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FLOREON+ and HPC as a service

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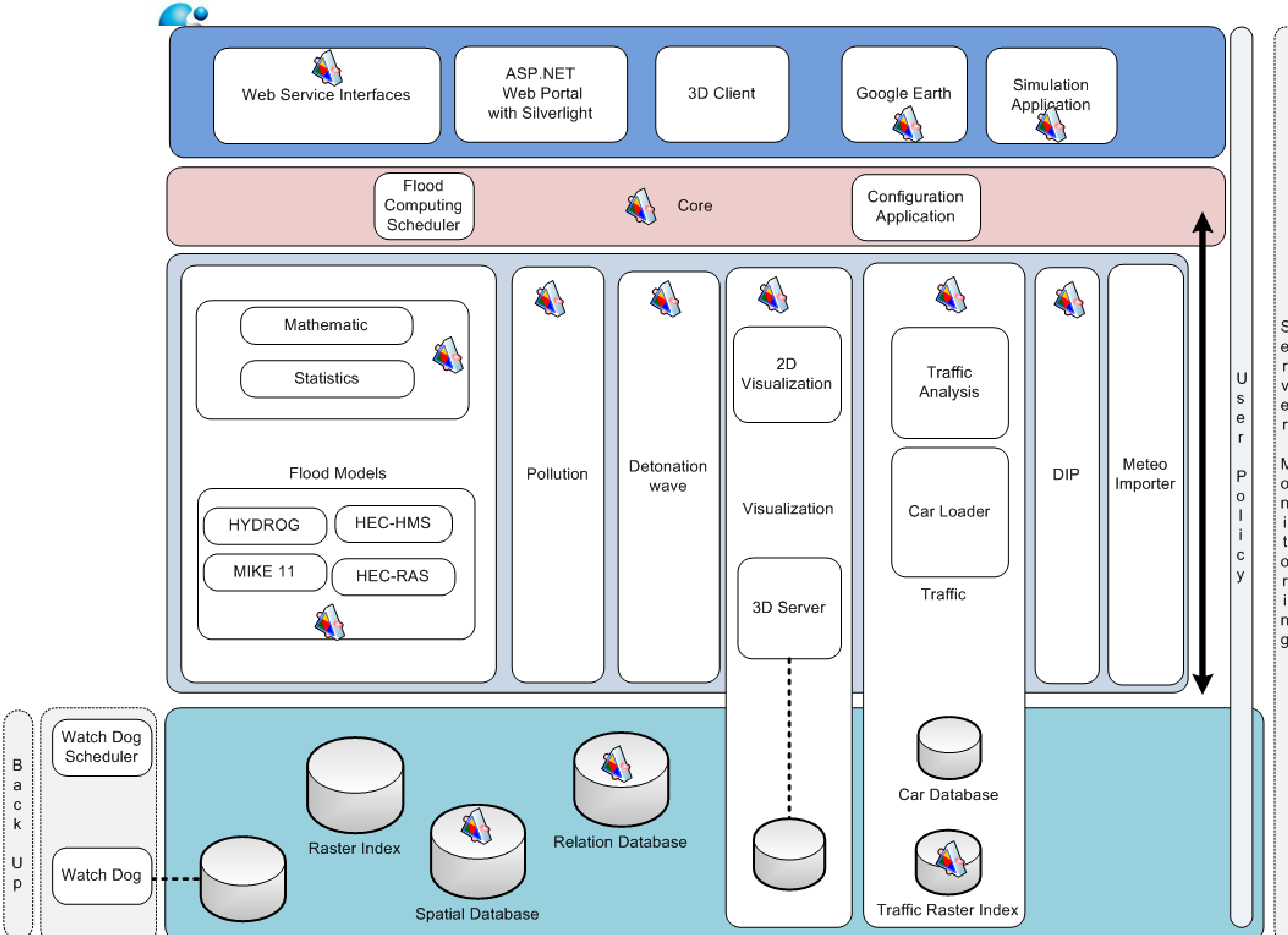
Outline

- FLOREON+
- HPC as a Service
- Rainfall-Runoff Model Verification and Uncertainty Modelling

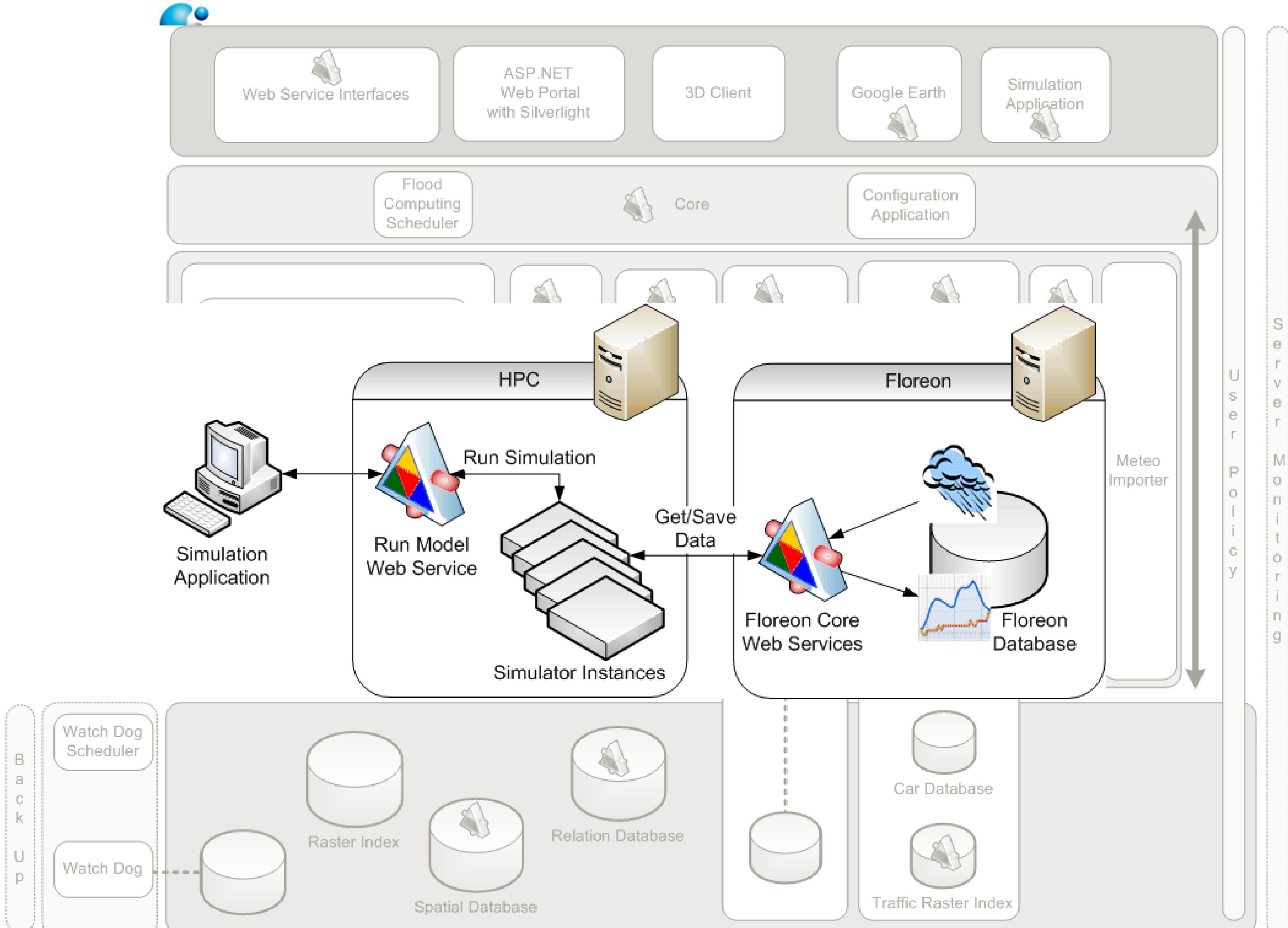
FLOREON+ System

- FLOods REcognition On the Net
- Modular web-based system for environmental risks modelling and simulation in the Moravian-Silesian region, Czech Republic
  - Flood risk
  - Transportation risk
  - Water and air pollution risk
- Results should simplify the process of disaster management and increase its operability and effectiveness


Web Service Interfaces
ASP.NET
Web Portal
with Silverlight
3D Client
Google Earth
Simulation
Application
Flood
Computing
Scheduler
Core
Configuration
Application
Mathematic
Statistics
Flood Models
HYDROG
HEC-HMS
MIKE 11
HEC-RAS
Pollution
Detonation
wave
2D
Visualization
Visualization
3D Server
Traffic
Analysis
Car Loader
Traffic
DIP
Meteo
Importer
User Policy
Server Monitoring
Back Up
Watch Dog
Scheduler
Watch Dog
Raster Index
Spatial Database
Relation Database
Car Database
Traffic Raster Index

Simulations in Hydrology and HPC environment

- HPC parallel environment can be used for running many simulations concurrently or very large simulations on multiple computing nodes
- Shortens waiting times for simulation results particularly during critical situations
- Very useful for calibrating models – running independent simulations with different parameters
- Combination of several disaster phenomena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Floreon
Run Simulation
Simulation
Application
Run Model
Web Service
Simulator Instances
Get/Save
Data
Floreon Core
Web Services
Floreon
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Meteo
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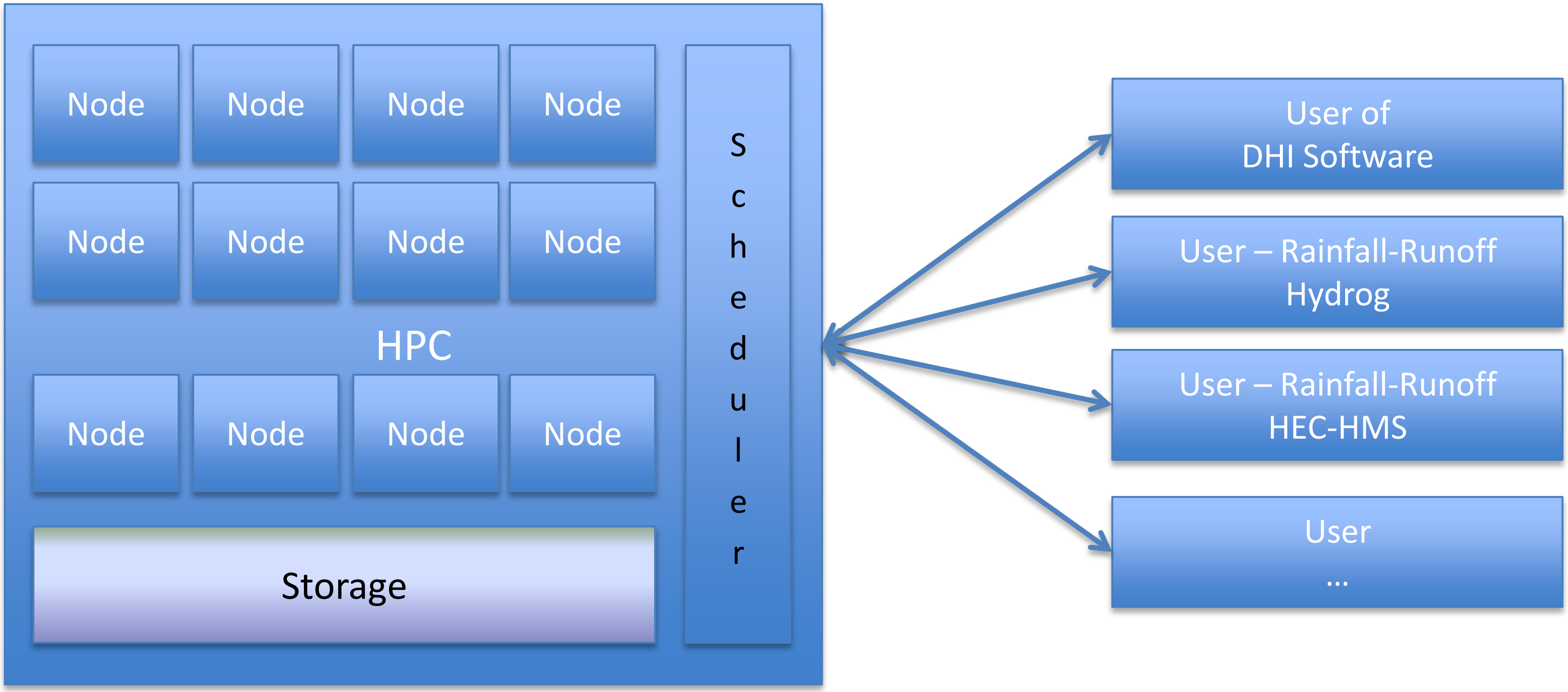
Raster Index
Spatial Database
Relation Database
Car Database
Traffic Raster Index

FLOREON+ and HPC

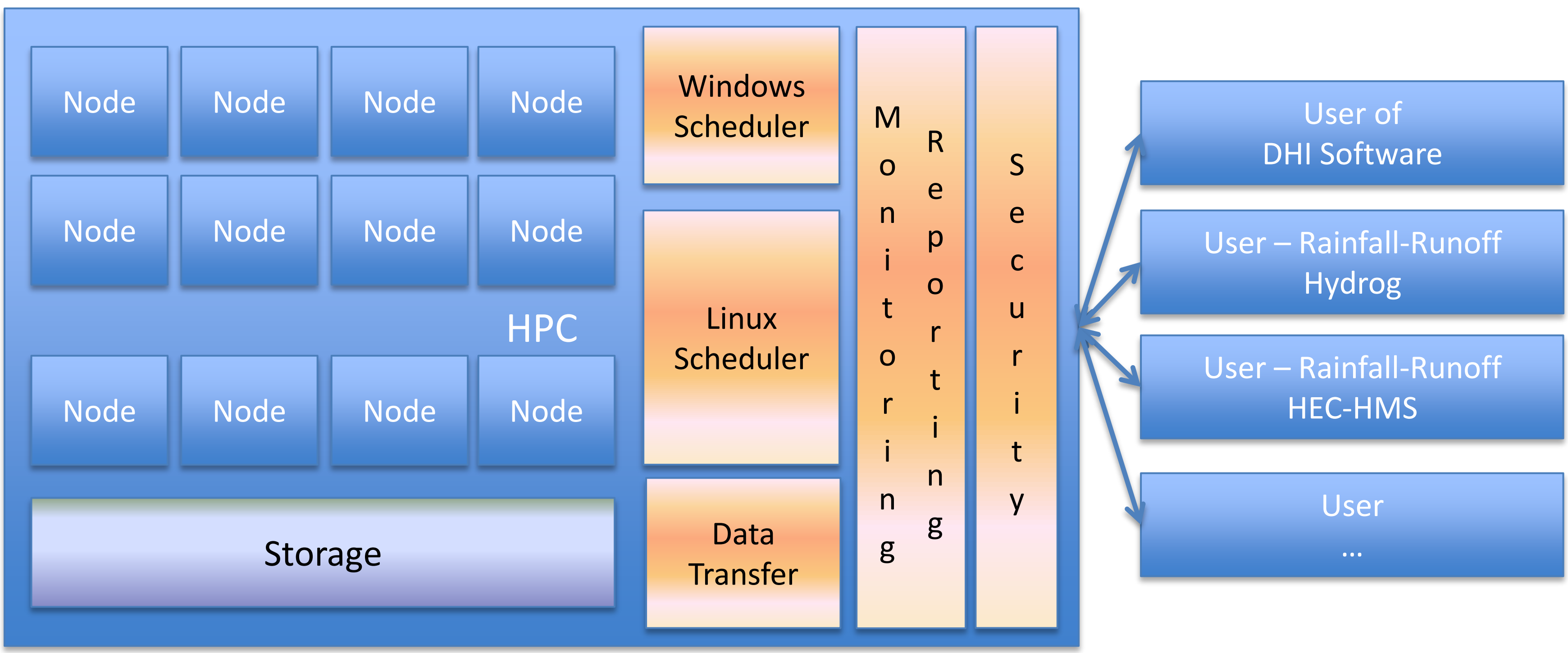
- Model communication inside FLOREON+
  - Automatic process execution
  - OpenMI: standard for models data exchange
  - GIS standards

- **Remote model execution**
  - HPC as a Service

HPC as a Service – Why?



HPC as a Service – Problems



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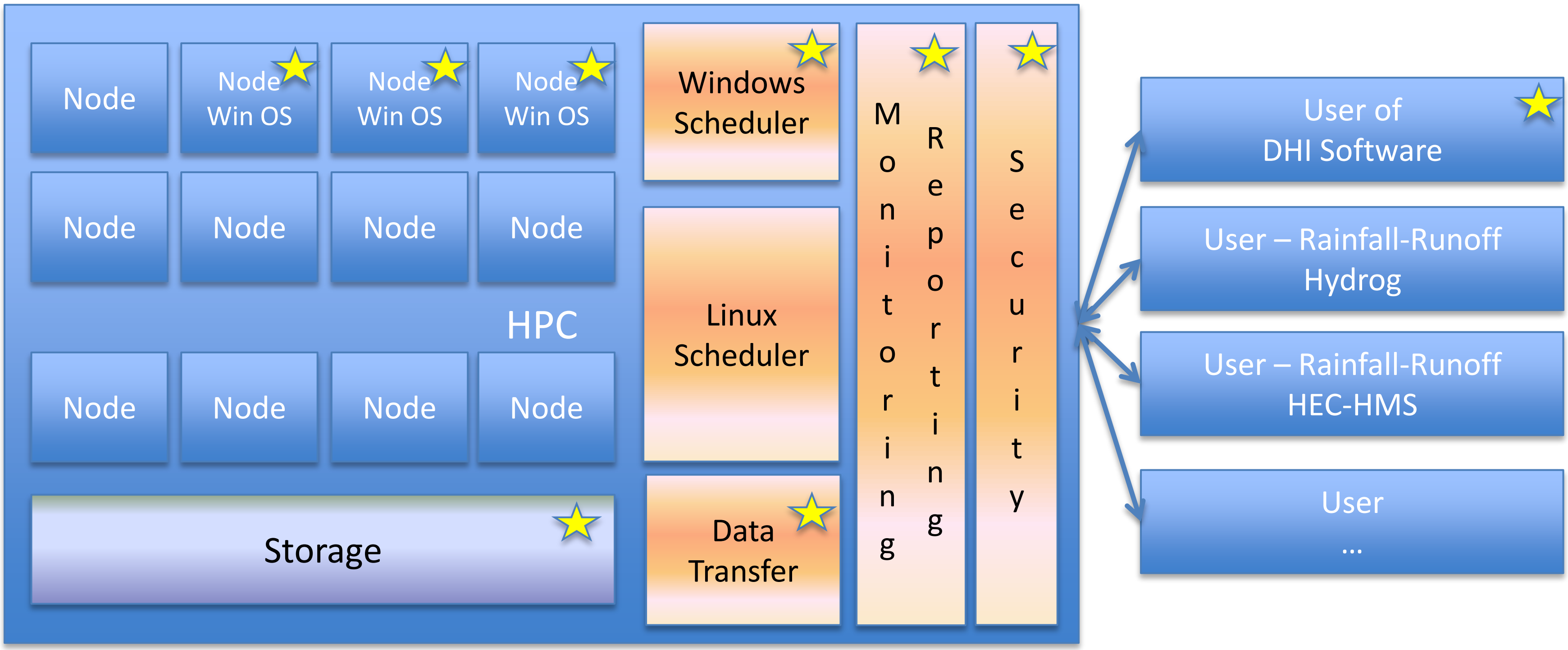
HPC as a Service
Actual Work with DHI



HPC as a Service
Current State

- Generic “HPC as a Service” Framework
  - Generic API for managing jobs on the clusters
  - XML configuration

- WinHPCAdaptor extends the “HPC as a Service” Framework
  - Specific for Windows HPC cluster
  - Testing phase of first version

- DHI REX tools with our WinHPCAdaptor
  - DHI Denmark is able to run their model on our cluster remotely
  - Prepared automatic installation of DHI Software to Windows HPC cluster

Rainfall-Runoff Model Verification and Uncertainty Modelling

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Rainfall-Runoff Model Verification

- Process of demonstrating that model is capable of making „sufficiently accurate“ simulations
- Comparison of predicted discharge volumes with actual measured discharge volumes
- Visual and statistical techniques used for verification

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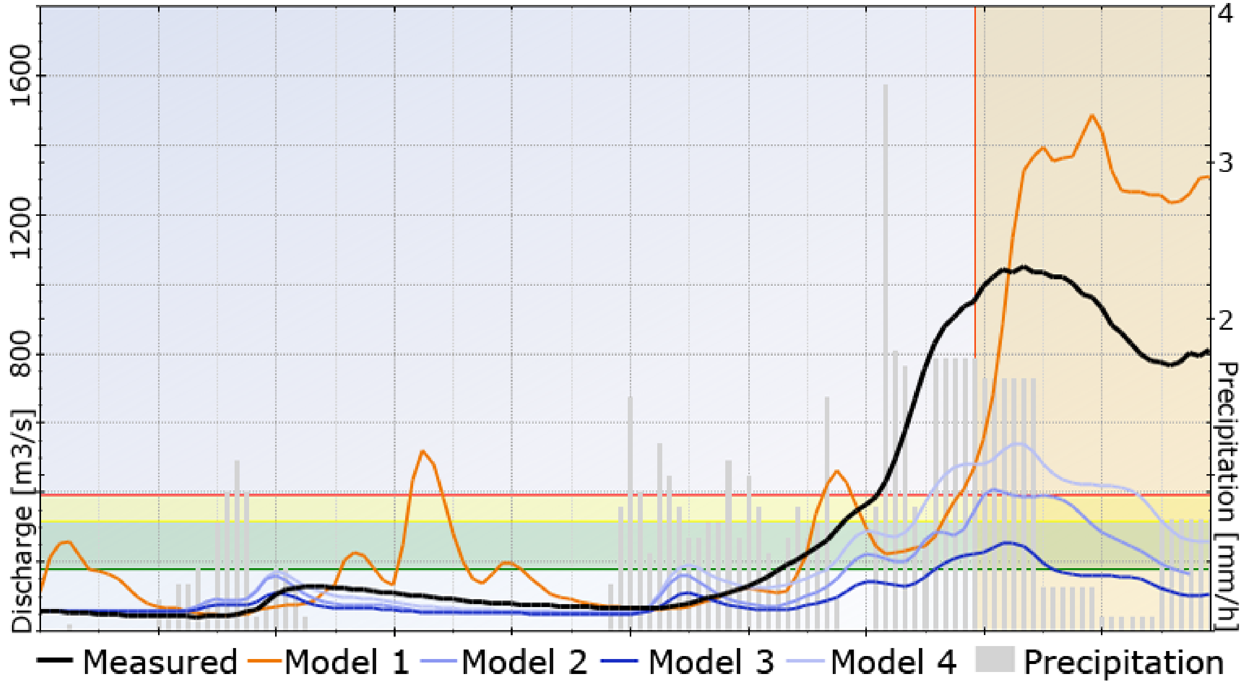
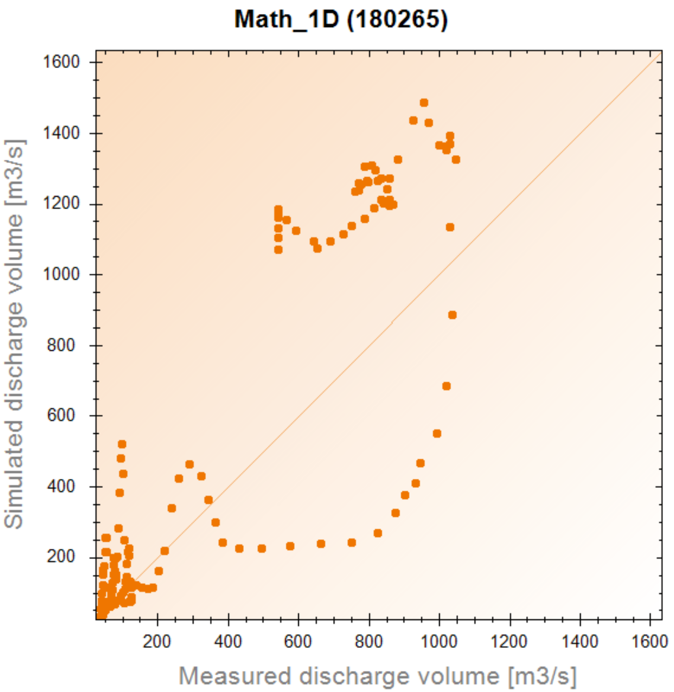
Visual Verification

- Hydrograph



Visual Verification

- Scatter plot



Statistical Verification

- Analysis of statistical indicators
- Commonly used error indicators
  - mean estimate error (ME), root mean square error (RMSE), mean absolute error (MAE), mean percentage error (MPE), mean absolute percentage error (MAPE), relative error in volume (VE), relative error for peak (MF)
- They indicate error in units or as a percentage
- Low error indicators signify precise model, individual models can be easily compared

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Uncertainty Modelling

- Some input model parameters are not specified exactly but are also predicted approximately
  - e.g. precipitation forecast, soil infiltration, ...
- These imprecisions influence the whole prediction and can lead to bad decisions
- Monte-Carlo simulations can estimate possible situations and their probability

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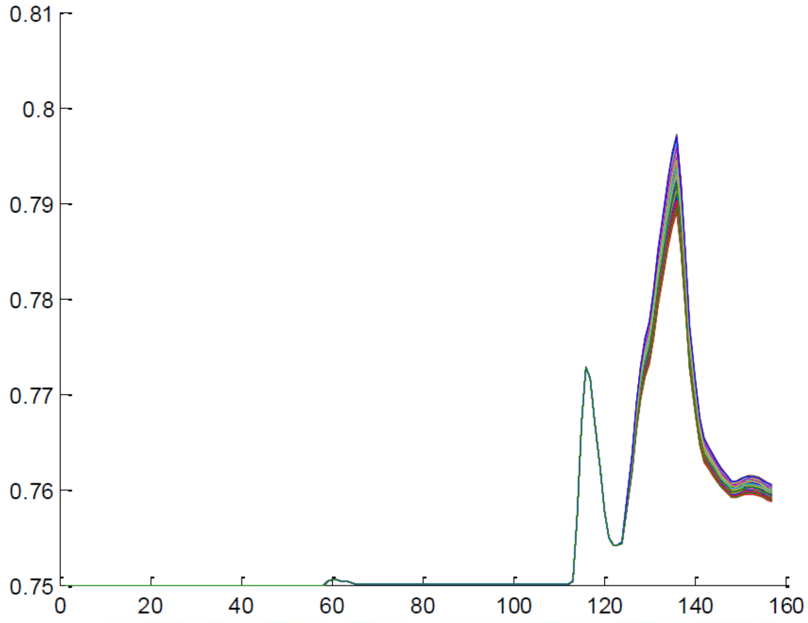
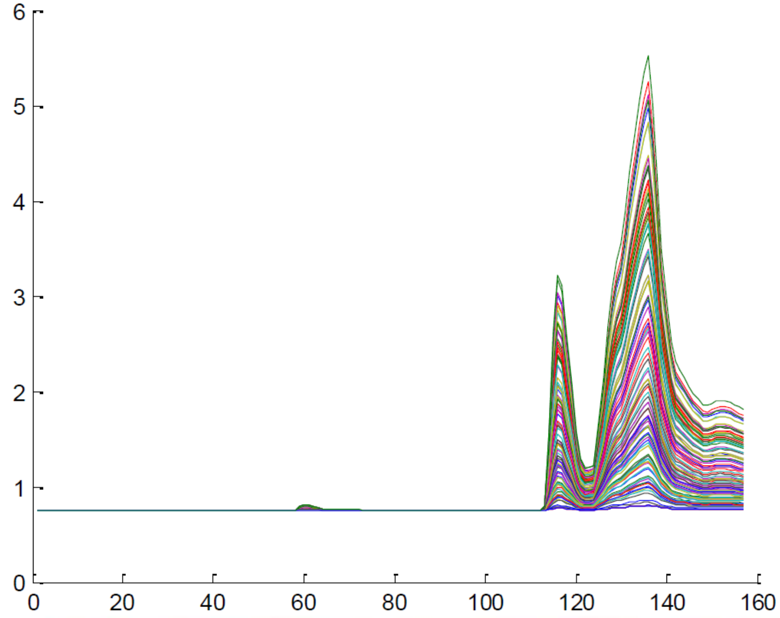
Monte-Carlo Simulations Example

- CN Curve = 55, Predicted precipitations +/- 10%



Monte-Carlo Simulations Example

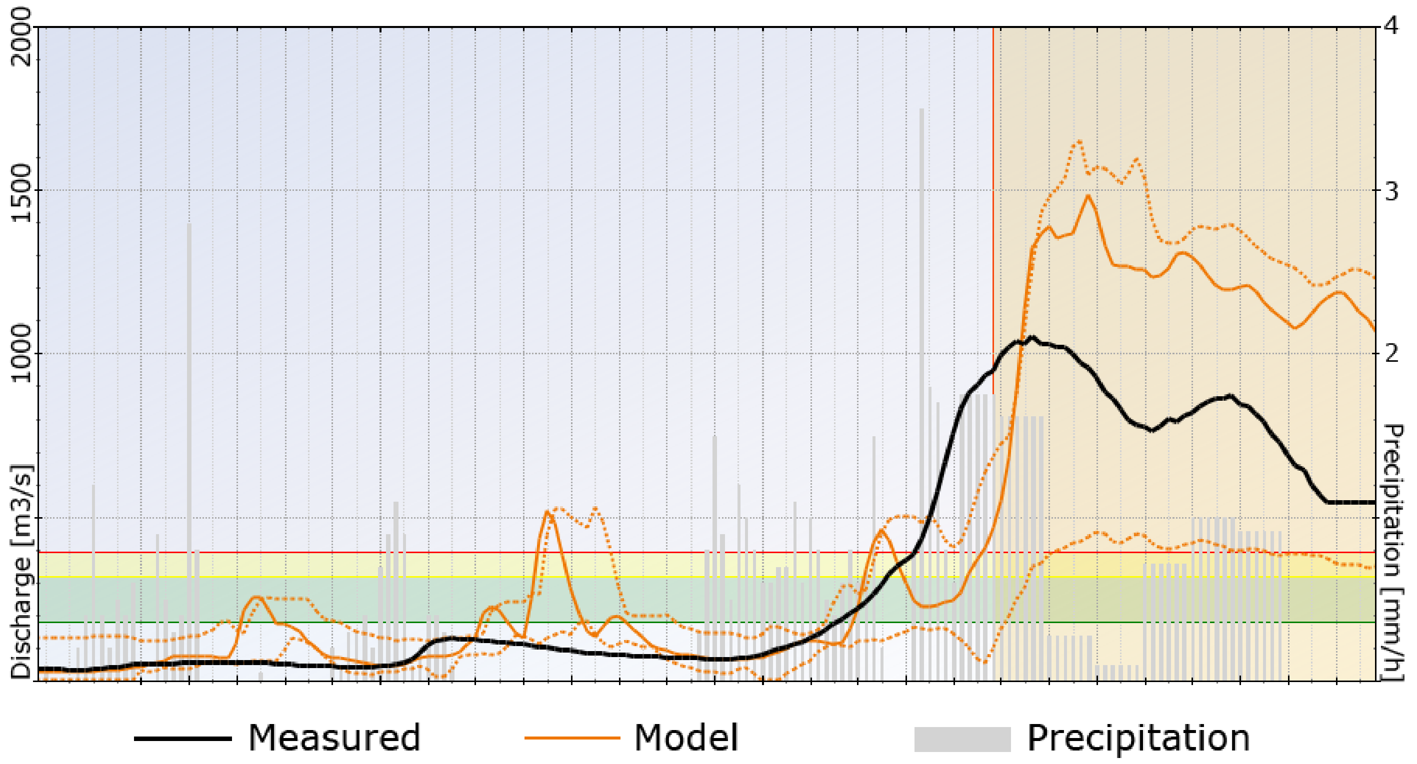
- CN Curve = <55;95>, Predicted precipitations +/- 10%



Integration to FLOREON+

- HPC environment is ideal for running Monte-Carlo simulations
- Individual simulations are collected from HPC but only significant results are stored
- Significant results:
  - 5%, 15%, 25%, 75%, 85% and 95% percentiles
  - These percentiles form 50%, 70% and 90% confidence intervals

90% Confidence Interval



Confidence Interval Evaluation

- Comparison of confidence interval percentage with the percentage of measured values inside the interval

Confidence Interval	Values Inside	Values Outside	Interval Success	Is Successful
90%	45	3	93.75%	YES
70%	26	22	54.17%	NO
50%	4	44	8.33%	NO

Current State

- Visual and statistical verification of rainfall-runoff models is implemented in the FLOREON+ system
- Monte-Carlo method used to model uncertainty of input parameters in the rainfall-runoff models
- Uncertainty simulations demonstrated and evaluated using confidence intervals

Thank you for attention