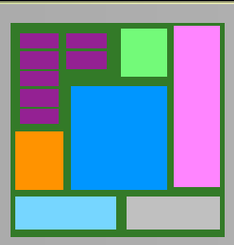
Development of a cloud-based modeling framework for complex advanced power systems

Increasing energy use

Increasing impact on the environment

Increasing resource scarcity

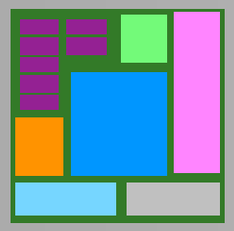


Energy and environmental challenges

Interactions between

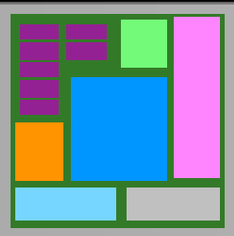
Engineered, human, and natural systems

are confounded by complexity



Holistic solutions are needed

Today we cannot model the richness, fullness, or complexity of engineered, human, or natural systems.



New modeling approaches are needed

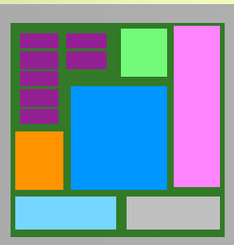
innovation

decision making

engineering

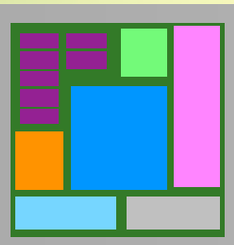
...

actionable information
that changes something



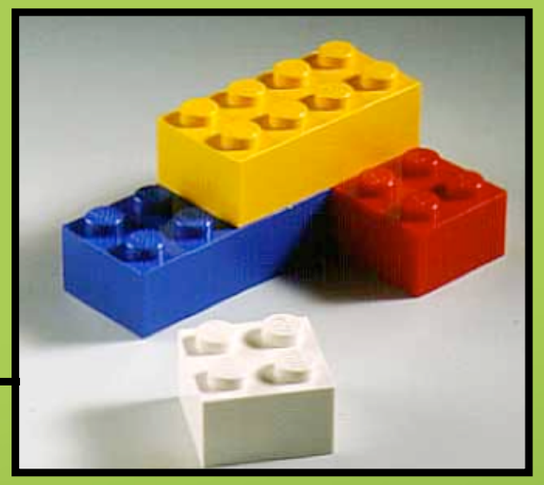
Why create models?

Computers will gather of information and format it for decision makers …

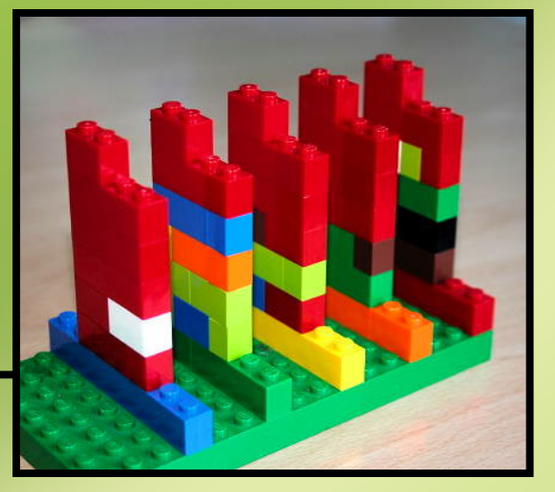


Old decision making paradigm

Snap



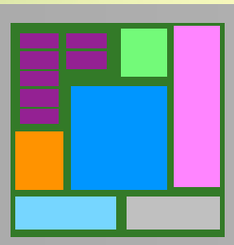
Build



Do

New decision making paradigm

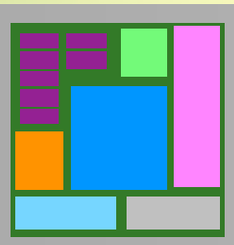
Decision making environments that integrate all the information, models, and other artifacts related to a product or process.



“What if” environments

What’s needed

1. Integration
2. Mediation
3. Interaction



Actionable information

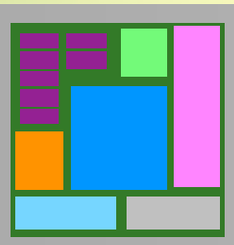
What's needed

Information

1. Integration
2. Mediation
3. Interaction

Actionable information

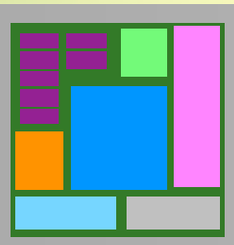
Connects engineering decisions (e.g., design changes policy options) to specific high level outcomes



Why integration matters

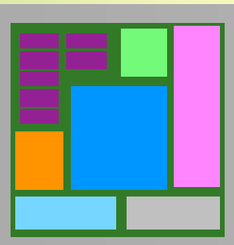
This …

- Guides model development,
- Indicates inconsistencies and shortfalls in modeling,
- Focuses efforts on simulation based engineering, and
- …



“… a centralized model encompassing a set of other models”

- integration framework
- global ontology and semantics

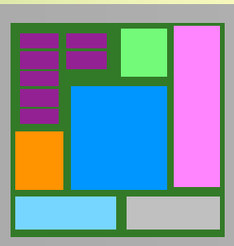


Integrated modeling

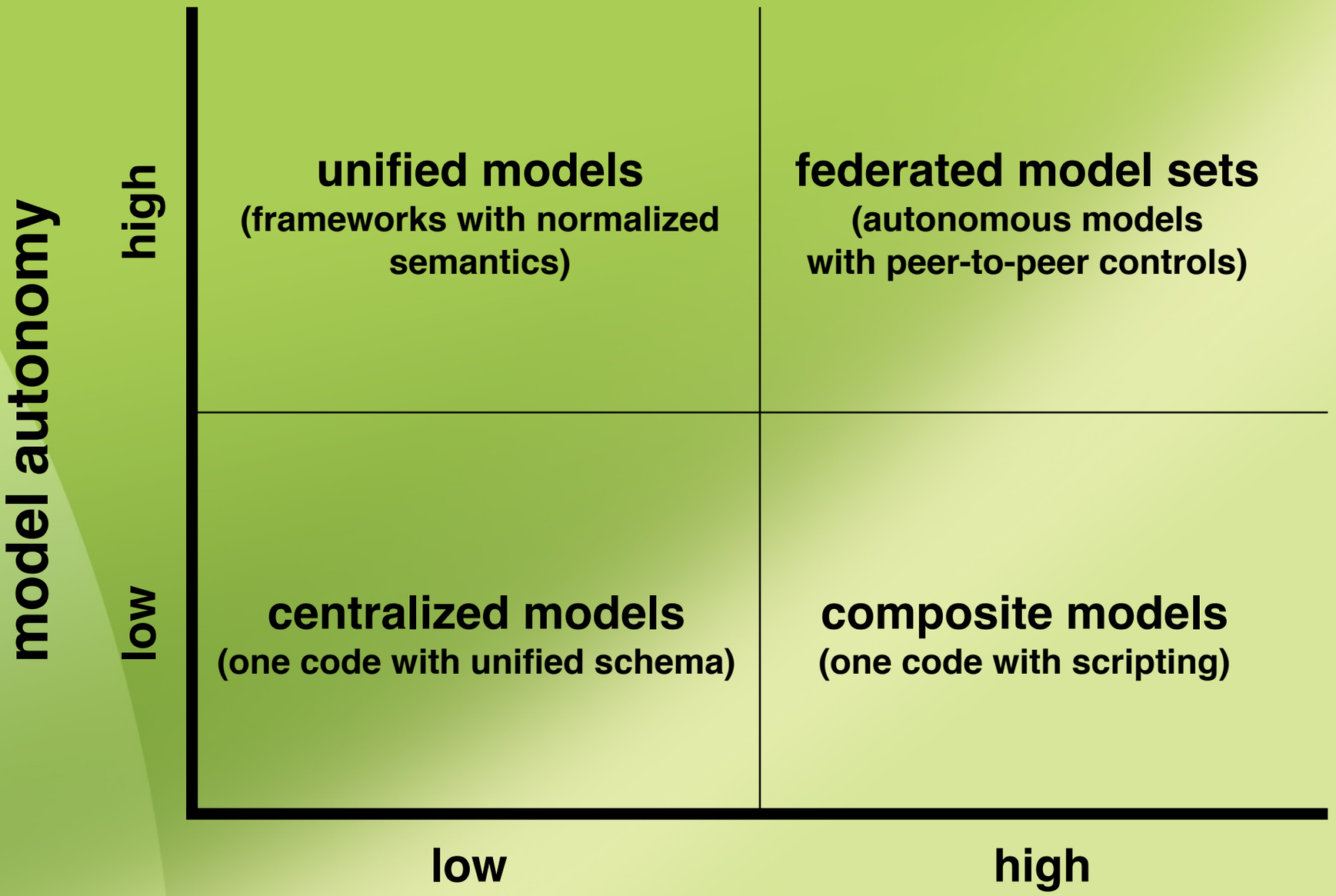
"… a centralized model encompassing a set of other models"

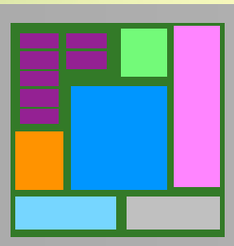
- integration framework
- global ontology and semantics

Pre-determined meta model



Integrated modeling

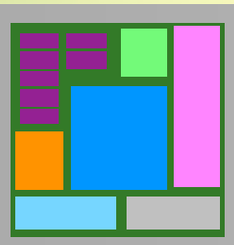




Model portability

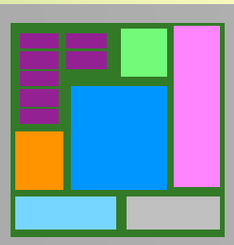
To provide

- high degree of independence for component models;
- a common, light-weight mechanism for model linkage; and
- a basis for deploying the federated model set.



Goal of developing a new architecture

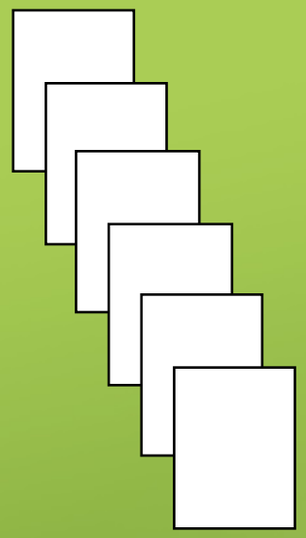
- **Constituency**
  the capability of models to come together in groups that have coherence and substitutability
- **Articulation**
  a simple and precise mechanism for describing how the models are chosen, linked, executed, and results reported
- **Convergence**
  a knowledge of the topological mapping of the federation and the capability to route and converge information through the federation to complete the assigned tasks



Model Warehouse

- Model A
- Model B
- Model C
- Model D
- Model E
- …
- …

Library



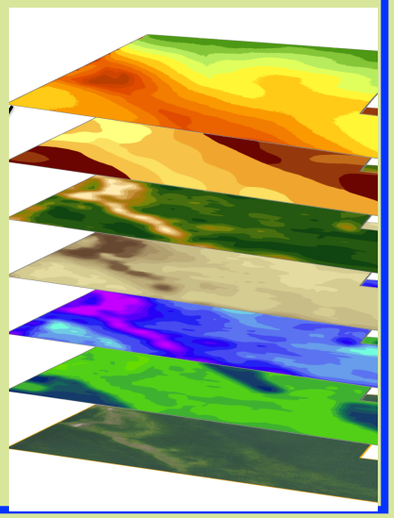
Federation schema

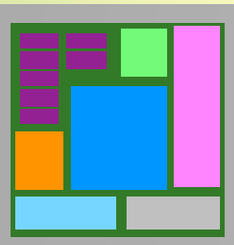
inputs
outputs

Model A …
Model C …
Model E …
Duplicate
    Model F …
    Model G …
End duplicate

Federation management system

User interface



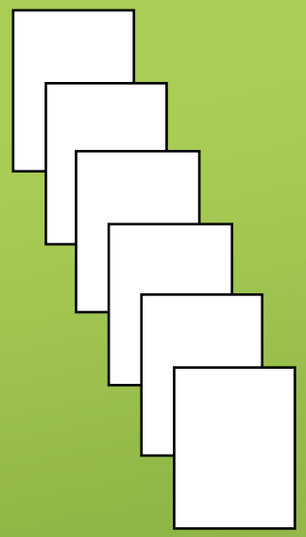


Components and information flow

Model Warehouse

- Model A
- Model B
- Model C
- Model D
- Model E
- …
- …

Library



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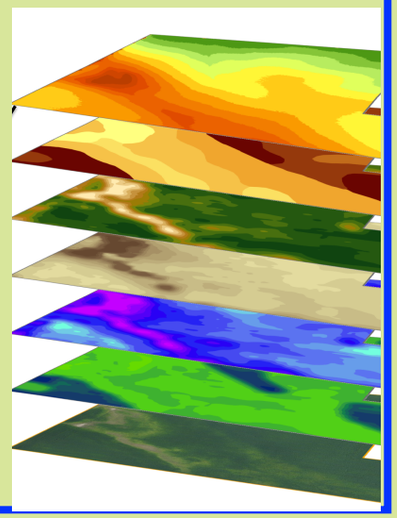
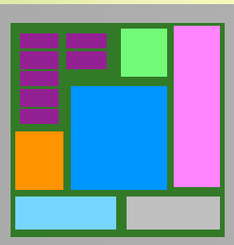
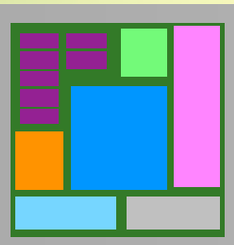
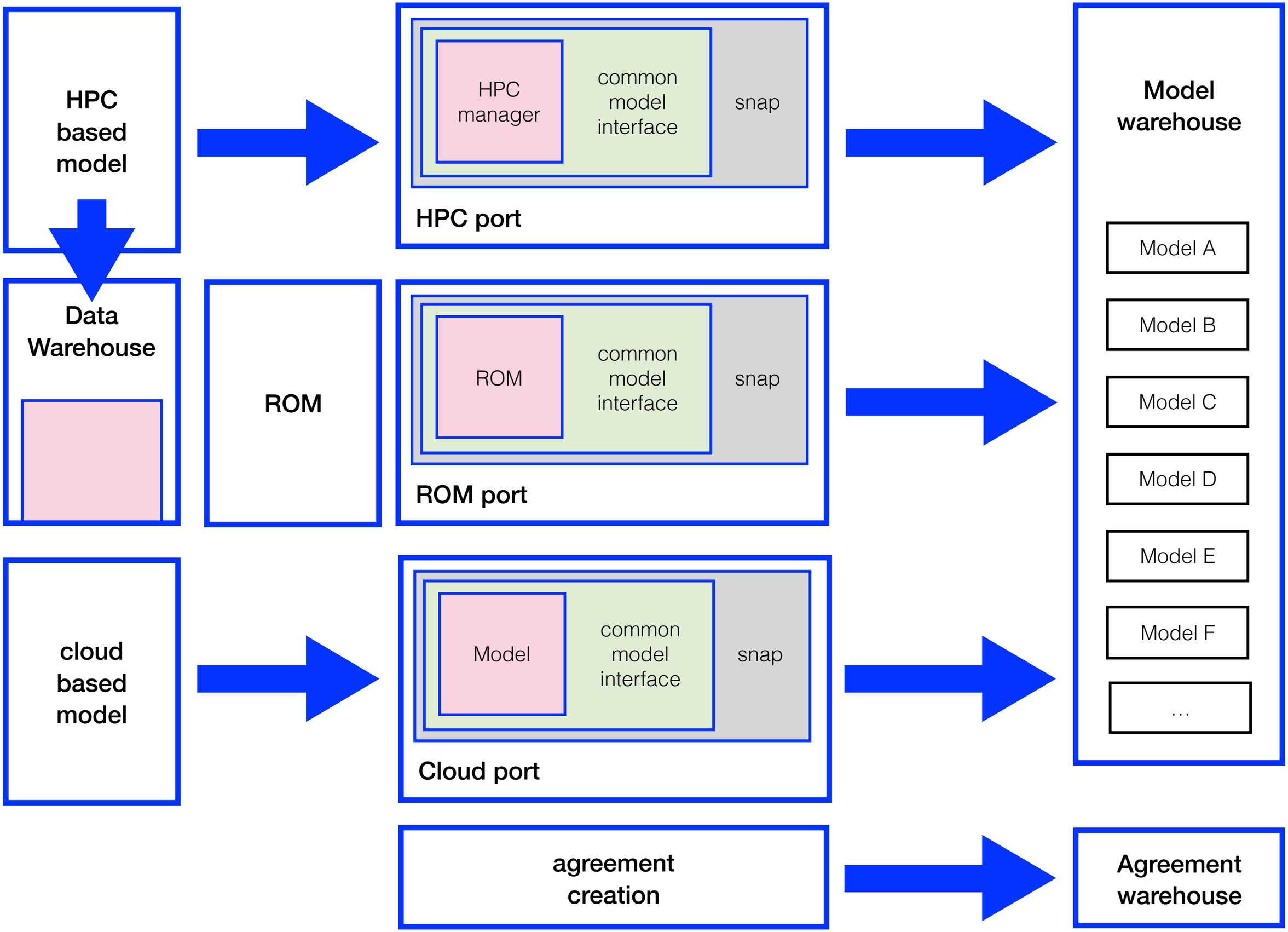




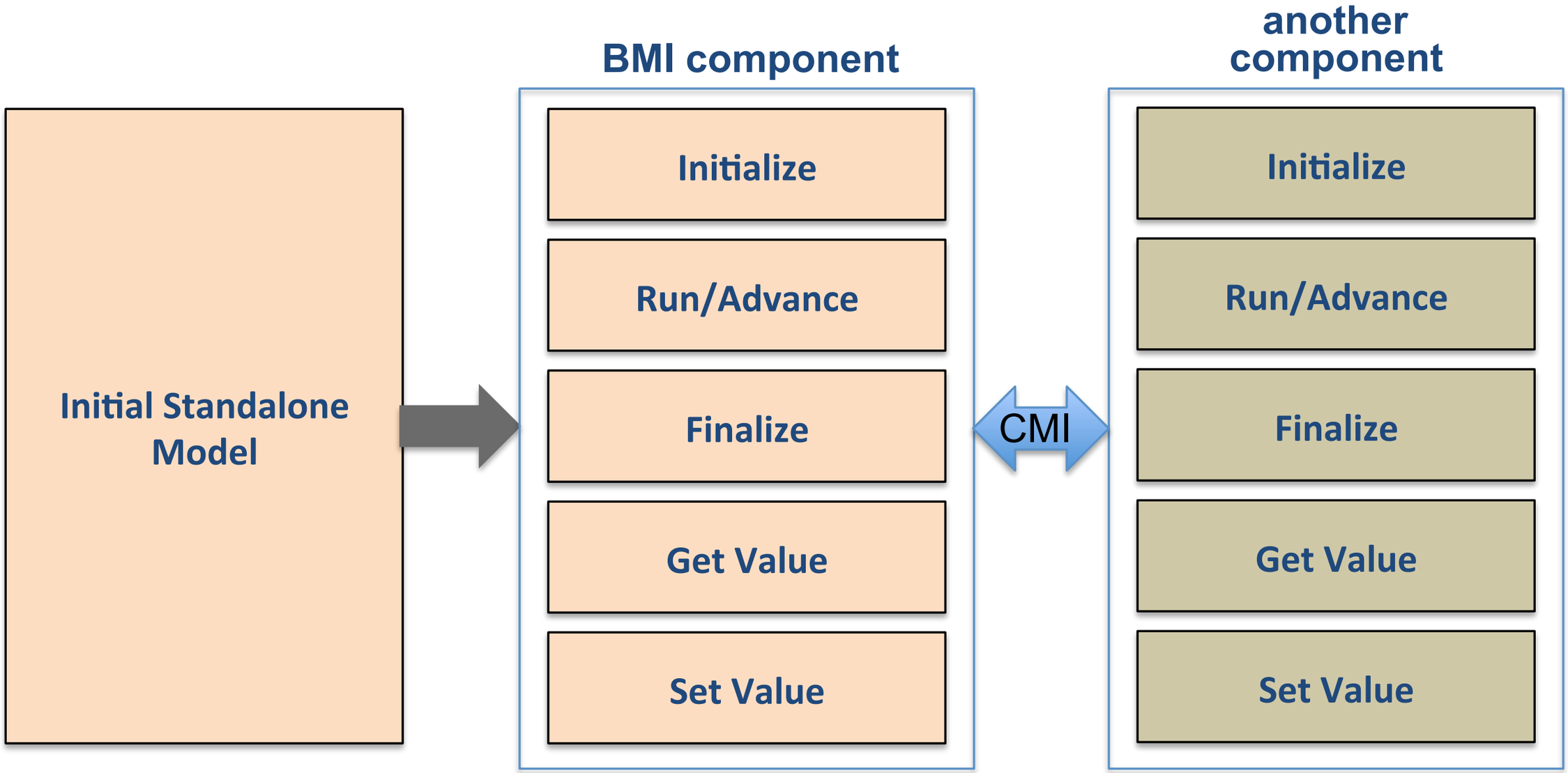
Components and information flow

- Content creation process
- Model integration schema,
- ROM management schema
- Federation management system
- Development of a domain specific language

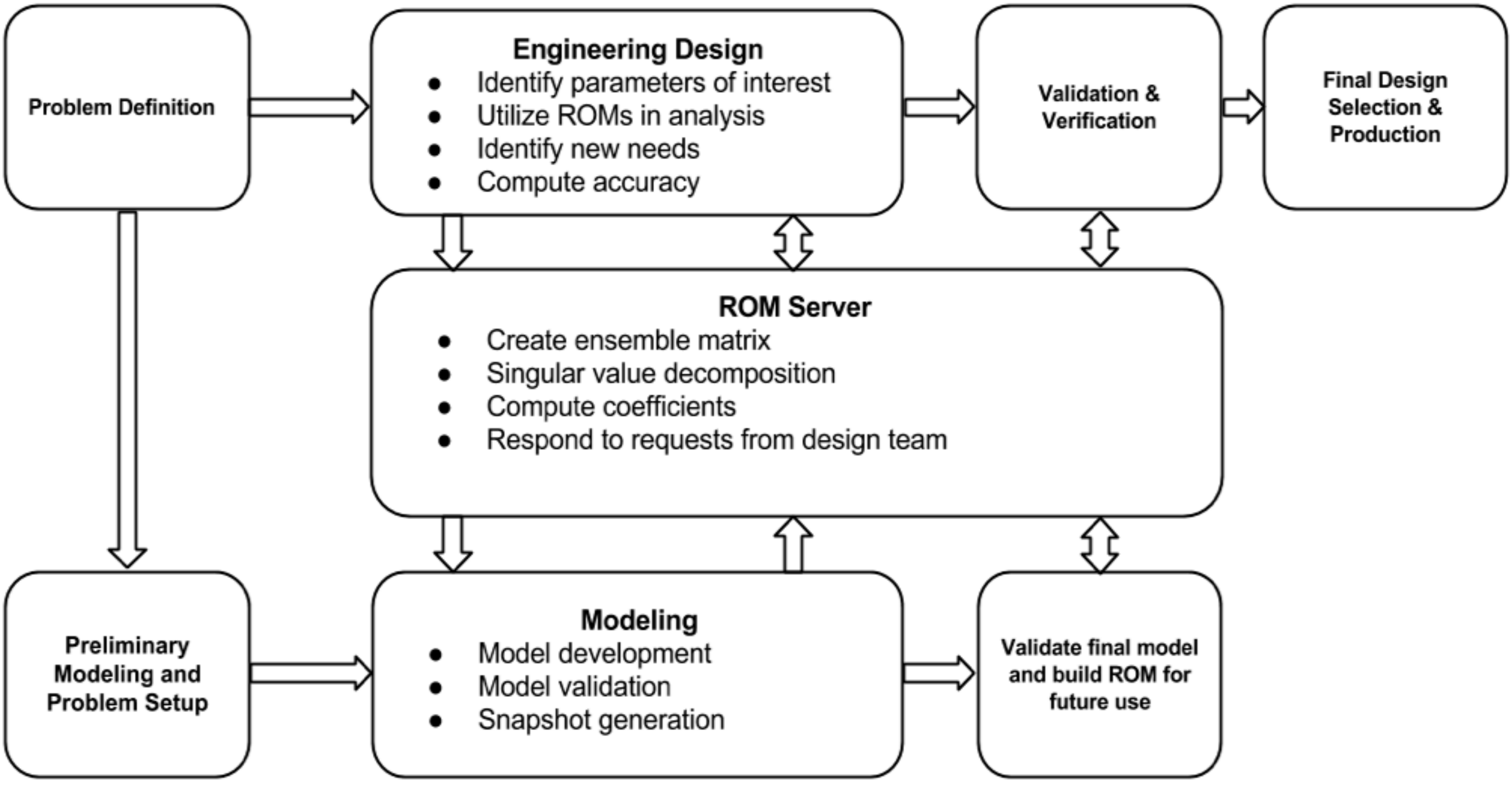




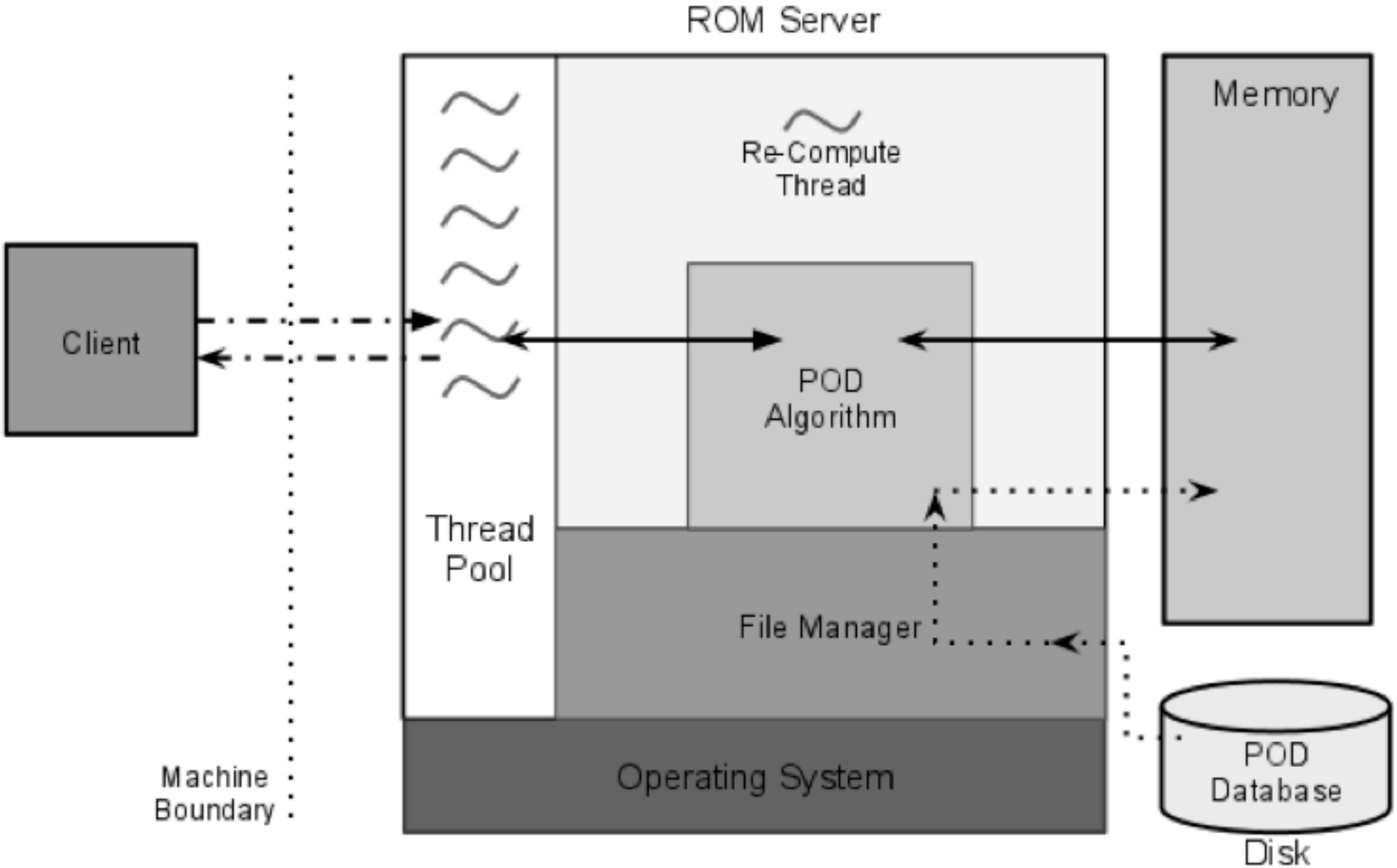
User defined content creation process



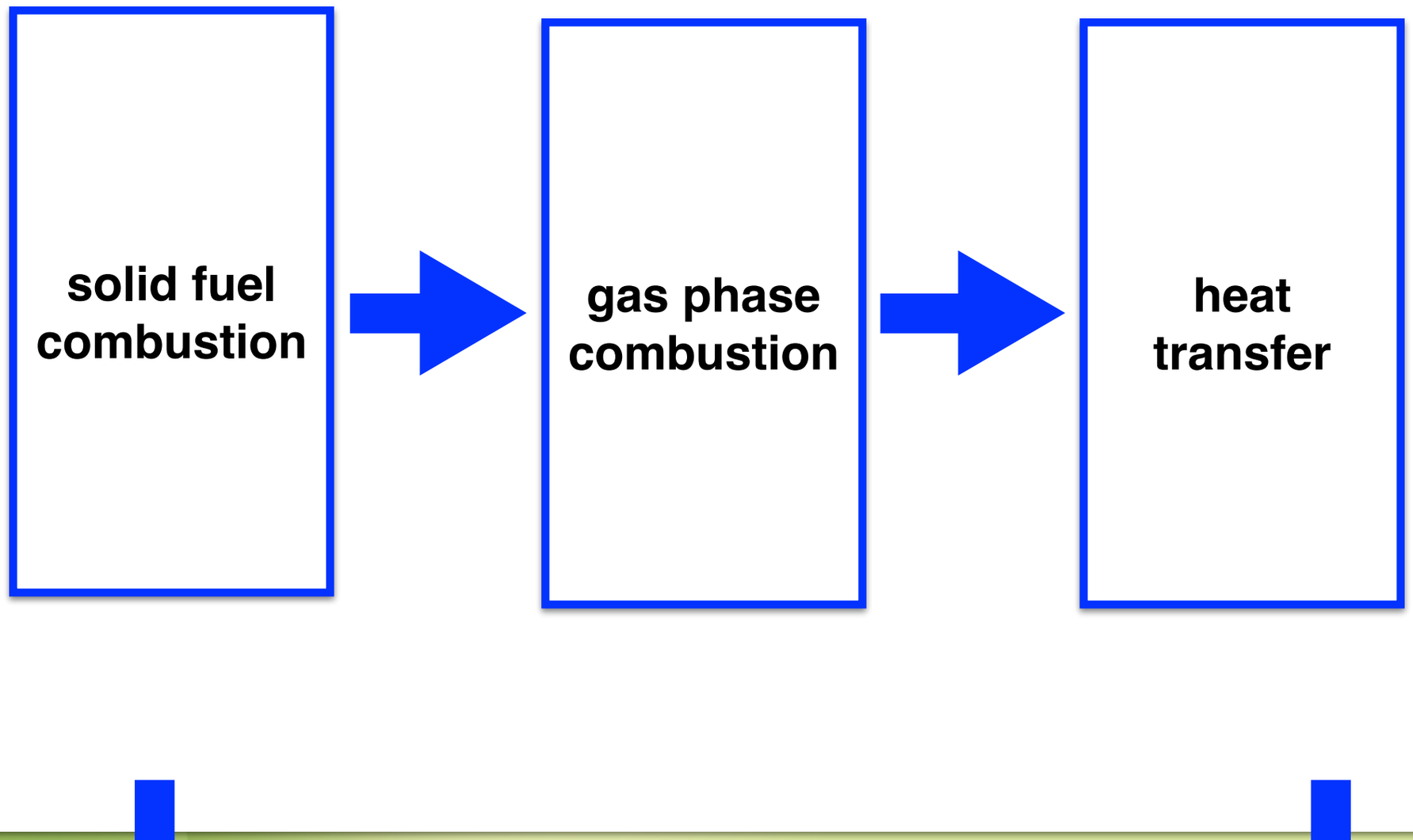
initial model integration schema



ROM management schema

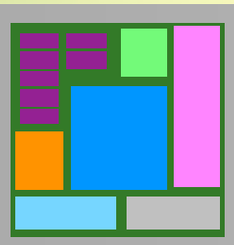

ROM Server
Memory
Re-Compute
Thread
Client
POD
Algorithm
Thread
Pool
File Manager
Machine
Boundary
Operating System
POD
Database
Disk

User sees the web interface



HTTP endpoint

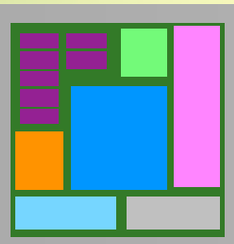
HTTP endpoint



Federation management system

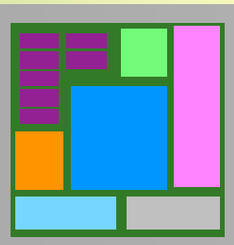
Domain specific language

- starting point is University of Colorado work on systems integration,
- define energy specific needs,
- provides an engineering workspace.



Federation schema

- Initial demonstration of an application based on analysis as a web based service,
- Develop federated model of the NETL Hyper system,
- Extend Federation Management System
- Define other example cases.



Planned work

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