Reference architecture for wind power forecasting systems

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EWEA Technology Workshop:
Wind Power Forecasting

3 & 4 December 2013, Rotterdam
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Research project EWeLiNE

Introduction reference architectures

Wind power forecasting reference architecture
EWeLiNE

– Cooperation of
  • IWES
  • DWD
  • TenneT
  • Amprion
  • 50 Hertz Transmission
EWeLiNE

– Key research areas

• Integration of new types of data (power production) into meteorological prediction system

• Optimization of the model system towards energy applications

• Development of forecast products in close communication with the users
Improvement of energy applications (e.g. forecast applications)
Reference architecture

– Template solution for software architectures for a particular domain
– High level of abstraction
Reference architecture importance

– Early and important design decisions
– Proven solution
– Transferable abstraction of a system
– Communication among stakeholders
Reference architecture development

Software-systems and software-architectures

Principles

Concepts

extraction of knowledge

Reference architecture

Specific requirements

apply reference architecture

Software-architecture and software-system (based on ref.-arch.)

Following: [Appel2012], [Reuss2009]
Reference architecture

Reference model

Architectural pattern

Reference architecture

software-architecture

>: More design elements

[Bass200]
Reference model

– Model chain
  • Key concept
  • Focused on core forecasting systems

Example:

NWP
Measured Power

Windfarm forecasts

Upscaling

MOS
Architectural pattern

– Pipes and Filters
  • Processing data streams
  • Chain of processing elements
  • Each processing step is encapsulated in a filter
  • Data is passed through pipes
  • Datasource, pipe, filter, data sink

see: [Busch1969], [Hohpe2011]
Mapping of reference modell and architectural pattern

- Model chain and pipes and filters
  - Process a stream of data
  - Flexibility (reorder, exchange)
  - Non-adjacent steps do not share information
Apply reference architecture

- Software architecture (based on ref. arch.)
  - Simple stand alone forecasting system
  - Added design pattern: DAO, DTO

Data-Source

NWP-DAO

Measured Power-DAO

DTO

Windfarm Forecasts Filter

DTO

Upscaling Filter

DTO

MOS Filter
Thank you

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Appendix
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http://projekt-eweline.de

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EWeLiNE

„Erstellung innovativer Wetter- und Leistungsprognosemodelle für die Netzintegration wetterabhängiger Energieträger”
IFP (Forecasting discussion forum)
– plattform for industry and applied science
– meets twice a year
– open to the public
Reference model and model chain

– Giebel, G.; a.o.
“State-of-the-Art on Methods and Software Tools for Short-Term Prediction of Wind Energy Production”

– Monteiro, C.; a.o.
"Wind Power Forecasting: State-of-the-Art 2009"

– Giebel; a.o.
“The State of the Art in Short-Term Prediction of Wind Power”
Definitions

Reference model
„A reference model is a division of functionality together with data flow between the pieces.” [Bass2006]
Definitions

Reference architecture

„A reference architecture is a reference model mapped onto software elements (that cooperatively implement the functionality defined in the reference model) and the data flows between them.”  
[Bass2006]
Definitions

Architectural pattern

„An architectural pattern is a description of element and relation types together with a set of constraints on how they may be used.” [Bass2006]
Literature

[Bass2006] Bass, Len; Clements, Paul; Kazman, Rick
„Software architecture in practice“

[Reuss2009] Reussner, Ralf; Hasselbring, Wilhelm
„Handbuch der Software-Architektur“
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„IT-Architekturentwicklung im Smart Grid “

[Clem2009]  
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“Documenting software architectures. Views and beyond”
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[Busch1996]
Buschmann, Frank
„Pattern-oriented software architecture“ Vol. 1
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[Hohpe2011]
Hohpe, Gregor; Woolf, Bobby; Brown, Kyle “Enterprise integration patterns”