



# Encapsulating Heterogeneous Geo-Analysis Models into Reusable Model Services (Model Description Document)

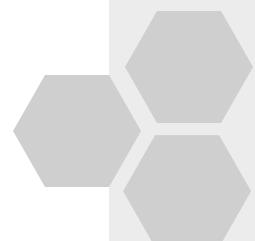
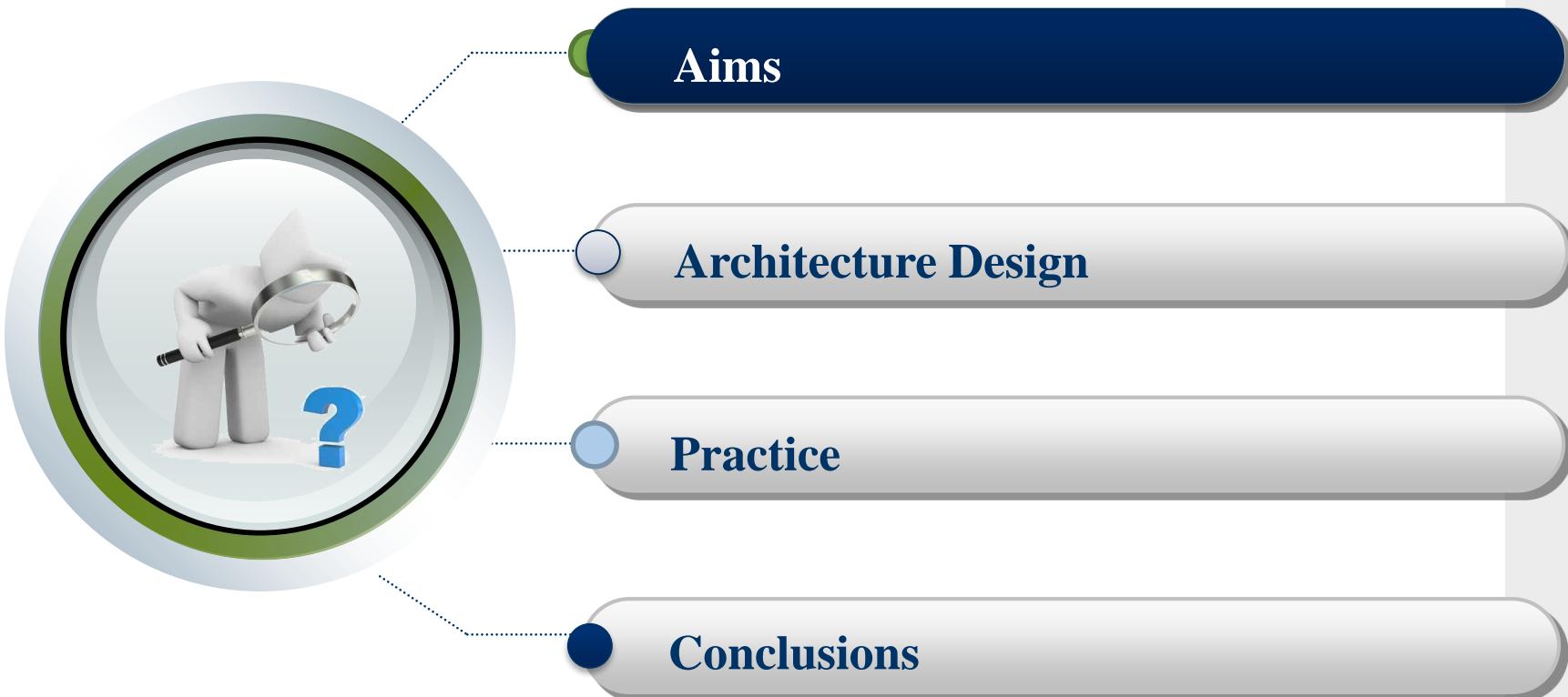


OpenGMS Team

Key Laboratory of VGE (MOE)  
Nanjing Normal University

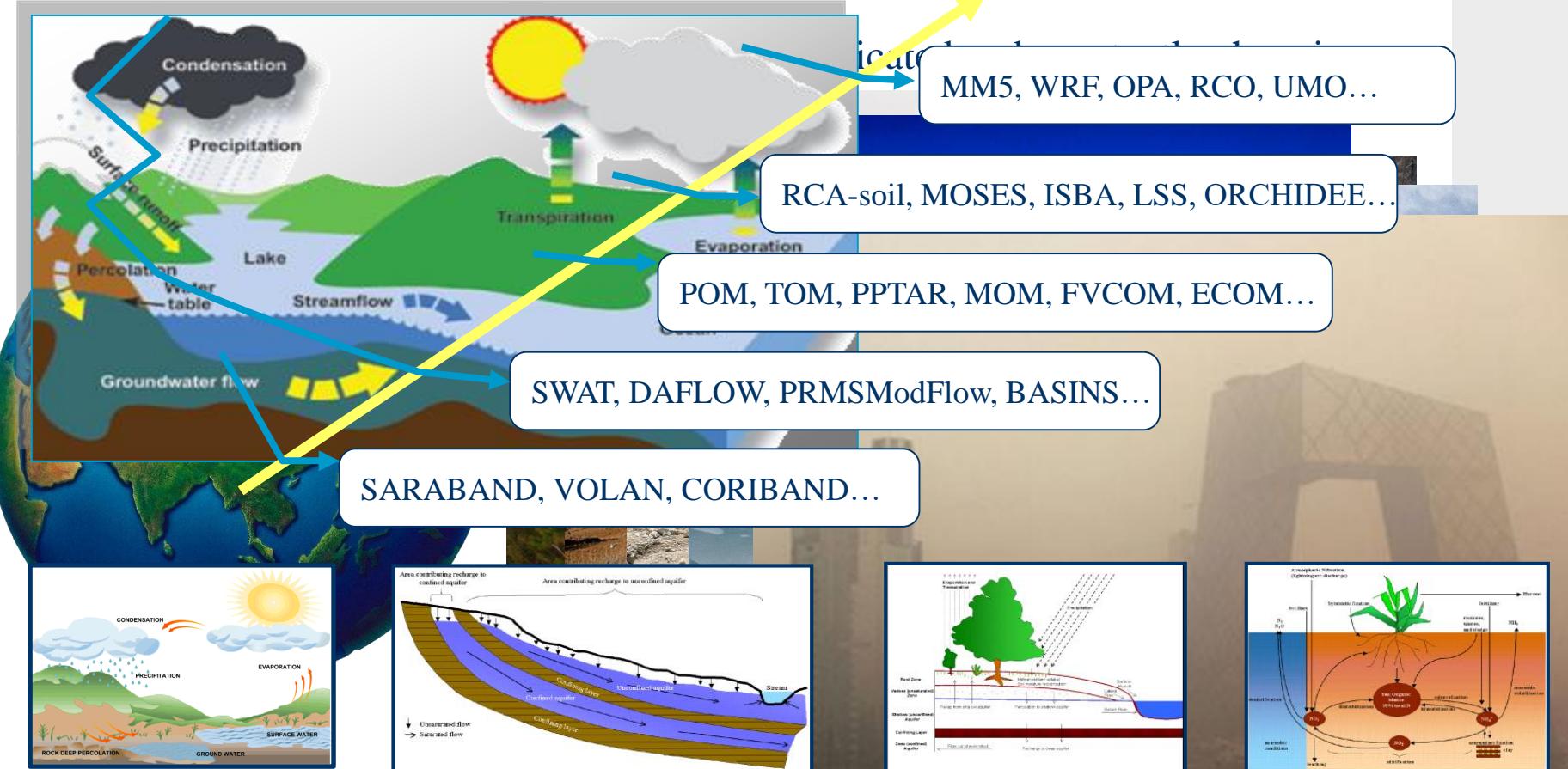


# Outline



# 1. Aims

## ❖ Geo-analysis Model



Geo-analysis models are widely used to describe geographic phenomena, simulate geo-processes, and depict regular geographic patterns in the environment.

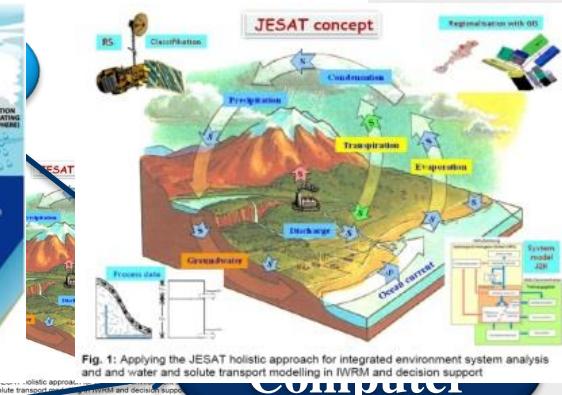
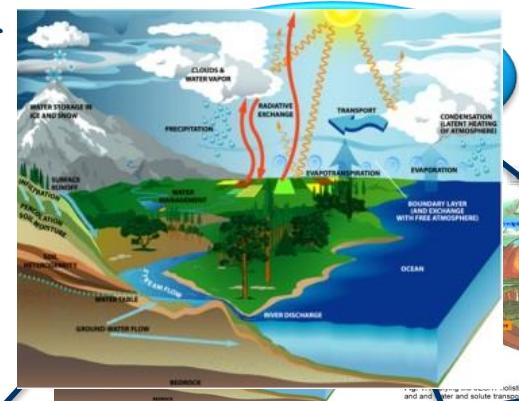
# 1. Aims

## ❖ Geo-analysis Model Sharing and Integrating

However, to **Simulate synthetic geo-processes** and **Solve complicated environmental problems**, any single study field is inadequate; the **collaboration** of different fields of study is required.

Virtual Geographic Environment (VGE) has been proposed as a new generation of geographic analysis tool to contribute to human understanding of the geographic world and assist in solving geographic problems at a deeper level. (Lin 2012)

Studying, reusing, sharing and integrating geo-analysis models can provide an interactive interface for researchers performing geographical experiment collaboratively in VGE.

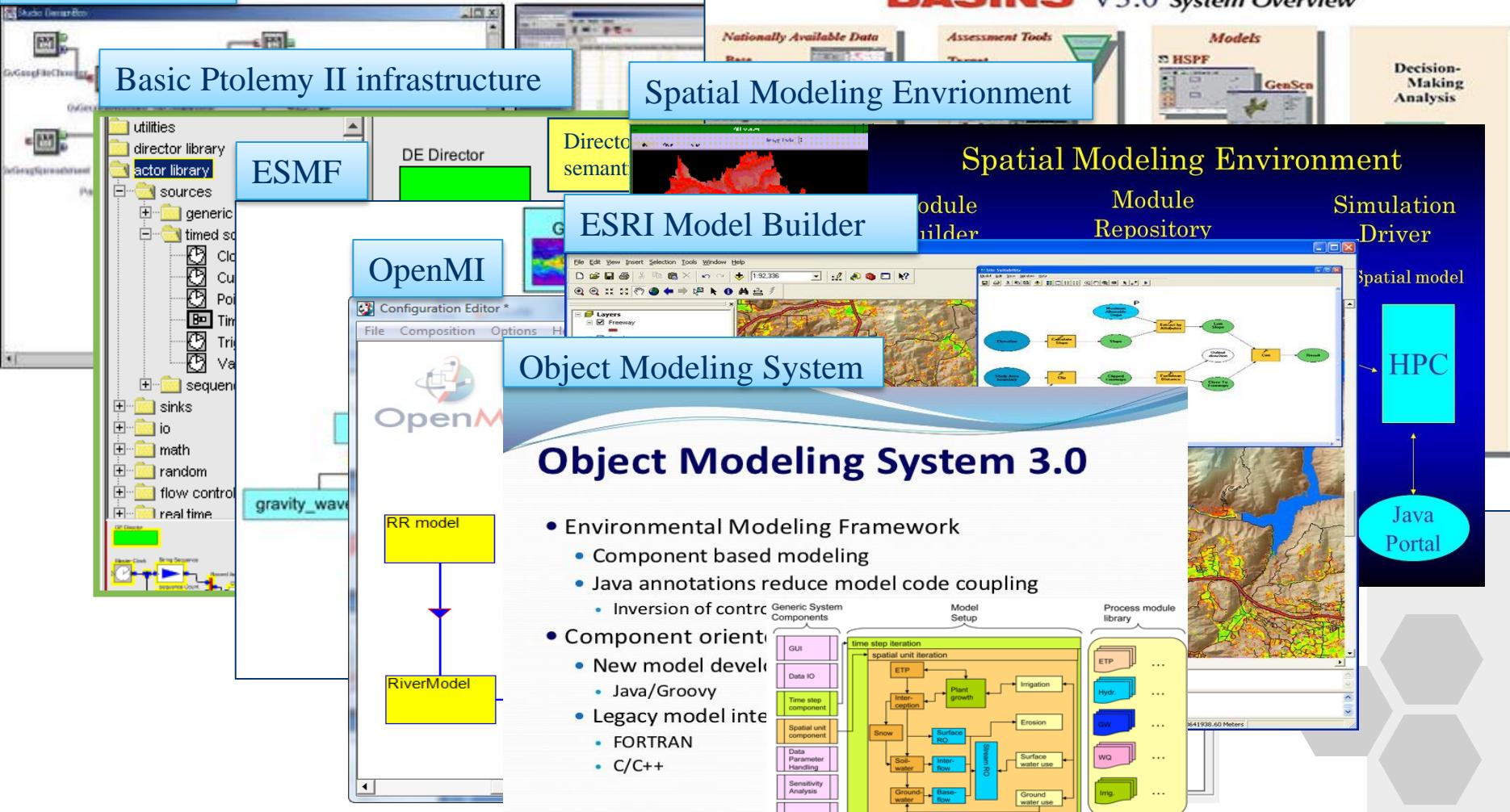


Model

# 1. Aims

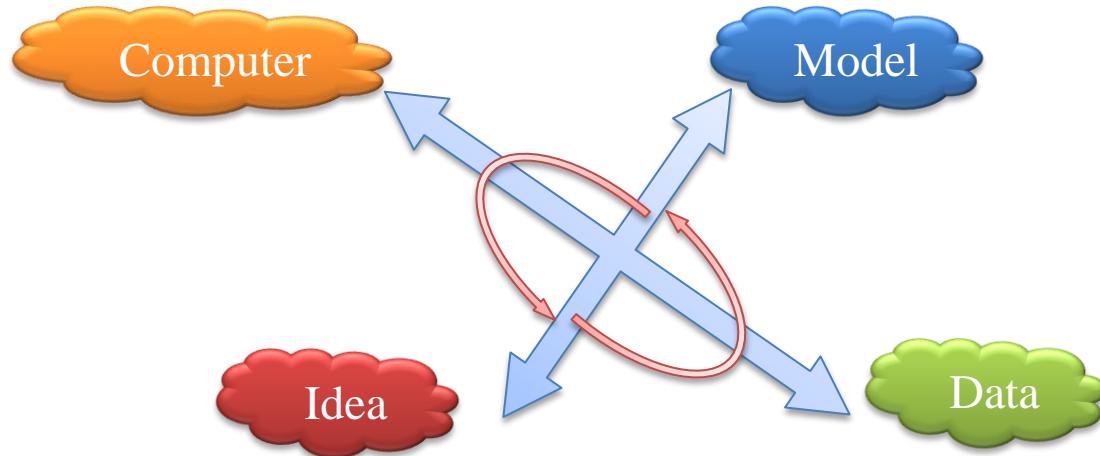
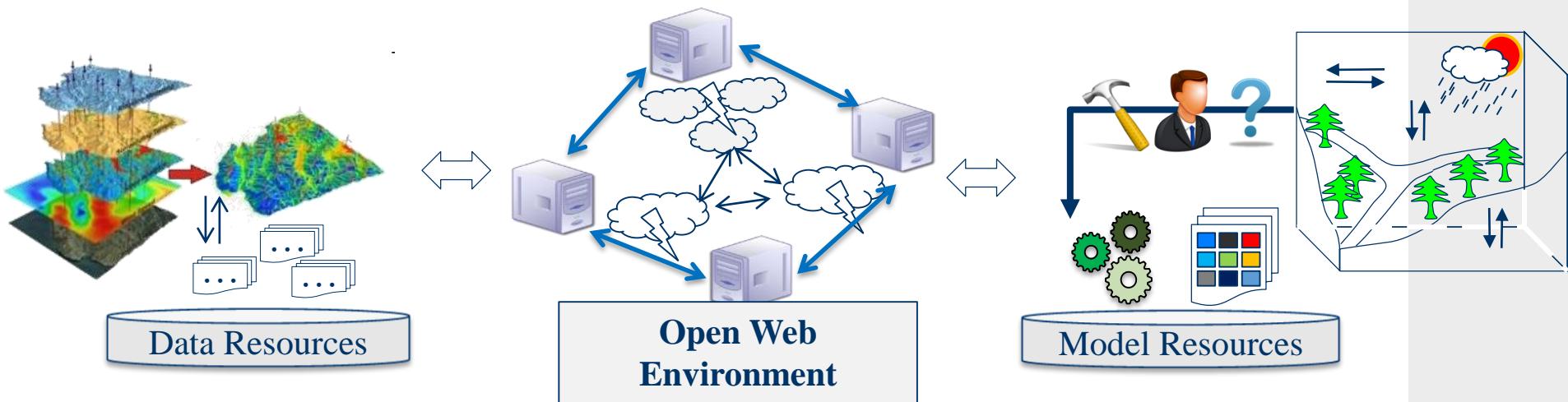
## ❖ Research of Model Integration Frameworks

GeoVista



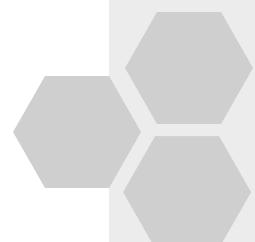
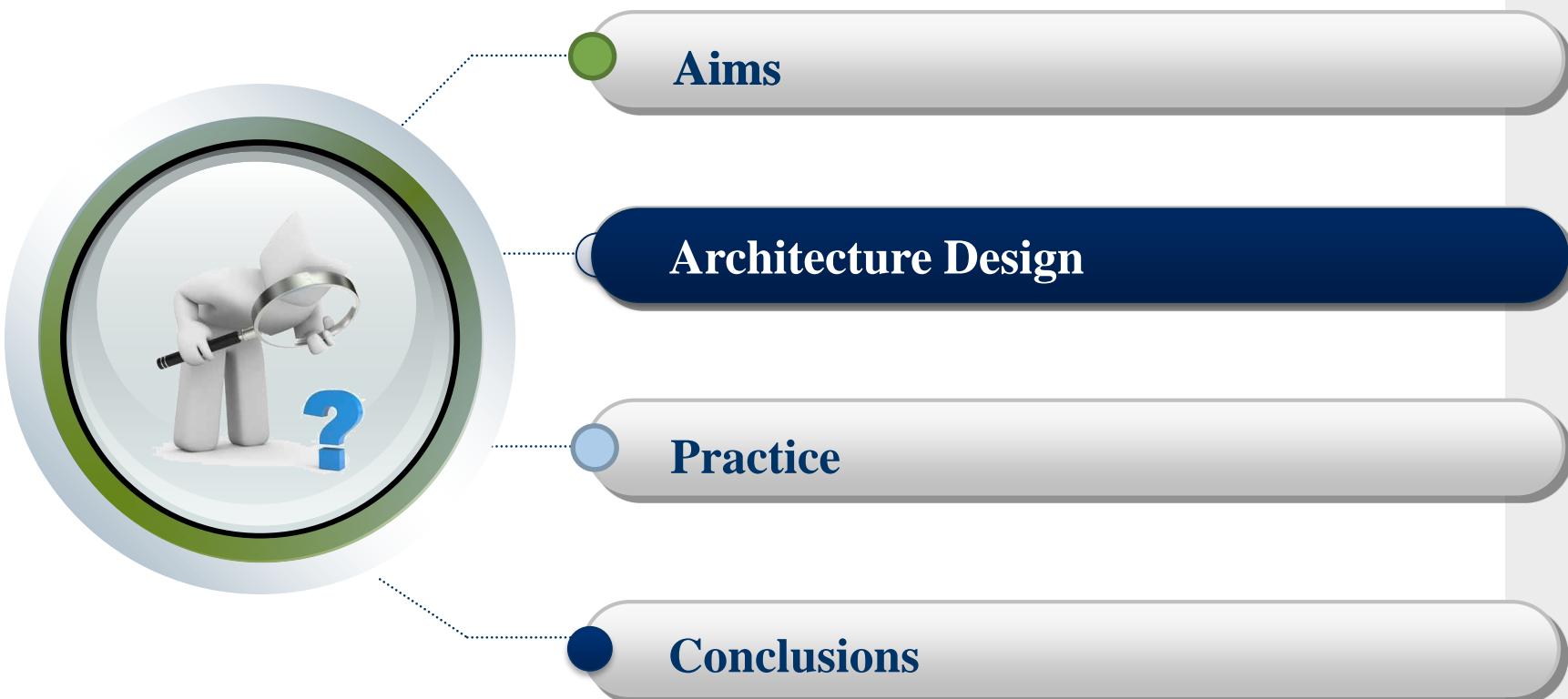
# 1. Aims

## ❖ Open web environment



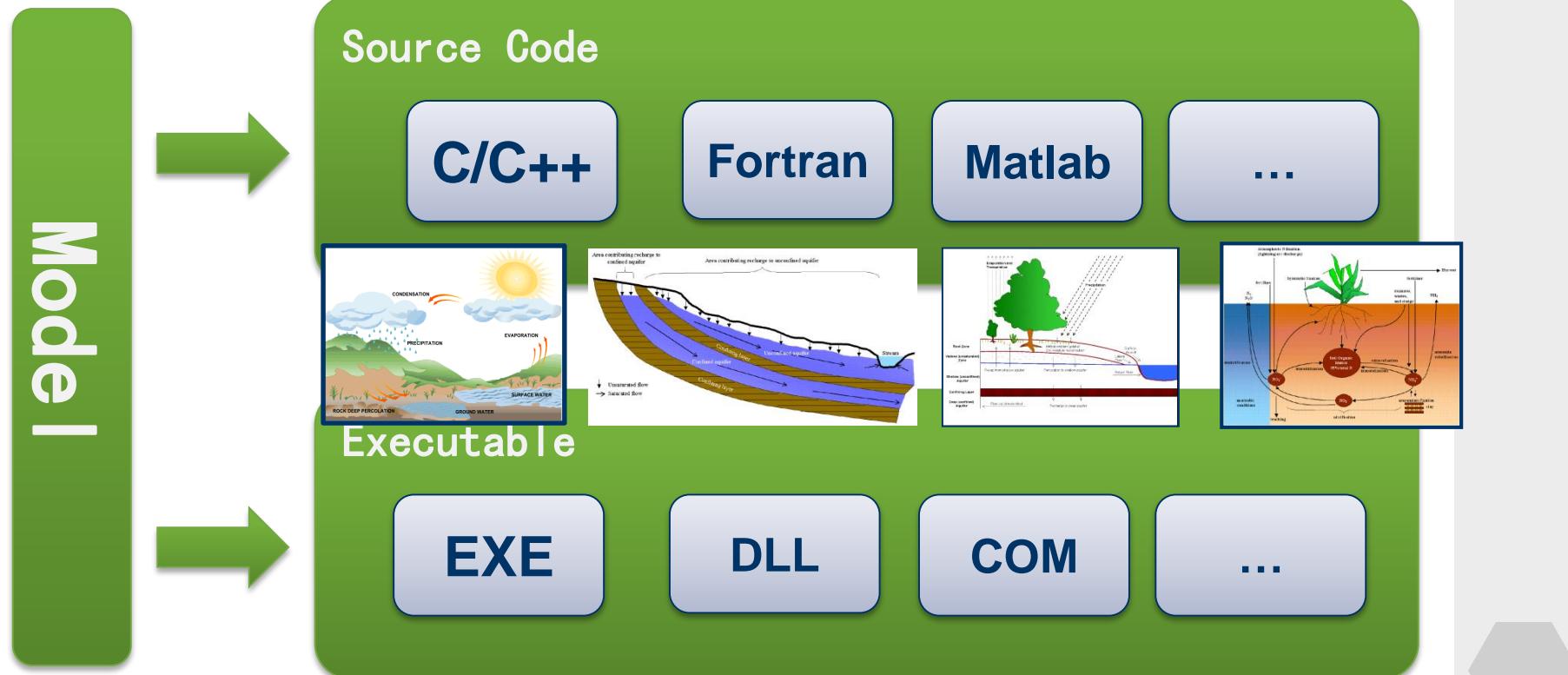


# Outline

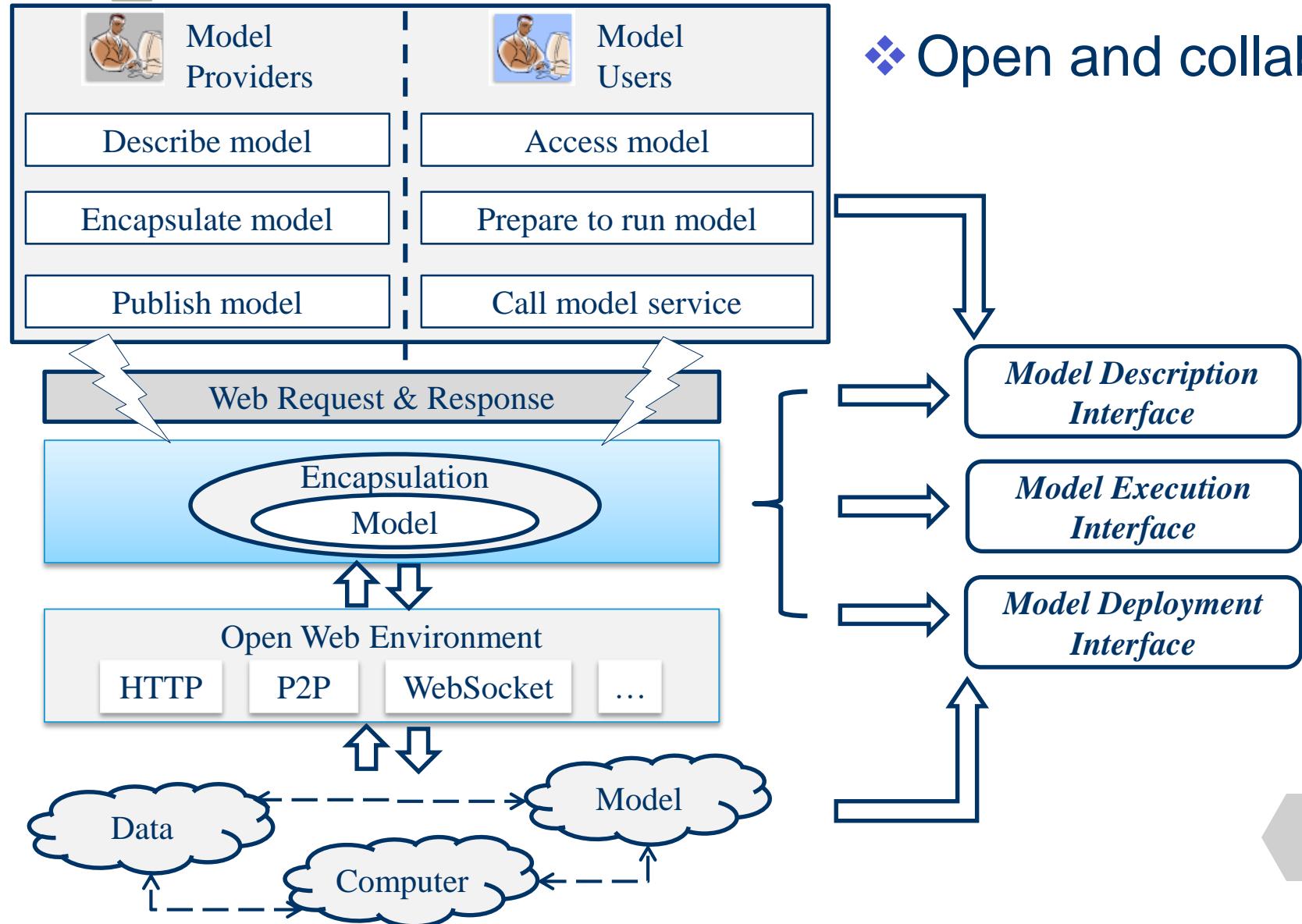


## 2. Architecture Design

### ❖ Heterogeneous models

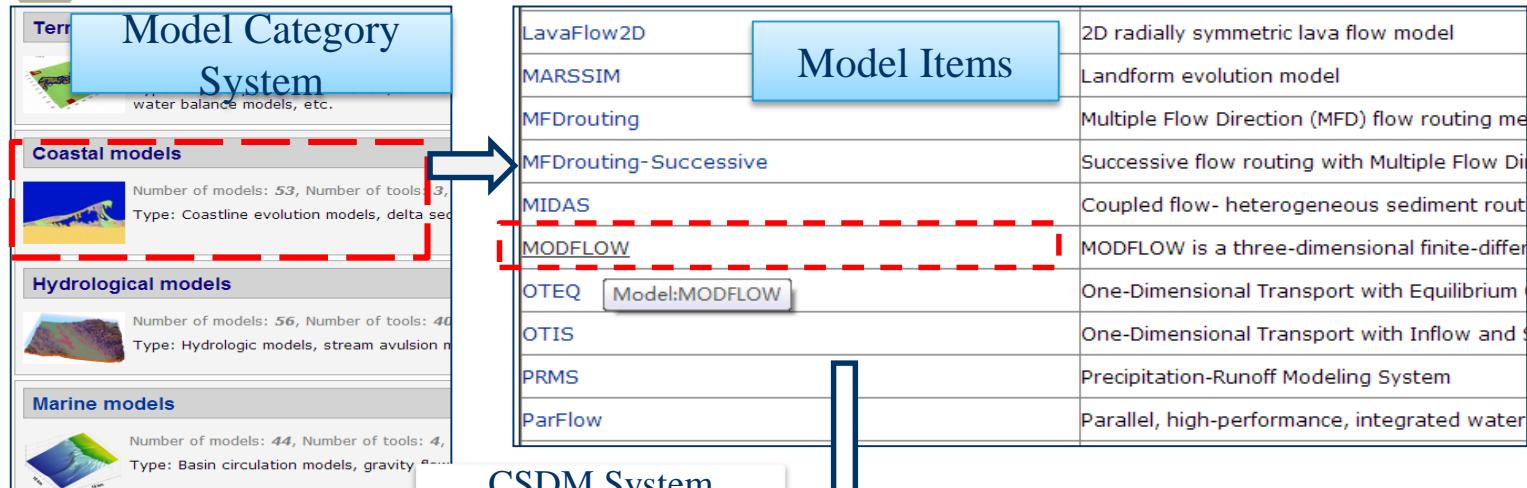


## 2. Architecture Design



❖ Open and collaborative

# 2.1 Model encapsulation - description



[http://csdms.colorado.edu/wiki/Coastal\\_models](http://csdms.colorado.edu/wiki/Coastal_models)

This screenshot shows the 'Localization Information' section for the MODFLOW model. It includes tabs for Summary, Contact, Technical specs, In/Output, Process, Testing, Other, and Component info. The 'Localization Information' tab is active, displaying the following details:

Localization	English
Also known as	
Model type	Modelling
Spatial dimensions	3D
Spatial extent	Watershed-Scale
Model domain	,
One-line model description	MODFLOW is a three-dimensional finite-difference ground-water model
Extended model description	MODFLOW is a three-dimensional finite-difference ground-water model that was first published in 1984. It has a modular structure that allows it to be easily modified to adapt the code for a particular application. Many new capabilities have been added to the original model. OFR 00-92 (complete reference below) documents a general update to MODFLOW, which is called MODFLOW-2000 in order to distinguish it from earlier versions. MODFLOW-2000 simulates steady and nonsteady flow in an irregularly shaped flow system in which aquifer layers can be confined, unconfined, or a combination of confined and unconfined. Flow from external stresses, such as flow to wells, areal

<http://csdms.colorado.edu/wiki/Model:MODFLOW>

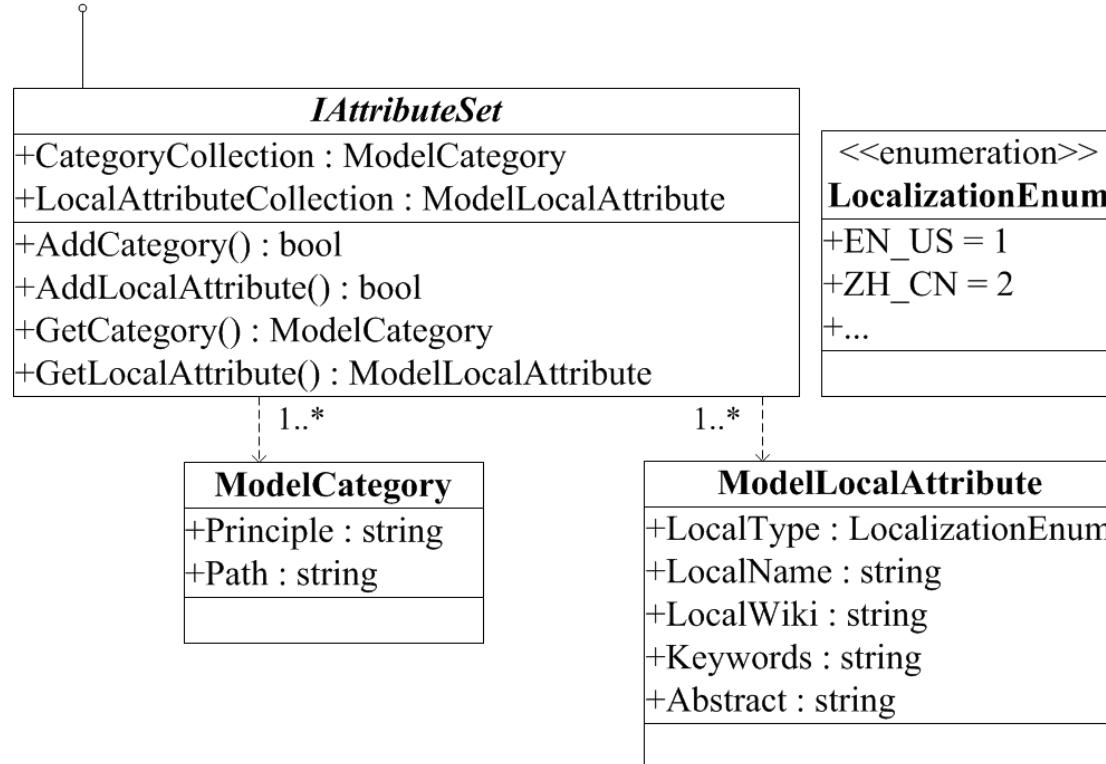
This screenshot shows the 'Localization Information' section for the MODFLOW model, translated into Chinese. The details are identical to the English version:

Localization	Chinese
名称:	mf2k1_19_01.tarUNIX.gz
大小:	4796 (k)
更新时间:	2010-09-21
开发者:	Winston Richard
管理者:	张耀南
提供者:	何振芳
模型语言:	Fortran77, Fortran90, C
关键词:	3D, finite-difference ground-water
实用范围:	流域尺度
运行条件:	Unix, Linux, Mac OS, Windows

[http://www.cryosphere.csdb.cn/html/modelView.jsp?TM\\_ID](http://www.cryosphere.csdb.cn/html/modelView.jsp?TM_ID)



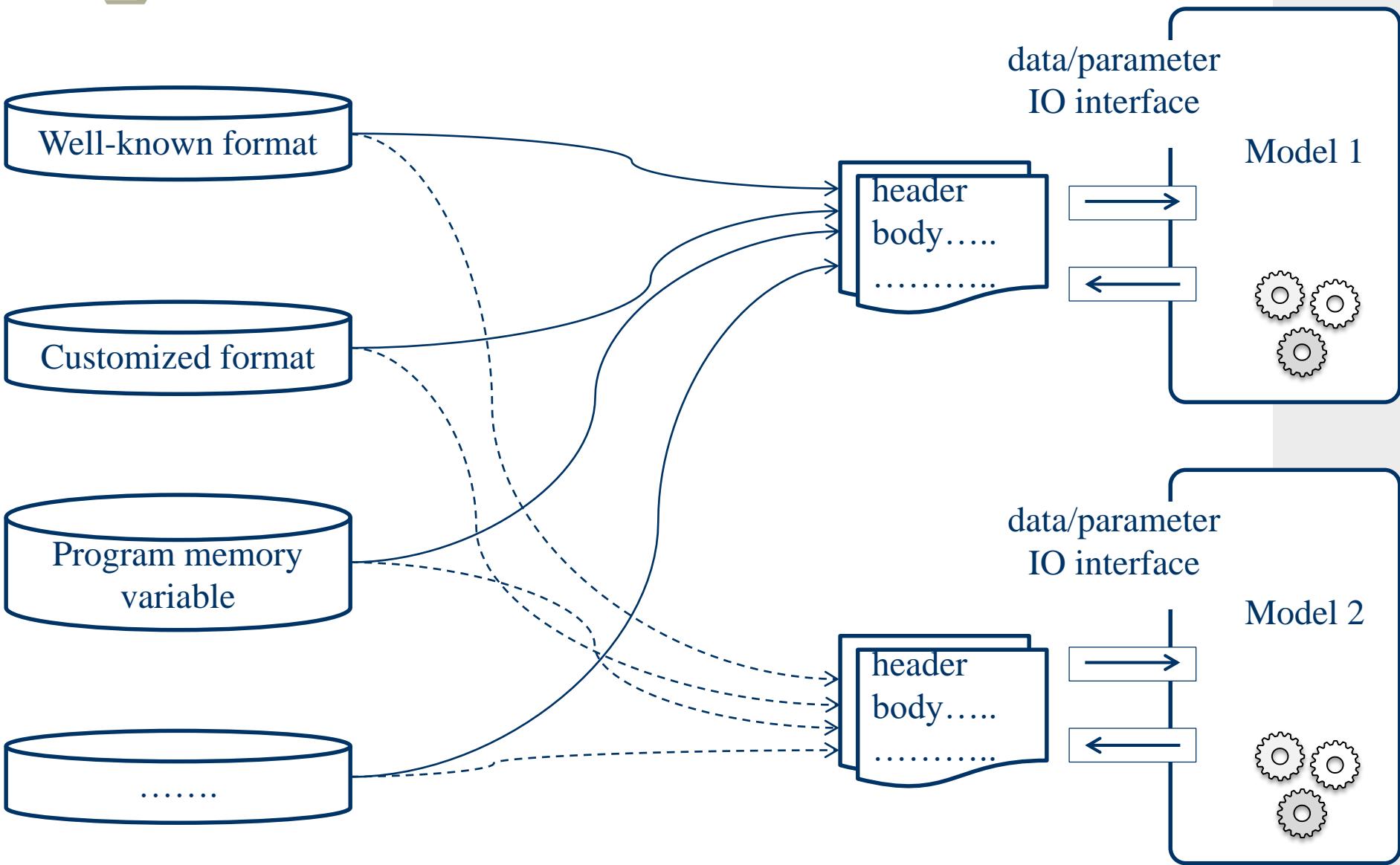
## 2.1 Model encapsulation - description



CategoryCollection is a set of the ModelCategory collection,  
LocalAttributeCollection is a set of the ModelLocalAttribute collection.

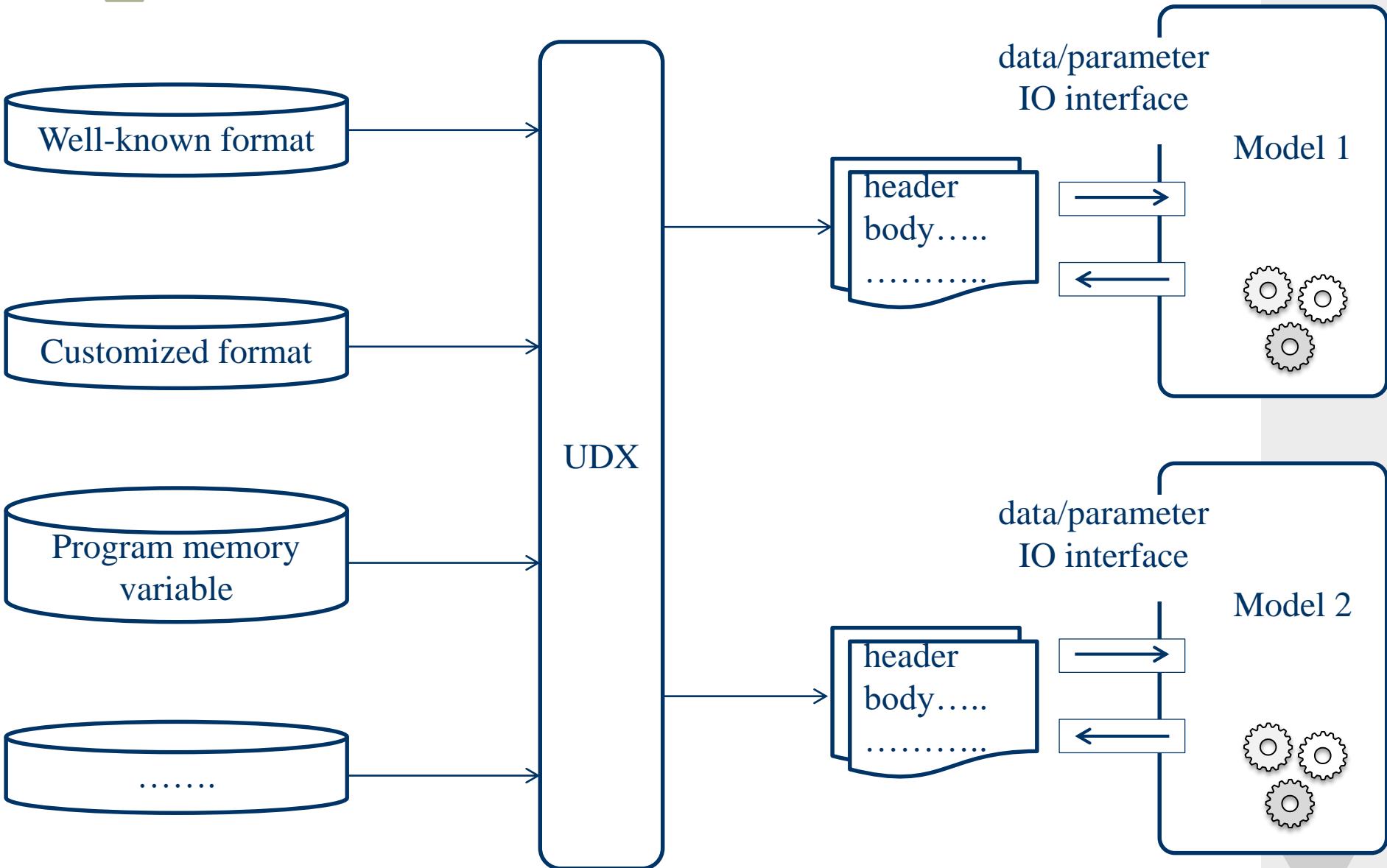


## 2.1 Model encapsulation - data

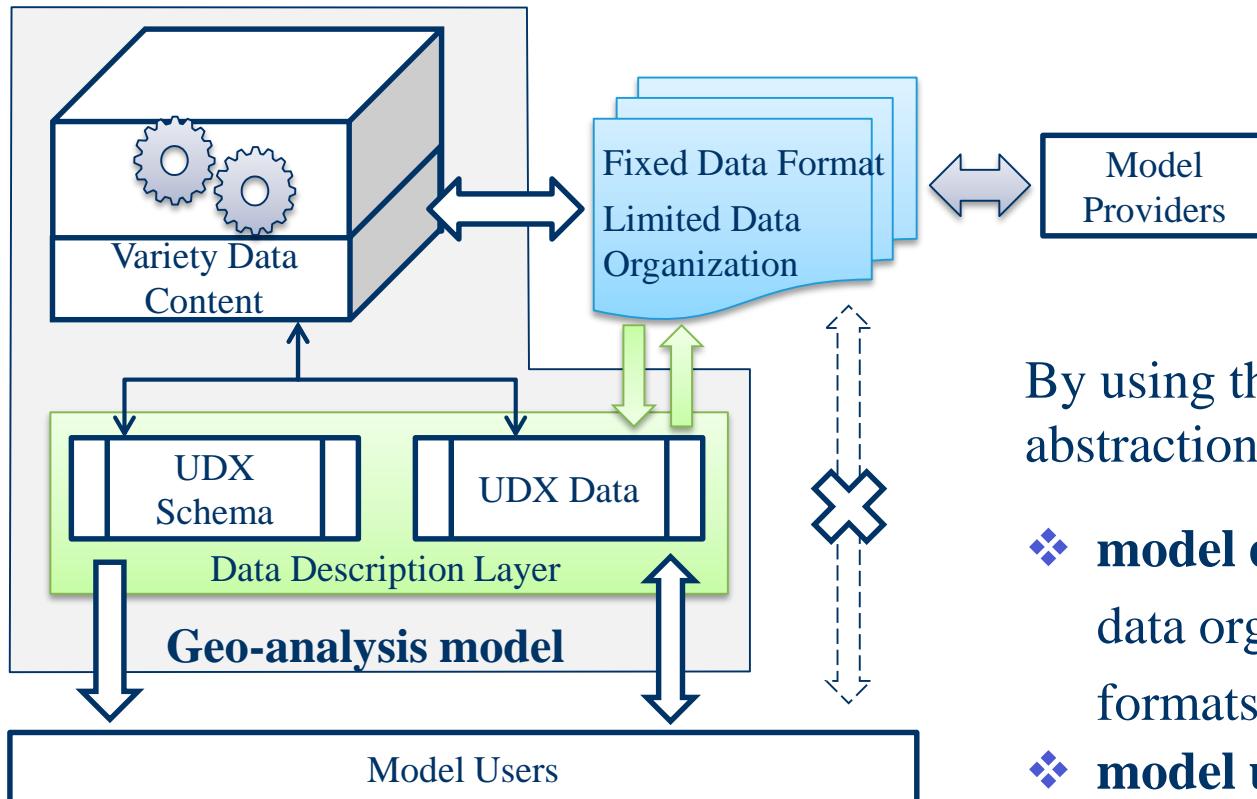




## 2.1 Model encapsulation - data



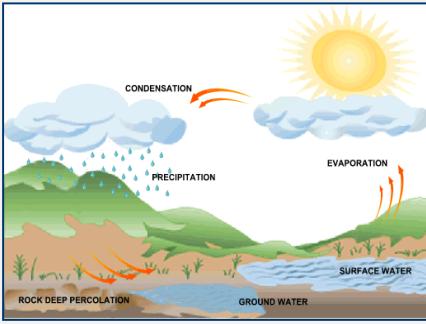
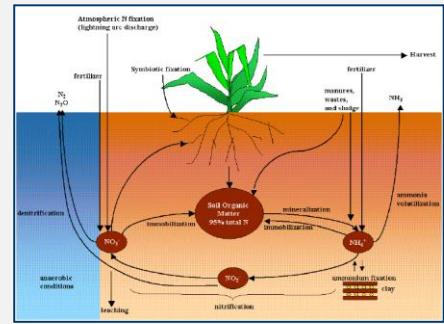
## 2.1 Model encapsulation - data



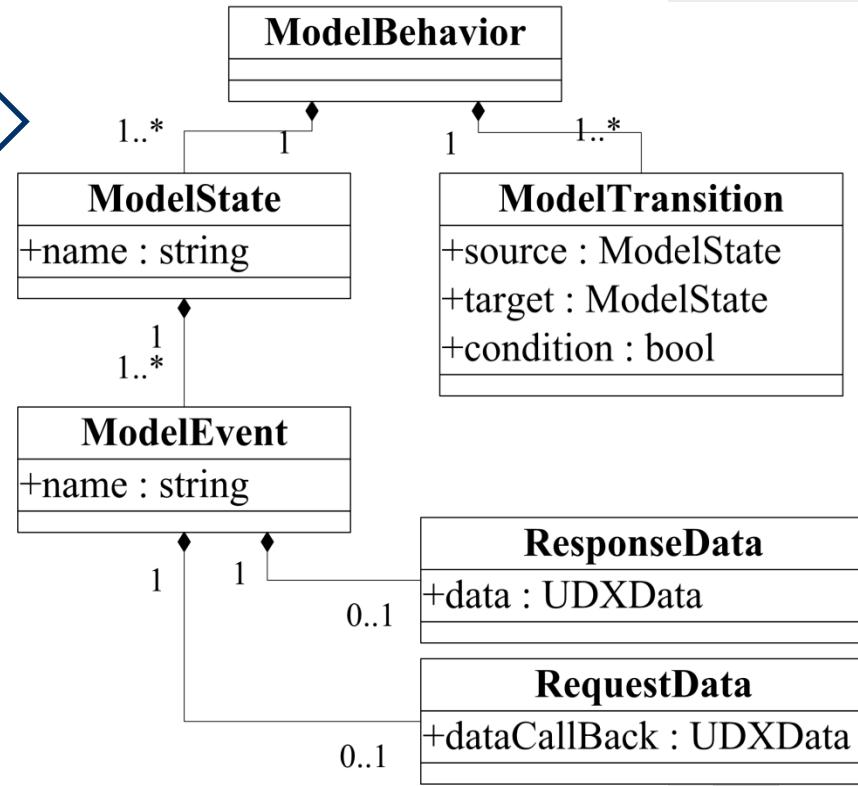
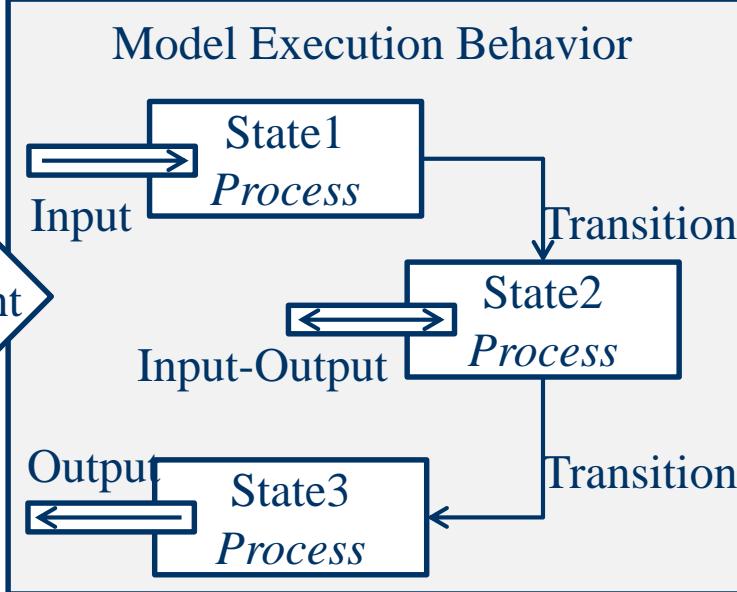
By using the UDX model, a middle abstraction layer is built between:

- ❖ **model data** (which require limited data organizations or fixed data formats)
- ❖ **model users** (who need to understand model data not only the value content but also its semantic information)

## 2.2 Model encapsulation - execution



Geo-processes



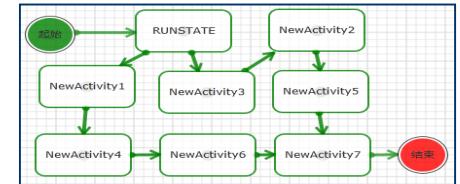
## 2.2 Model encapsulation - execution

○

<b><i>IExecutionBehavior</i></b>
+DataDeclarationCollection : UDXSchema
+ModelExecutionStates : ModelBehavior
+GetDataDescription() : UDXSchema
+GetModelBehavior() : ModelBehavior

*start-node* : 1  
*end-node* : 1  
*state-node* : n

State Simulation Style



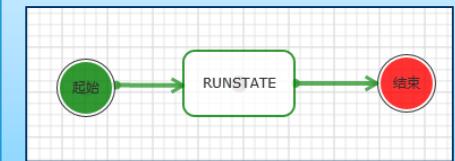
*start-node* : 1  
*end-node* : 0  
*state-node* : n



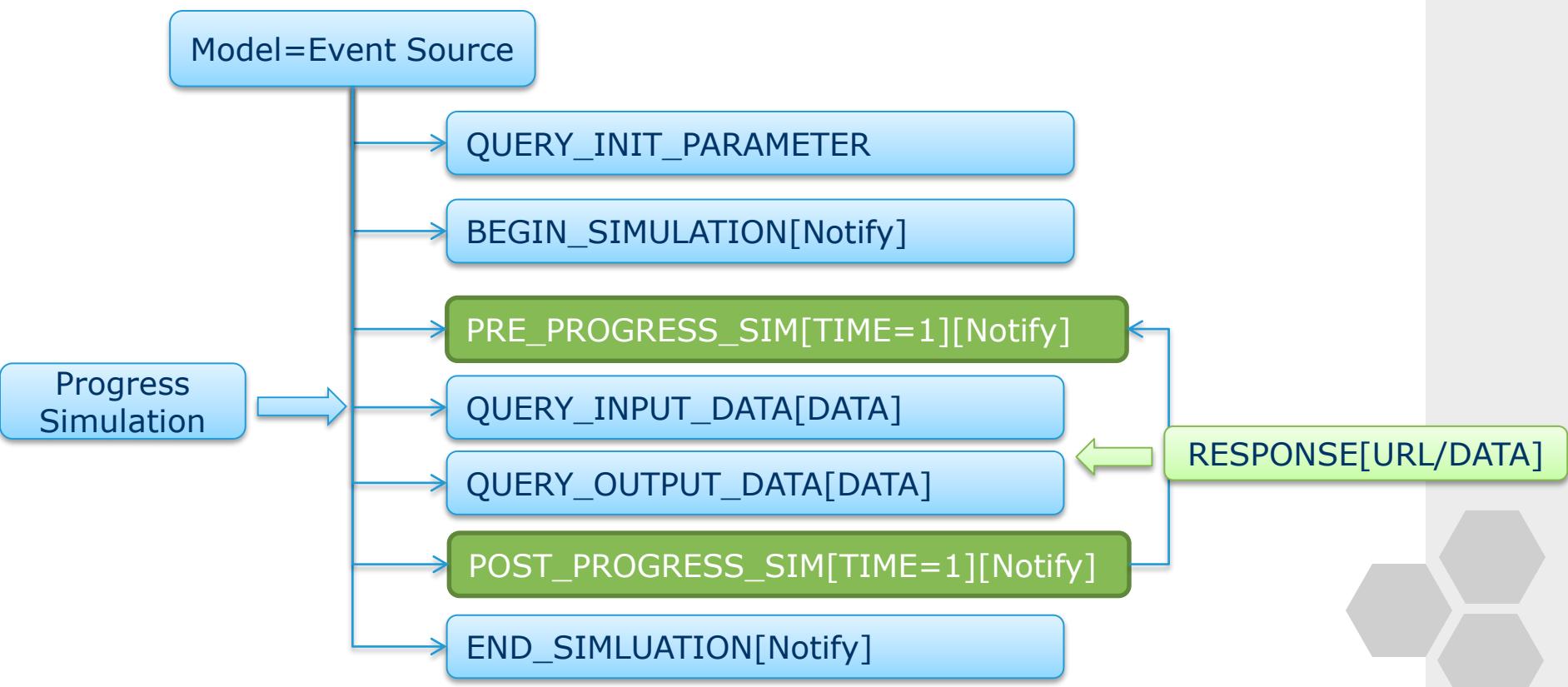
Time Series Style

*start-node* : 1  
*end-node* : 1  
*state-node* : 1

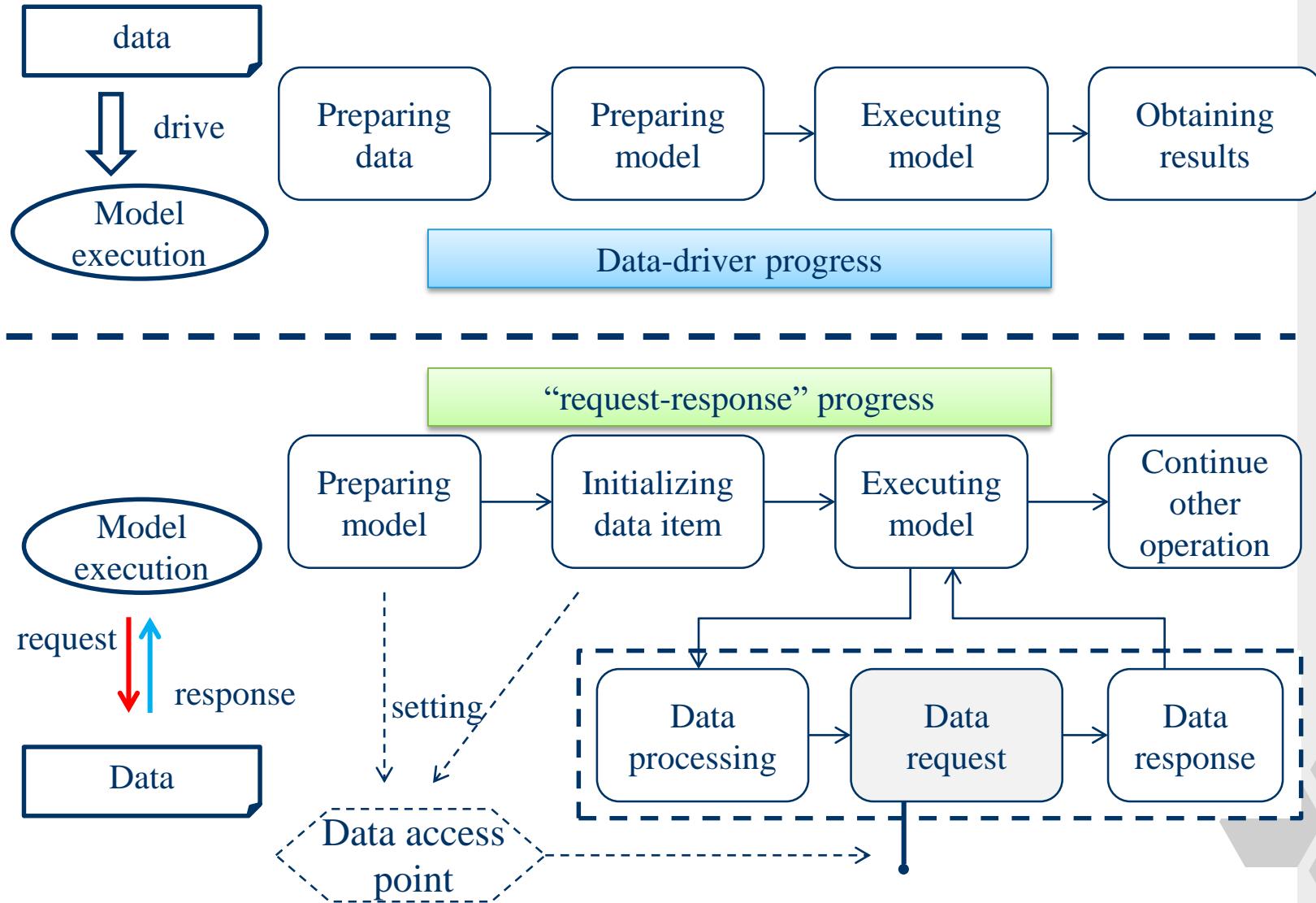
Simple Calculation Style



## 2.2 Model encapsulation - execution

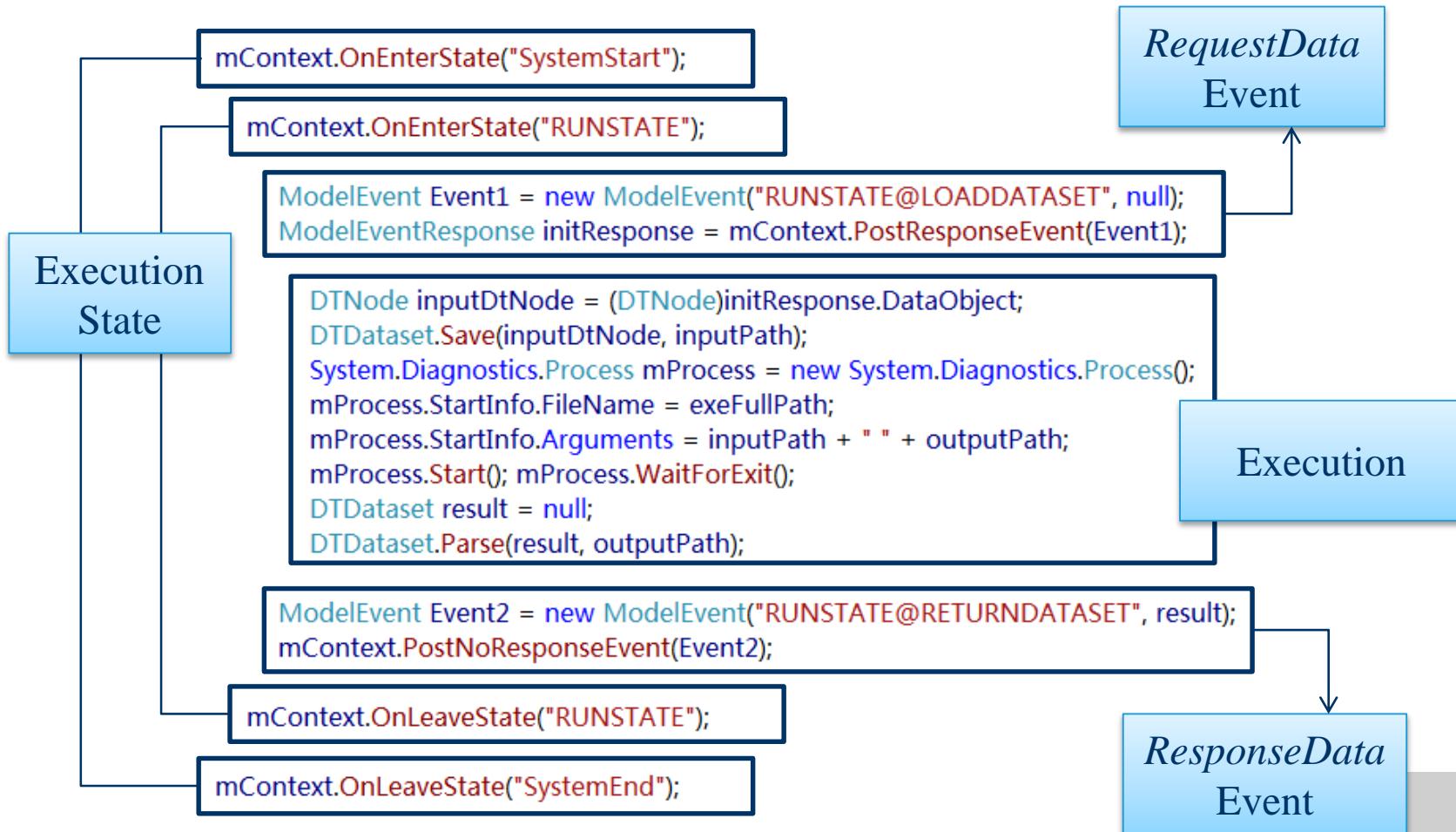


## 2.2 Model encapsulation - execution





## 2.2 Model encapsulation - execution





## 2.3 Model encapsulation - deployment

### Computer

Hardware environment

Memory Size,  
Disk Storage Size  
Number of CPU Core,  
CPU/GPU type  
.....

### Software

Software environment

Visual C++ 2008 runtime,  
Compac Fortran runtime,  
Intel Fortran runtime,  
.Net 2010 platform,  
MS SQL 2008,  
ArcGIS Engine rumtime,  
.....

### Model

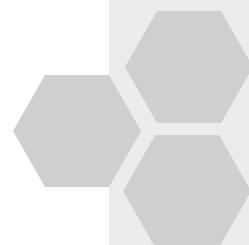
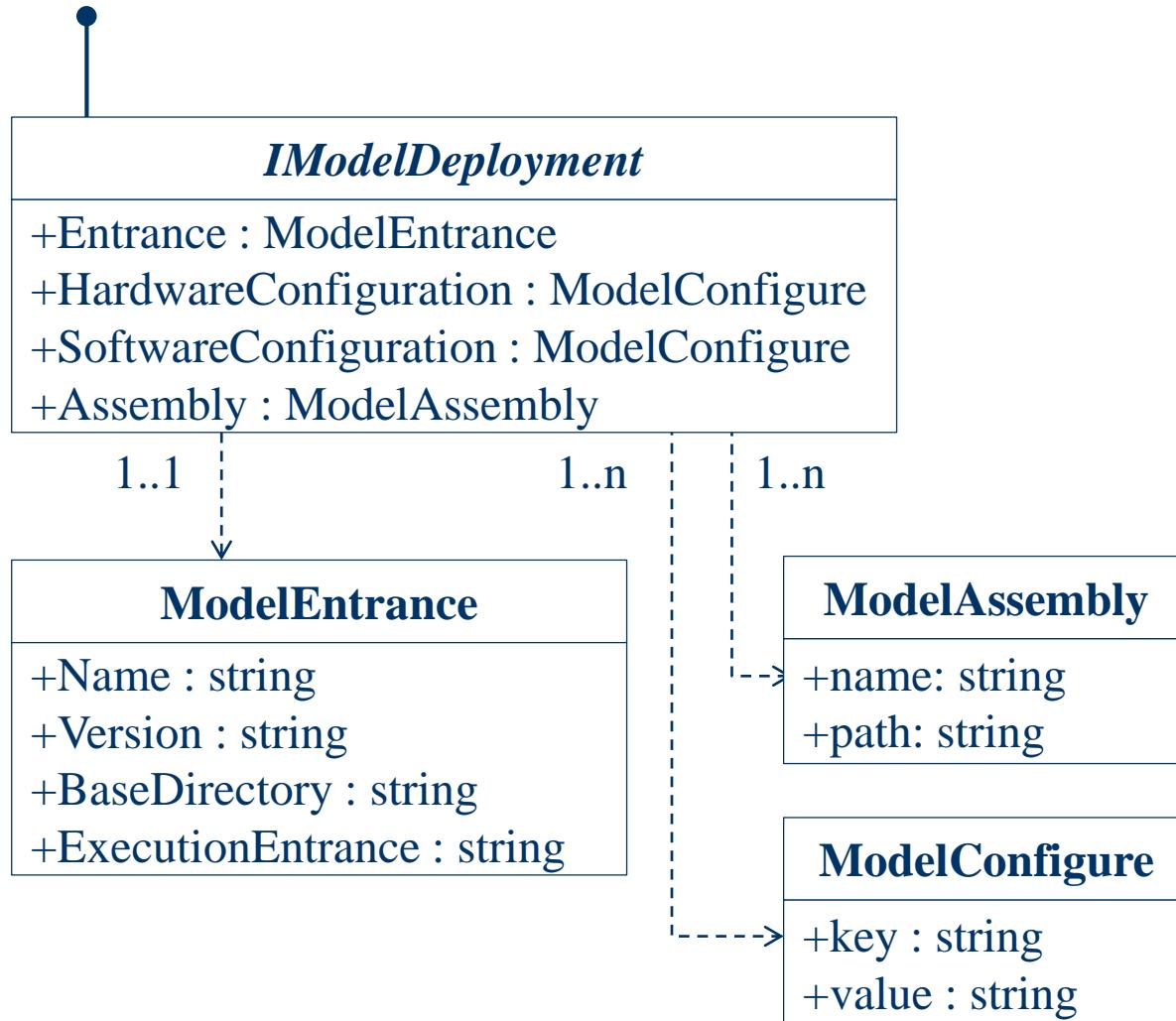
Execution dependencies

Dynamic Link Library,  
Model internal-related data,  
Execution program,  
.....



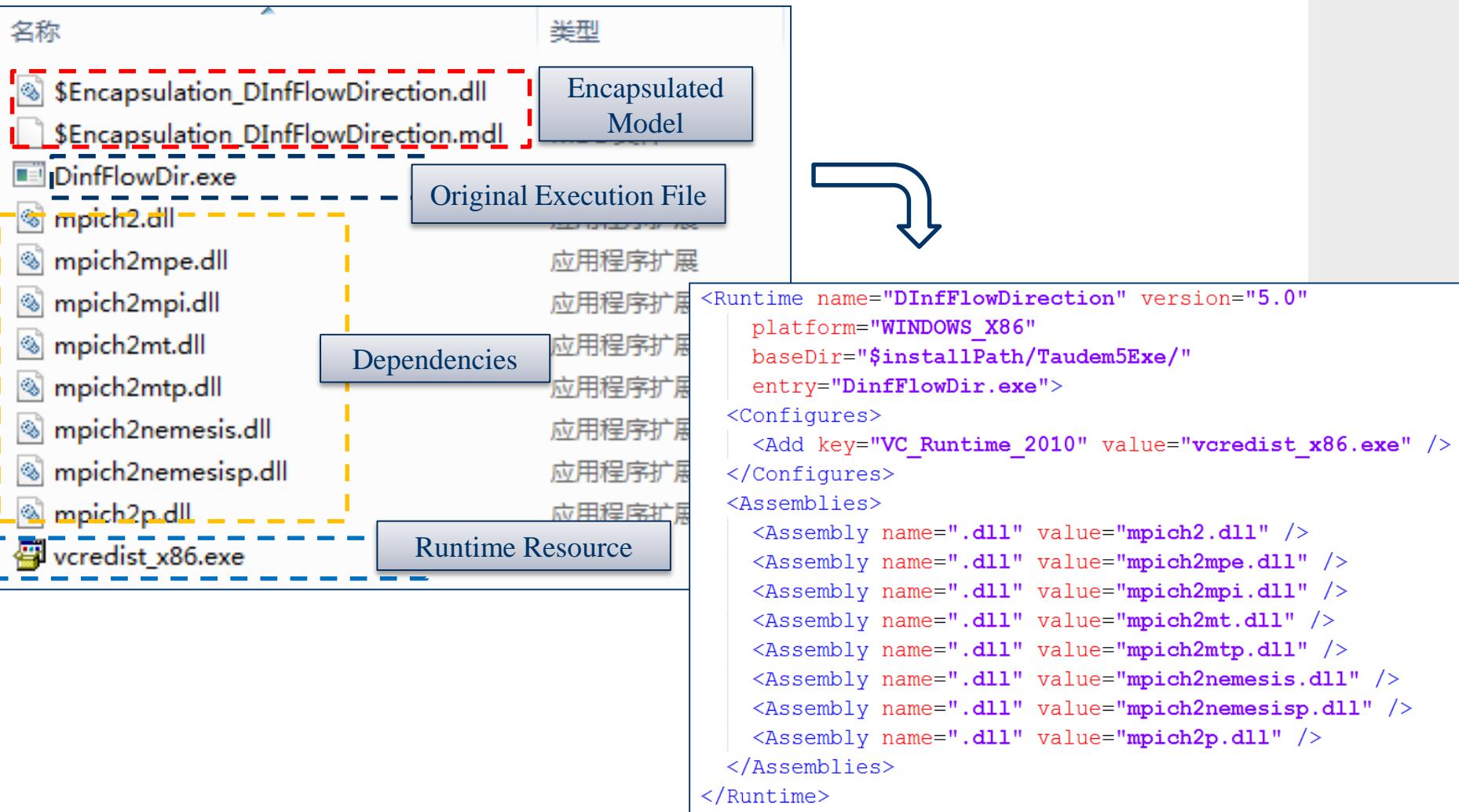


## 2.3 Model encapsulation - deployment



# 2.3 Model encapsulation - deployment

## Model Encapsulation Files

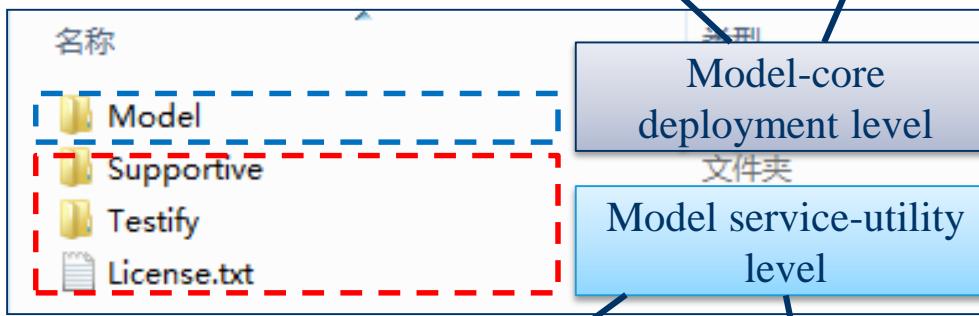


# 2.3 Model encapsulation - deployment

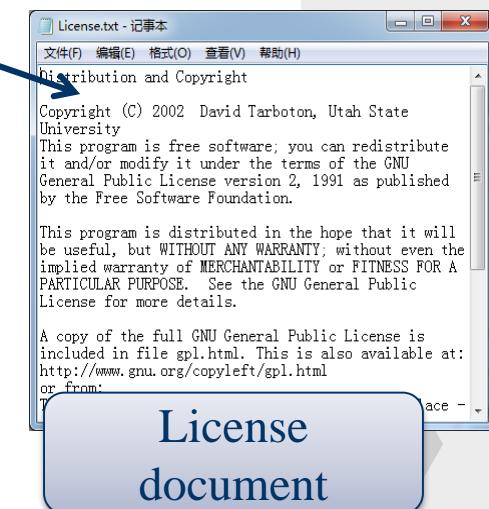
Execution



Deployment Package

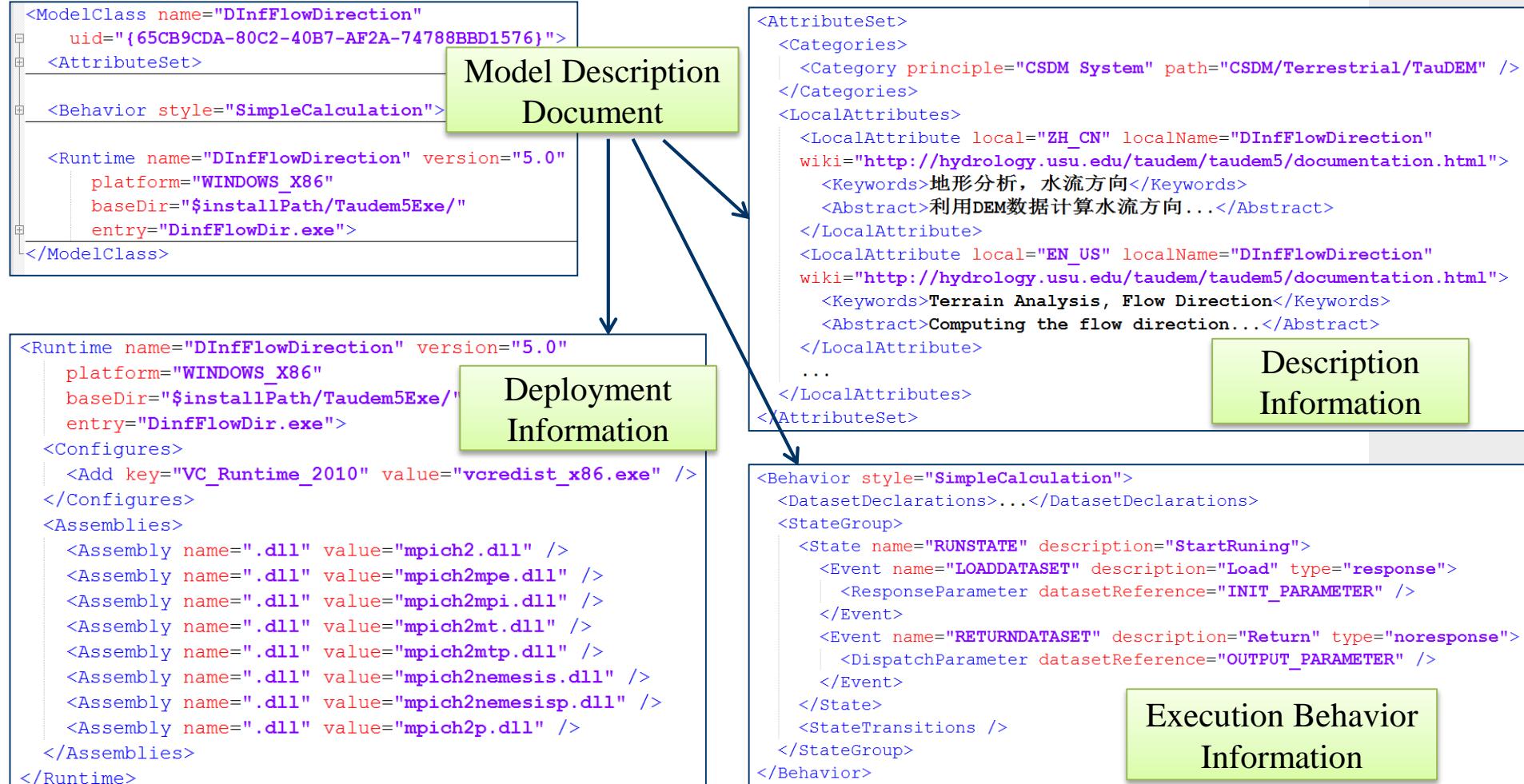


Service

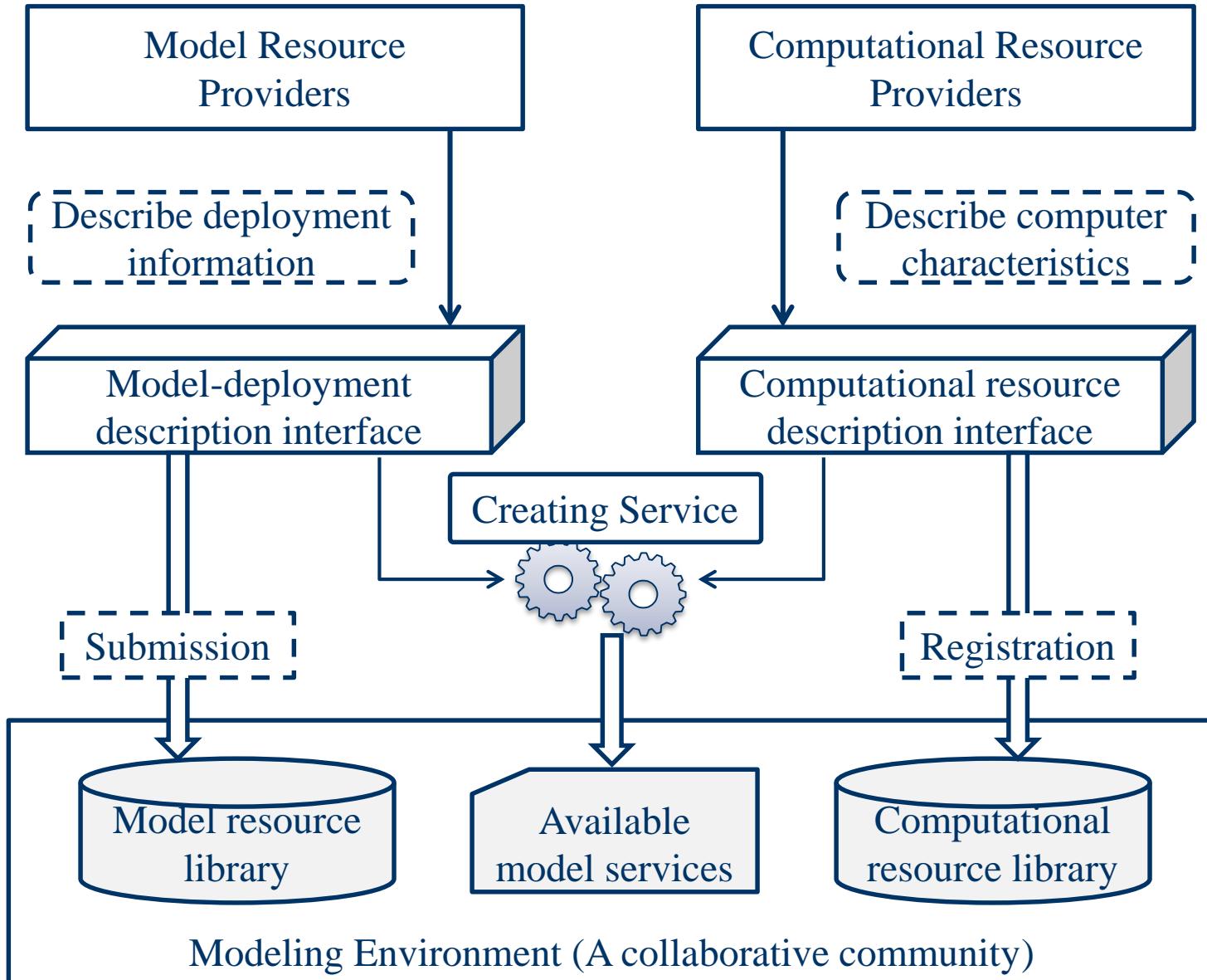


License document

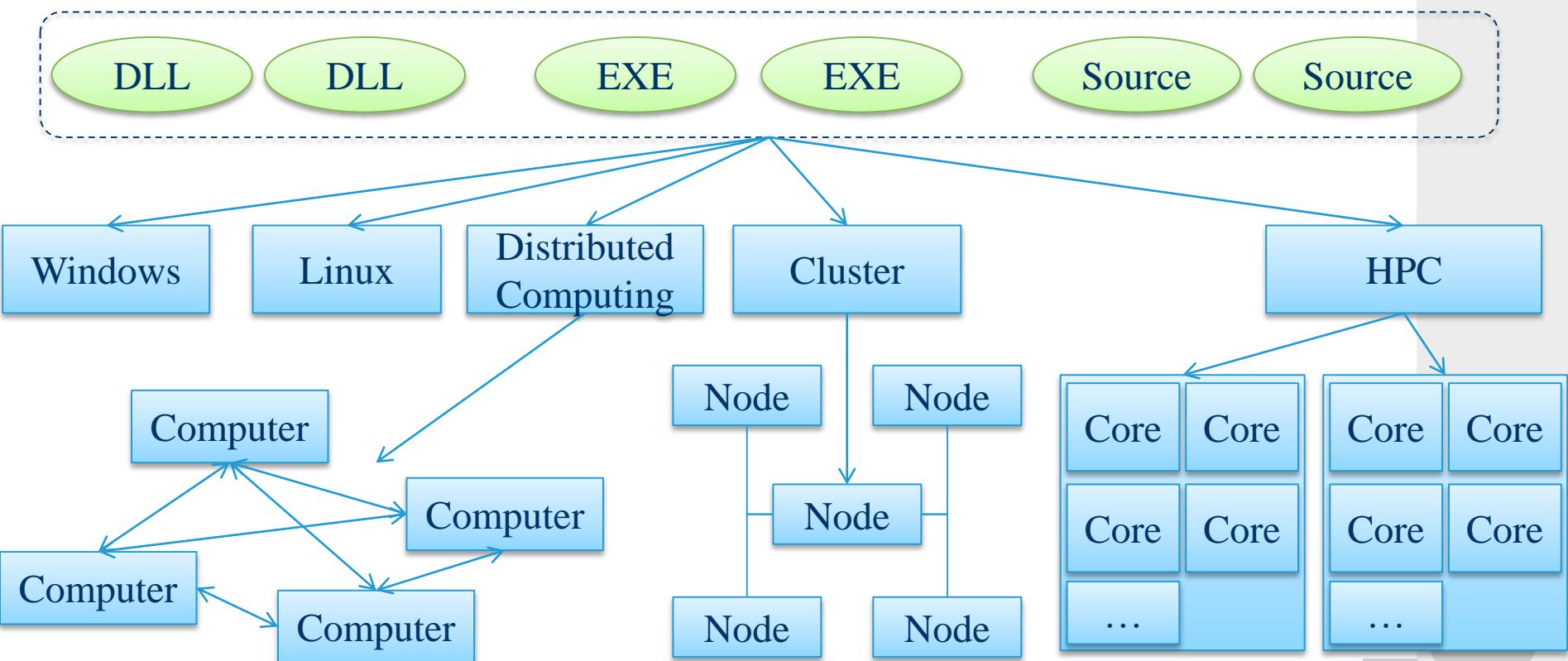
# 2.3 Model encapsulation - deployment



## 2.3 Model encapsulation - deployment

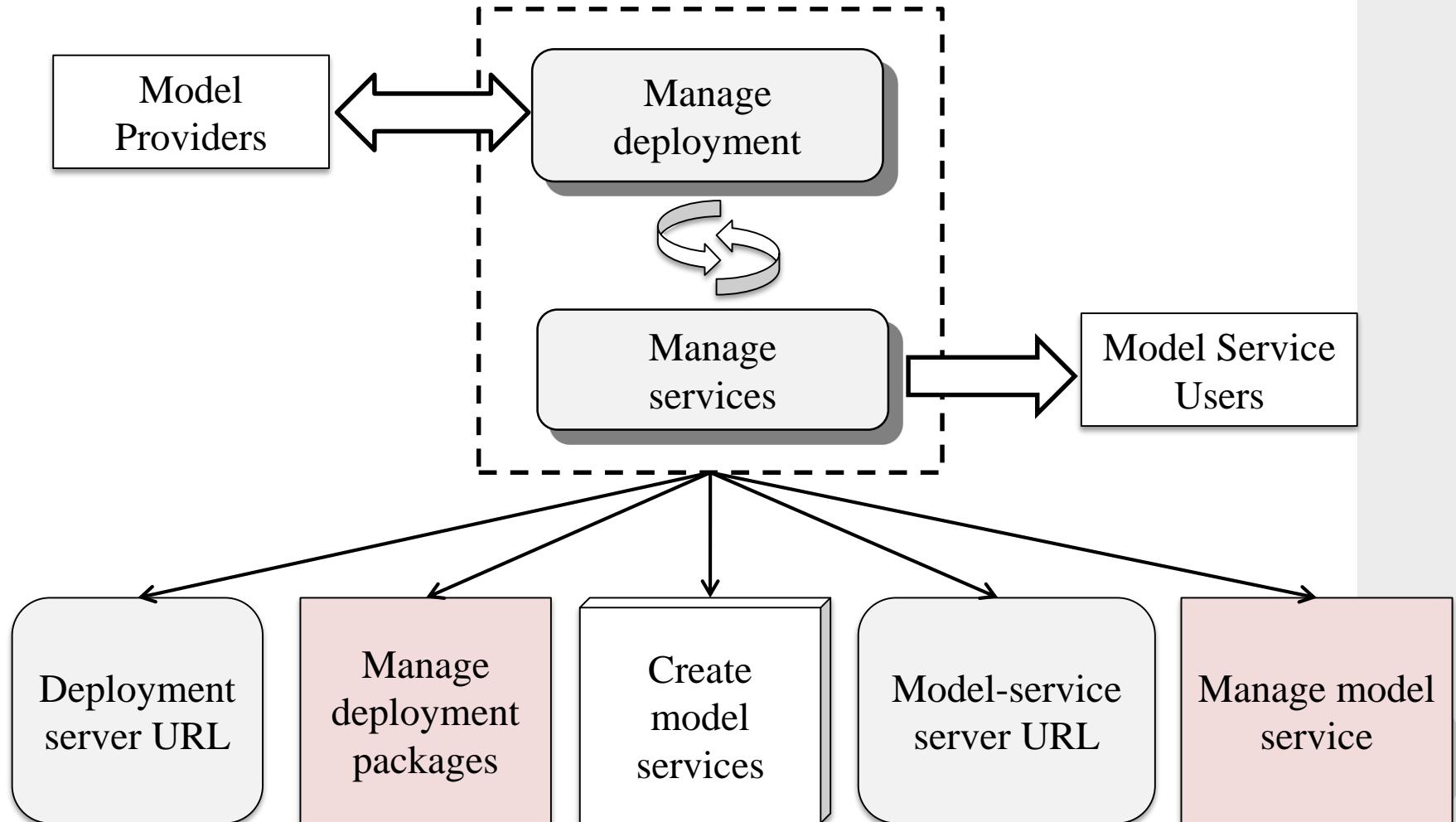


## 2.4 Model services



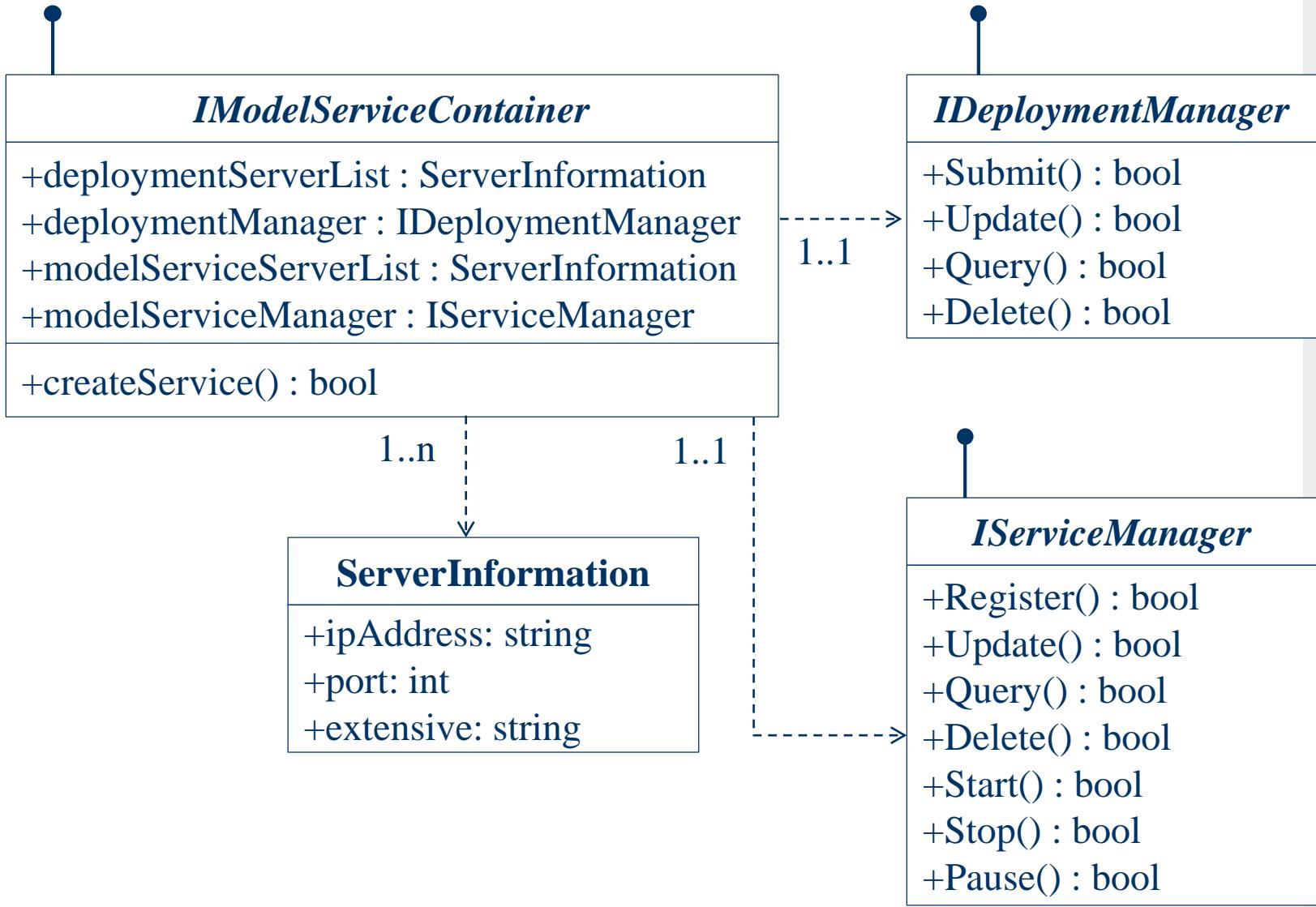


## 2.4 Model services



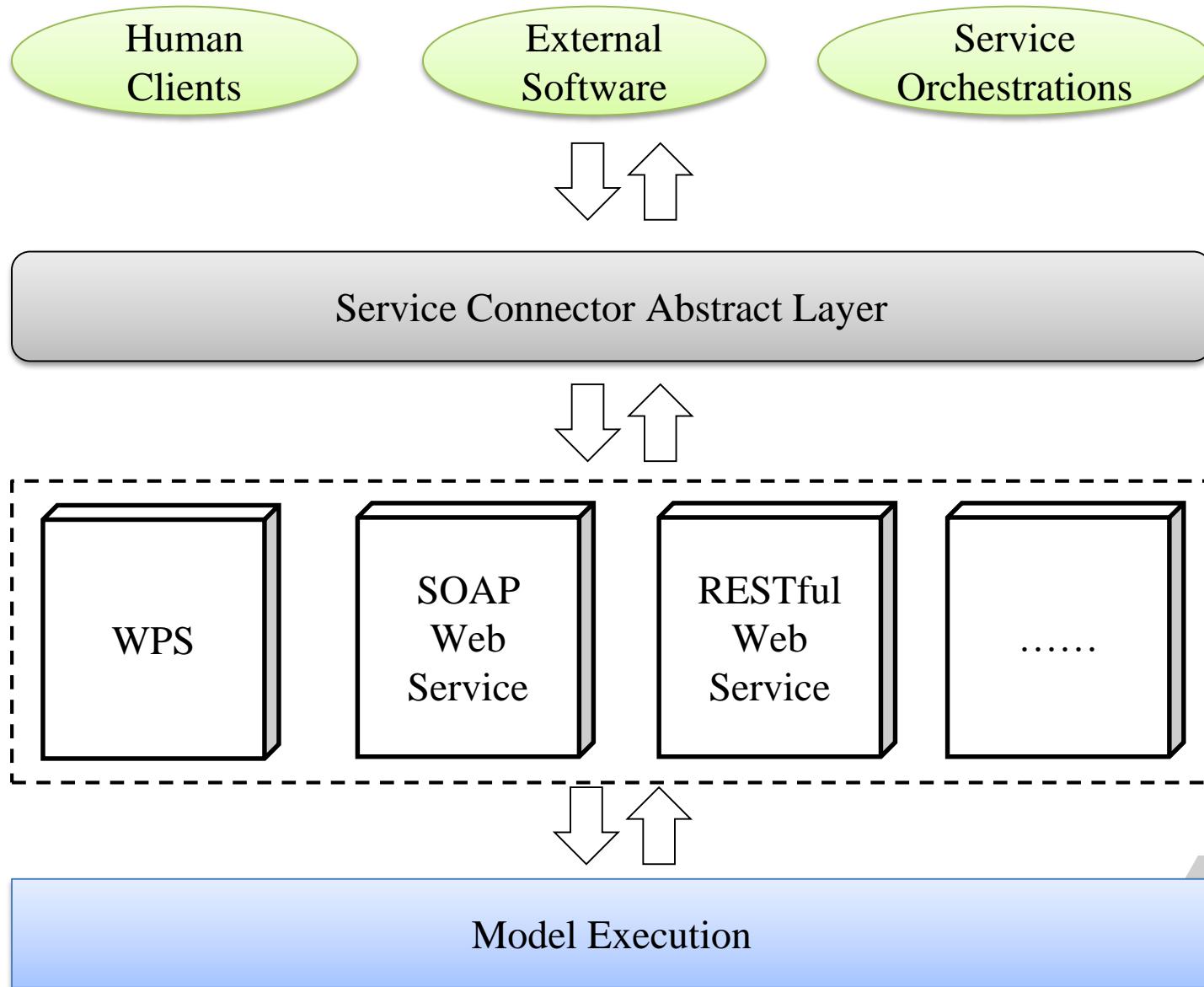


## 2.4 Model services



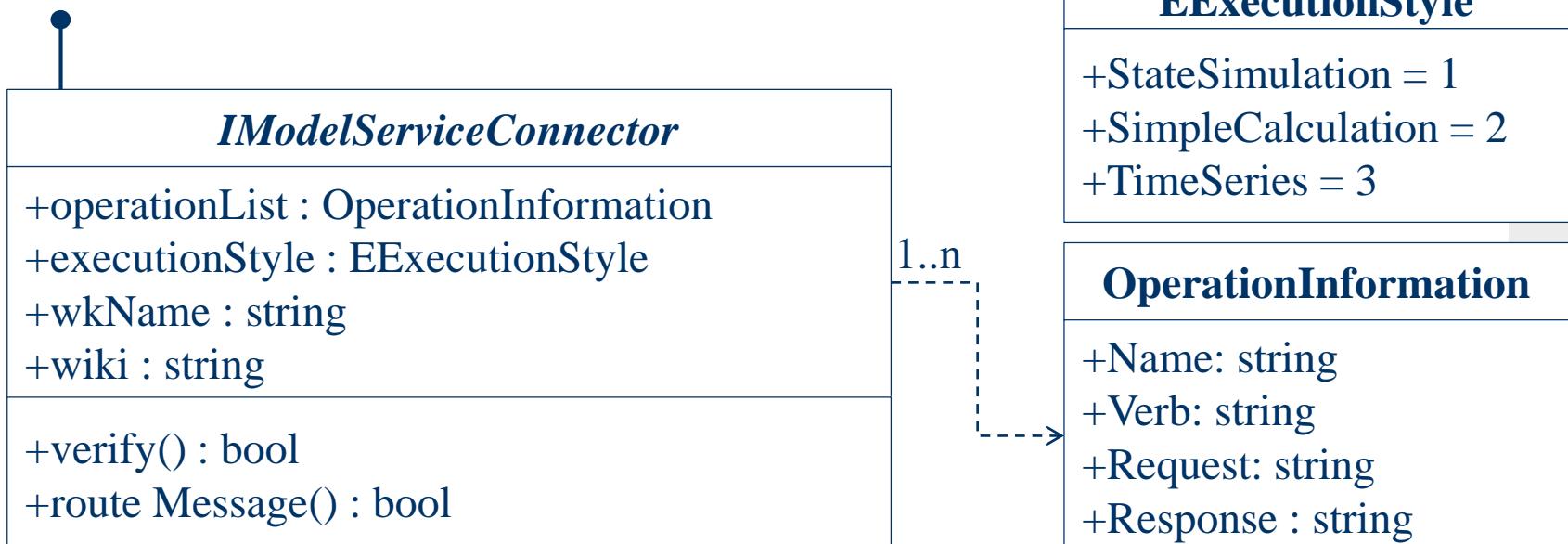


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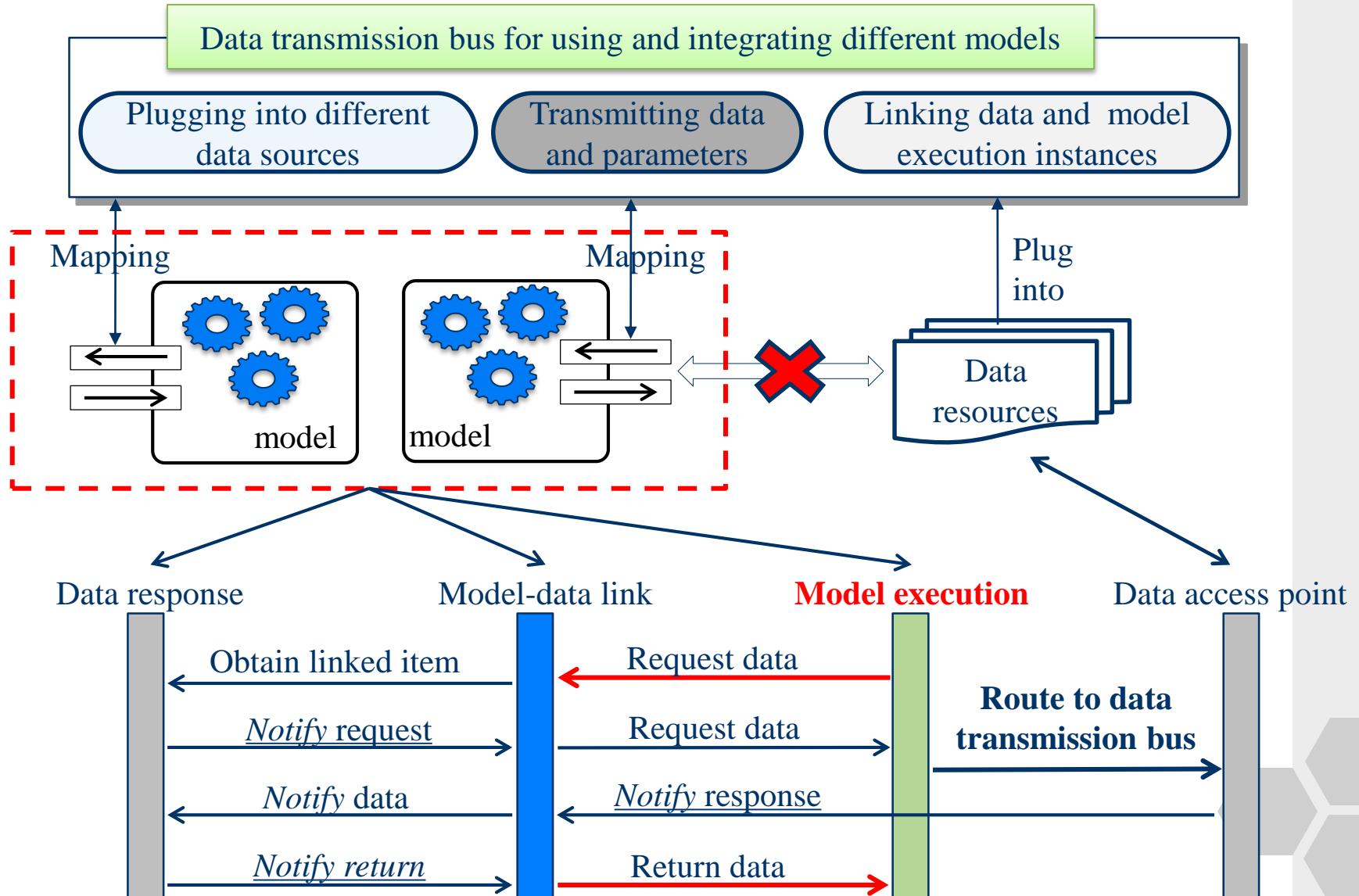




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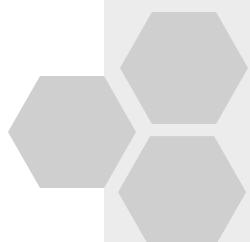
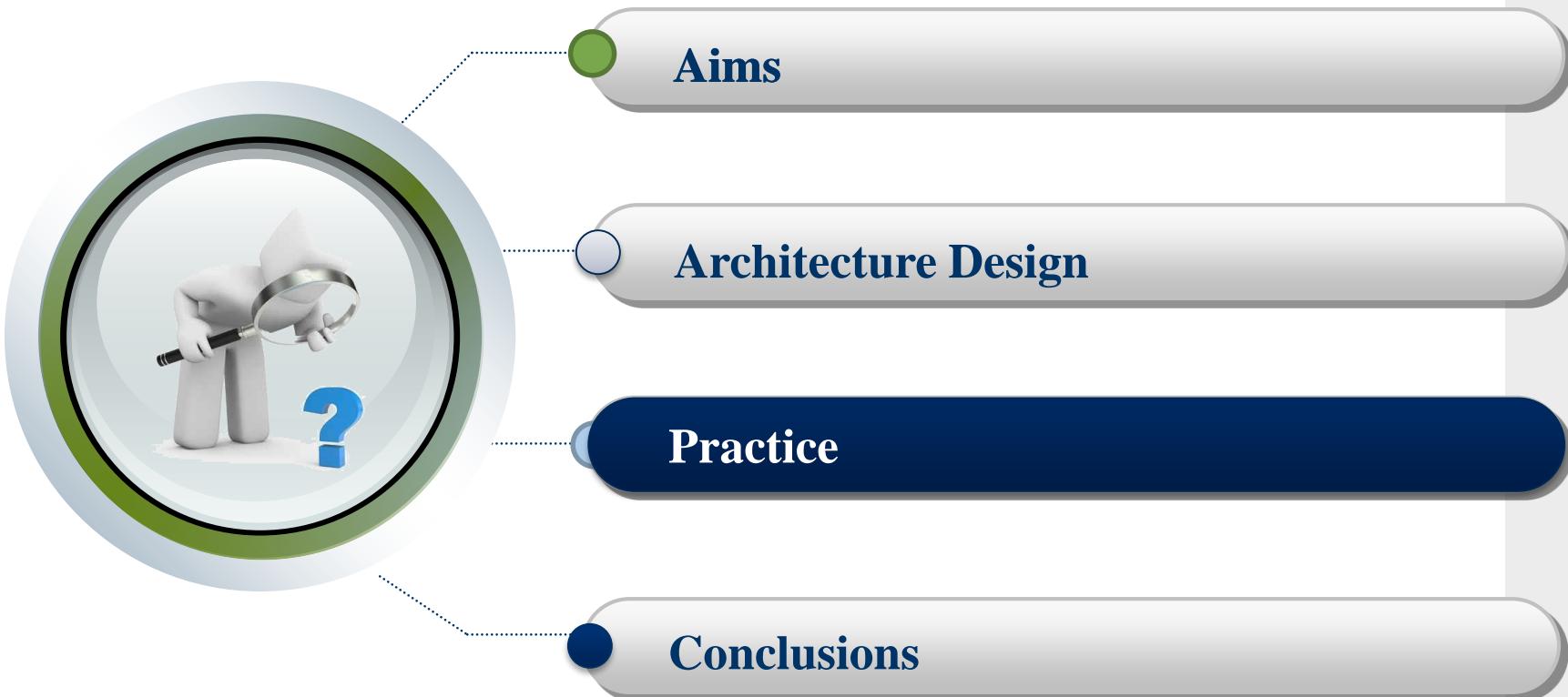


## 2.4 Model services

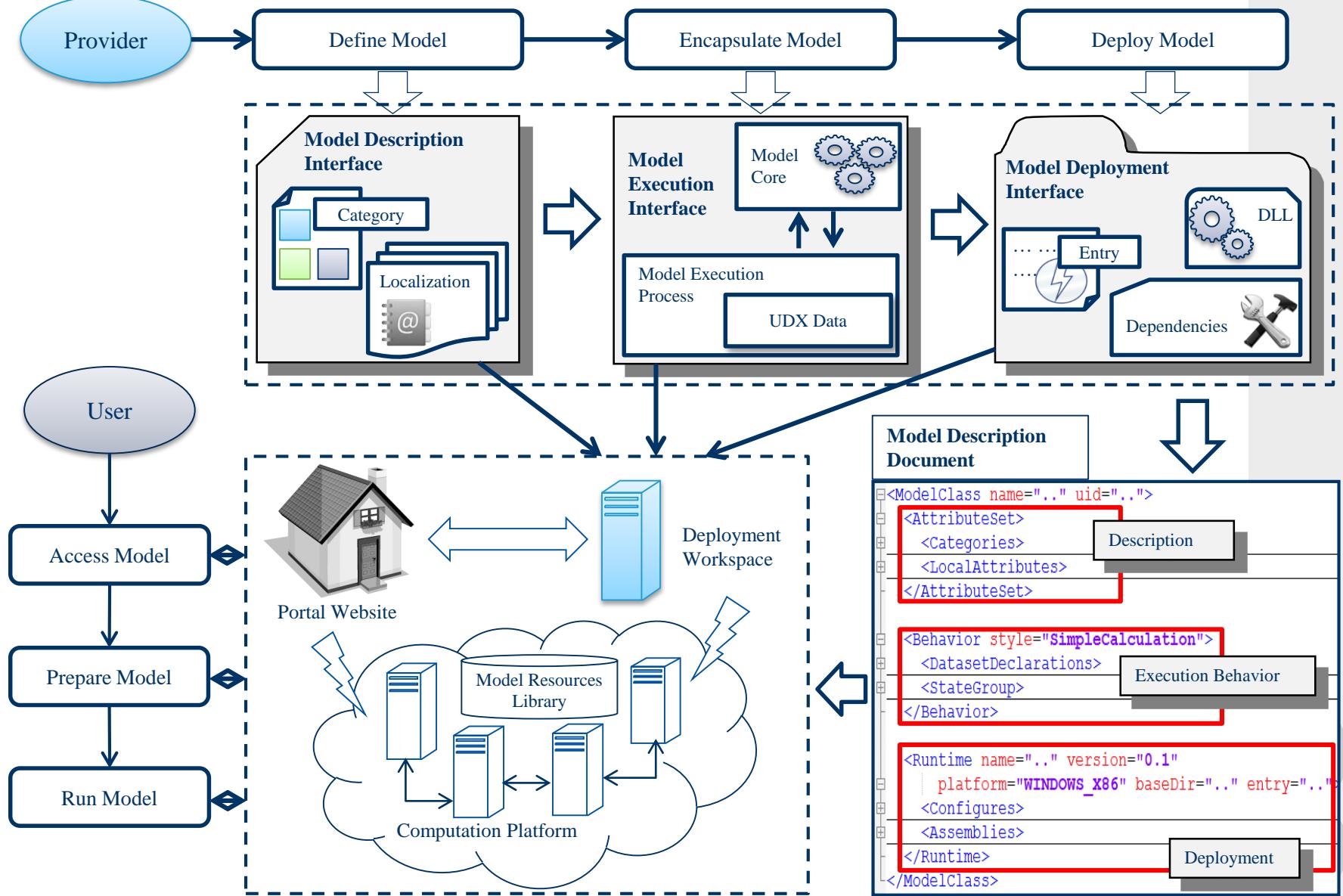




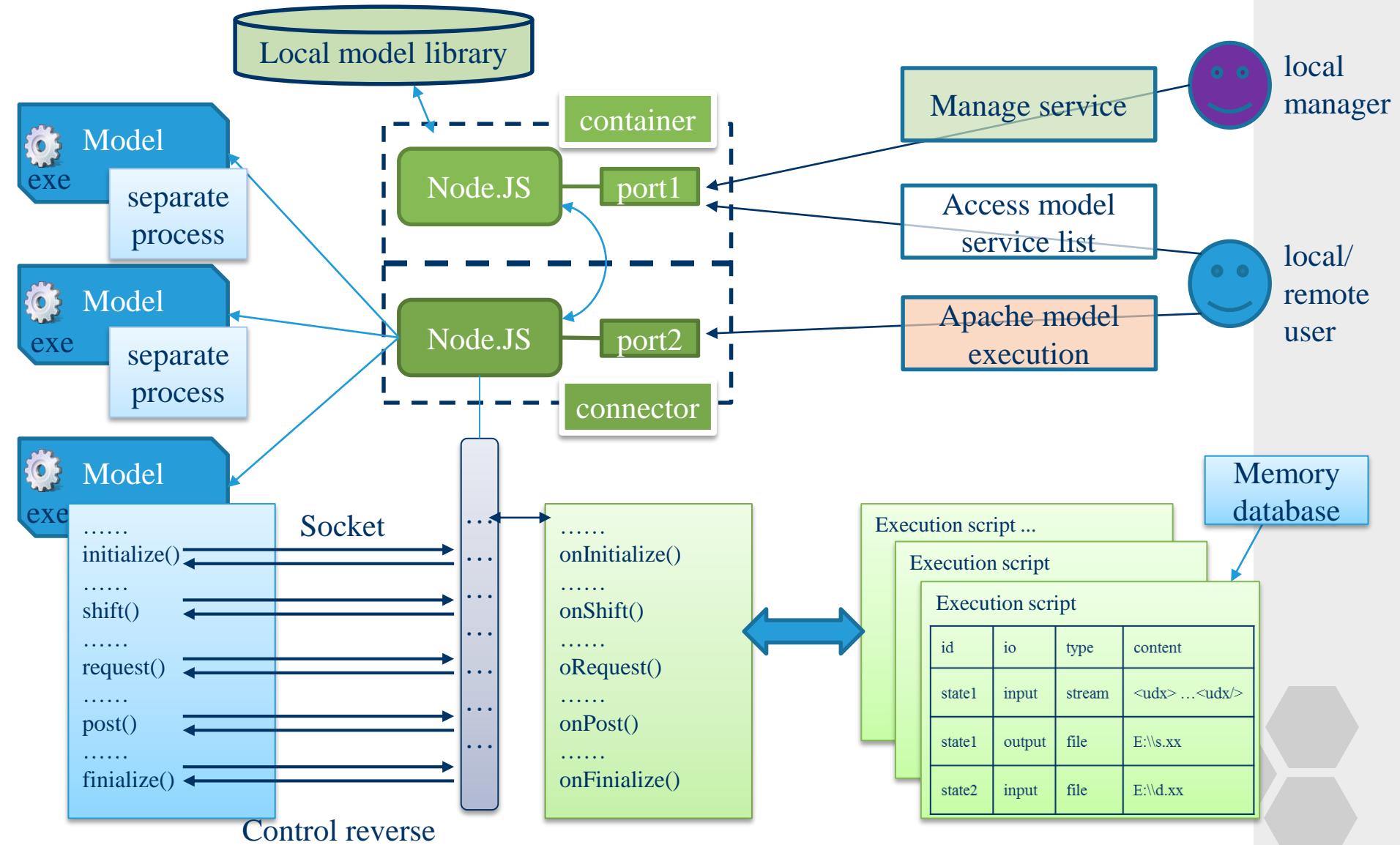
# Outline



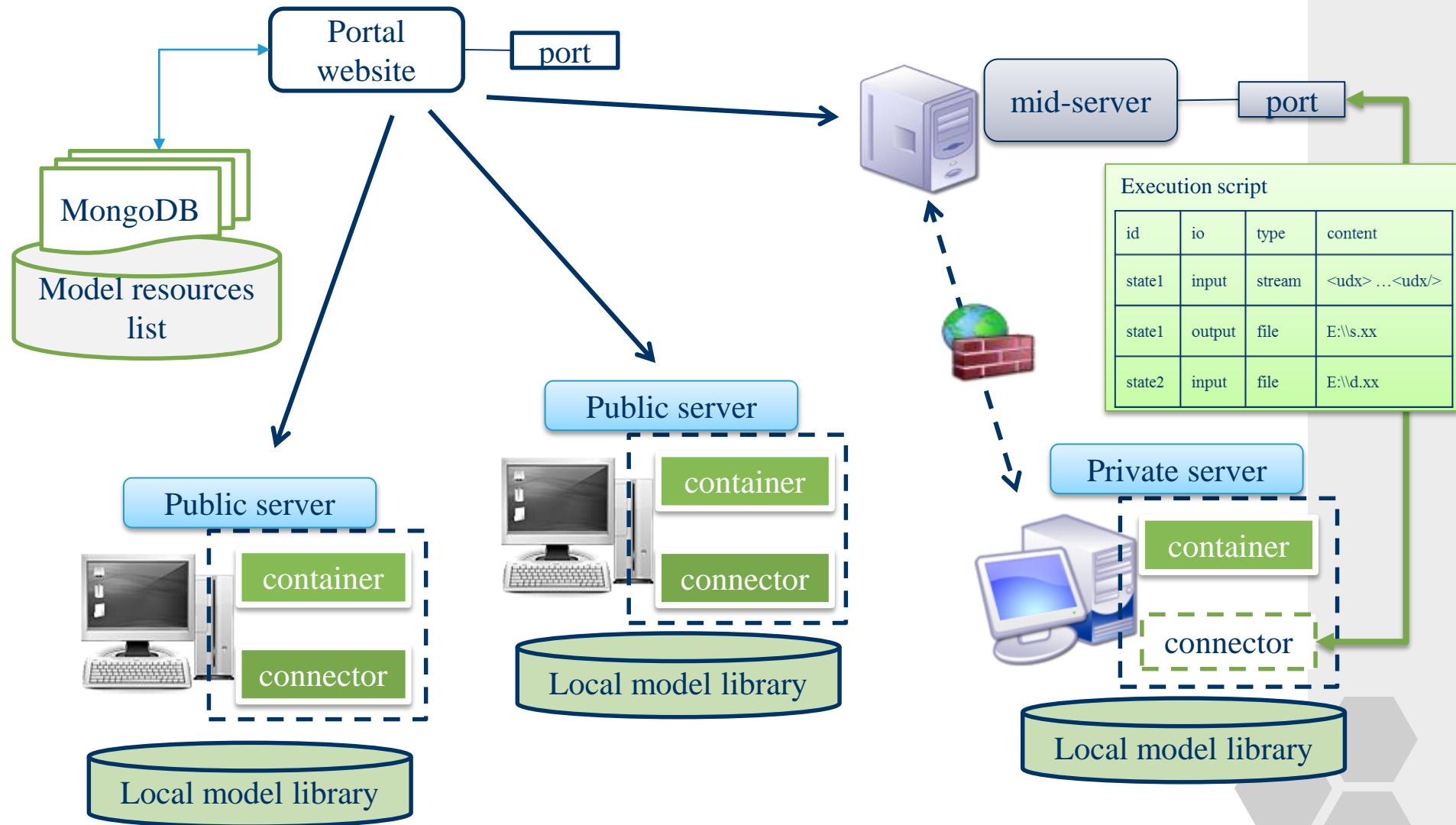
# 3. Experiments



### 3. Experiments – computation node

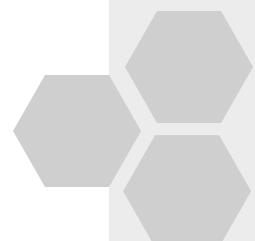
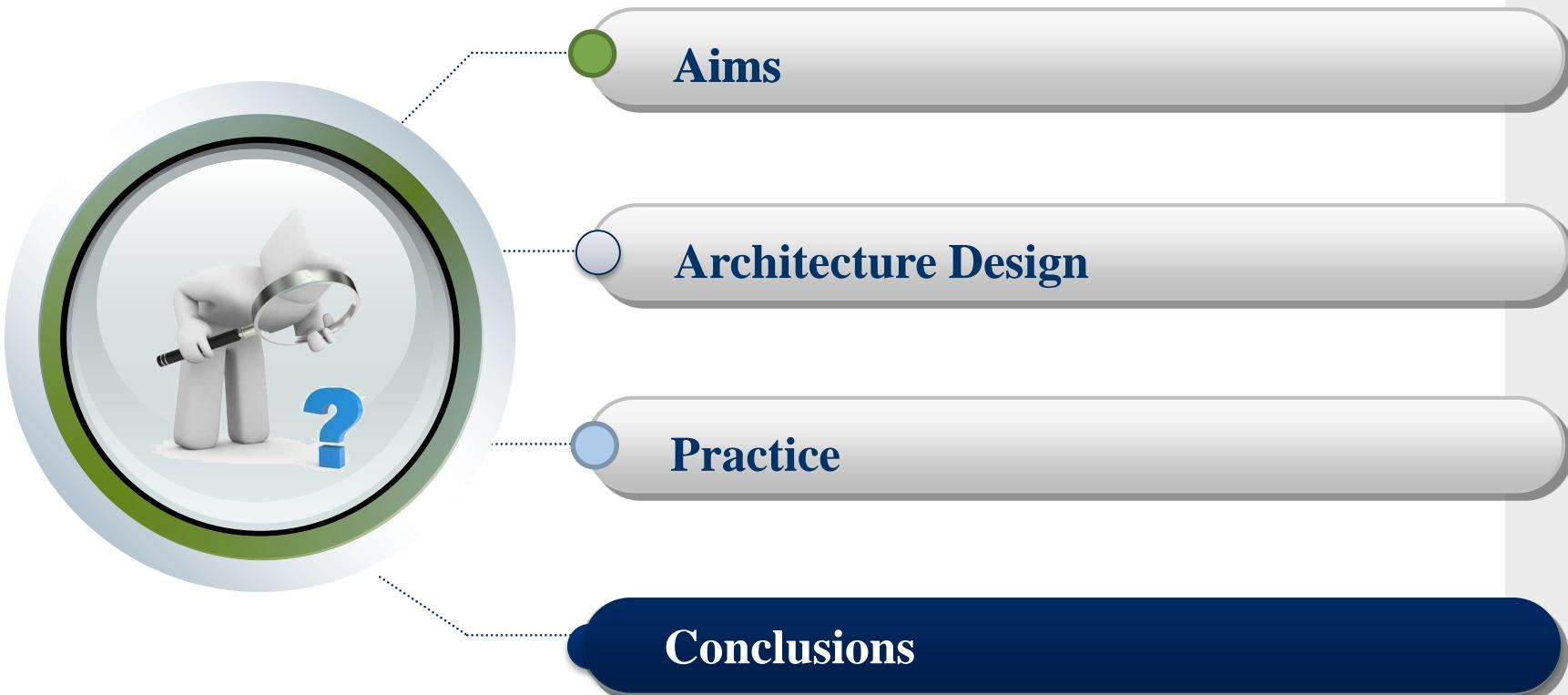


### 3. Experiments – computation node





# Outline





## 4. Conclusions

- ❖ The purpose of this study was to build an open environment for geographical analysis model sharing, and to construct a Volunteer-style sharing mode for modelling and computing resources. Our main focus was model description, model encapsulation and deployment.
- ❖ Using the proposed model-service encapsulation and deployment strategy, an open and collaborative environment for the sharing of geographical analysis models was designed and developed, model resource providers, computational resource providers and model-service users can more collaboratively work together.
- ❖ However, as geo-modeling and geo-model integration research is synthetic work, future research is needed: different web transmission methods should be considered to use model services and communicate with distributed model servers; QoS technology can be applied to support more intelligent model-service selection; the Geo-Processing Workflow (GPW), Business Processing Execution Language (BPEL), and other service-composition methods can be used to build scientific workflows; the web crawler method can be developed to help discover interested model resources.



This is an ongoing work

<http://geomodeling.njnu.edu.cn>



Thank You !