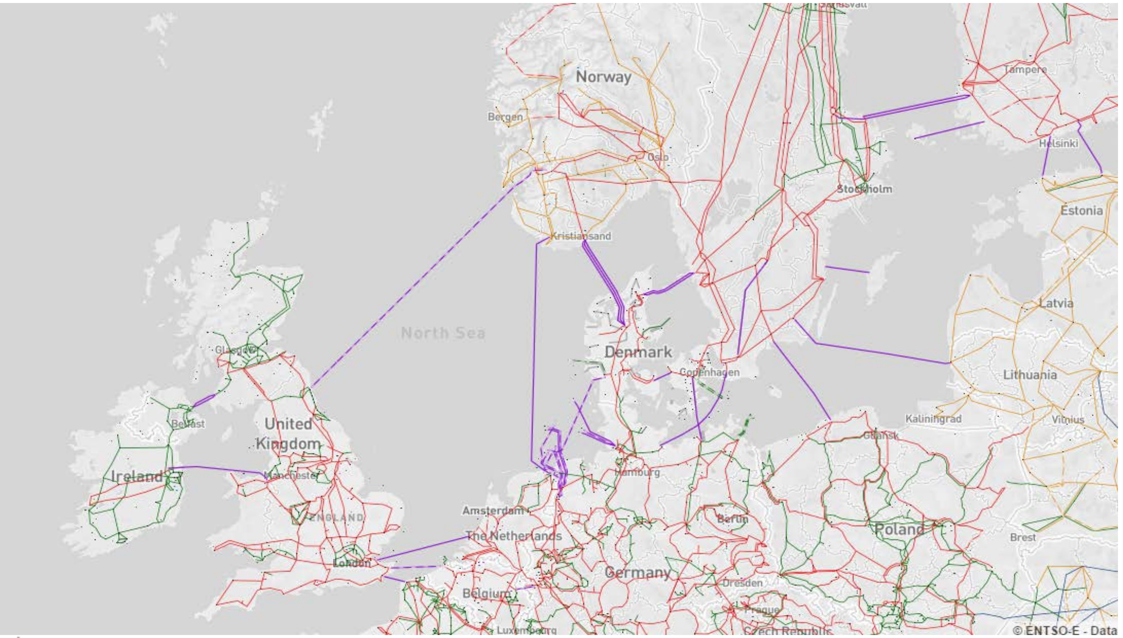
General System Architecture

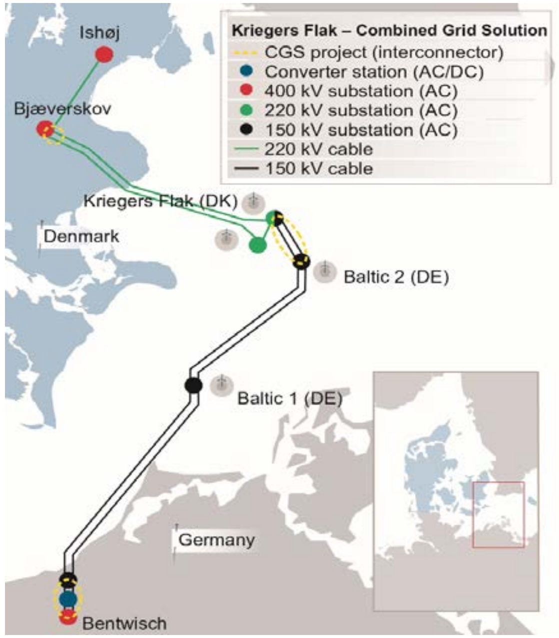


- Optimal schedules
- Unit committment
- Balancing group optimization
- Balancing power calls
- Combined heat and power optimization
- Multi-Energy site optimization
- Demand response
- Autonomous operation of distribution grids

Combined Grid Solution

New 400 MW interconnector utilizing existing or to be build offshore wind power collector grids





Implementation of a Master controller for Interconnector Operation

Summary

Highlights

- Designed and implemented by ABB
- Based on ABB OPTIMAX PowerFit
- Optimal power flow calculation using KF grid model with state estimation
- Geo-redundant servers
- IEC 60870-5-104 communication

Use of OpenModelica

Challenges and Pitfalls

Challenges

- Push advanced model-based control applications by making them accessible in a graphical tool
- Good: OpenModelica becomes increasingly applicable (features, speed, crashes, localization)
- Good: OpenModelica license permits widespread use
- Good: OpenModelica permits own contribution to push limits in cutting edge applications
- Missing: encryption of libraries

Pitfalls

- OpenModelica often appears as “do it yourself” tool for industrial applications
  - C runtime for academic use vs. C++ runtime for industrial use vs. embedded C runtime for R&D
  - Incomplete implementation of Modelica standard, e.g. synchronous features, inline integration, …
- Implementation of OpenModelica appears inefficient
  - See effort required to provide a new feature, like 64bit or replaceable models

Sources for inefficiency of MetaModelica

String conversion – good languages have a common convention; what about MetaModelica?

Modelica

`String()`

C++

`to_string()`

Julia

`string()`

MetaModelica (some examples)

- `intString()` – Integer: shortened type + String
- `ExpressionDumpTpl.dumpExp` – Exp: dump + type name
- `DAEDump.dumpOperatorString` – Operator: dump + type name + String
- `DAEDump.dumpExtDeclStr` – ExternalDecl: dump + shortened type name + Str
- `DAEDump.derivativeCondStr` – DerivativeCond: type name + Str
- …

Sources for inefficiency of MetaModelica

Array access – good languages use array access operator; what about MetaModelica?

Modelica

```
arr[index]
```

C/ C++

```
arr[index]
```

Julia

```
arr[index]
```

MetaModelica

```
Dangerous.arrayGetNoBoundsChecking(arr, Integer(index))
```

Sources for inefficiency of MetaModelica

Function signatures – means to distinguish function inputs from outputs; about MetaModelica?

Modelica

```
input arg
output ret
```

C/ C++

```
f(const reference)
```

Julia

```
f!(reference)
```

MetaModelica

```
protected function addSimVar
  input SimCodeVar.SimVar simVar;
  input SimVarsIndex index;
  input array<list<SimCodeVar.SimVar>> simVars;//input for output!?
algorithm
  Dangerous.arrayUpdateNoBoundsChecking(simVars, Integer(index),
    simVar::Dangerous.arrayGetNoBoundsChecking(simVars,
      Integer(index)));
  // simVars[index] := simVar :: simVars[index];
end addSimVar;
```

Conclusions

OpenModelica can not yet compete in the field of engineering design simulations

- Increasingly applicable in special cases though

OpenModelica is very attractive generation of controller code for advanced applications

- Openness, including also development process and testing, improve code quality
- Can customize yourself to industrial needs (e.g. C++ runtime)

Unsolved: need of industrial users to largely “do it yourself”

- C runtime vs. C++ runtime vs. embedded C runtime
- Increase dev productivity – better exploit software technologies developed after 1989 (C89)?
- First work on Modelica and FMI standards, proprietary additions with second prio

ABB