

Shahab Pourtalebi, Imre Horváth, 2016. Information schema constructs for defining warehouse databases of genotypes and phenotypes of system manifestation features. *Frontiers of Information Technology & Electronic Engineering*, 17(9):862-884. <http://dx.doi.org/10.1631/FITEE.1600997>

# Information schema constructs for defining warehouse databases of genotypes and phenotypes of system manifestation features

**Keywords:** Cyber-physical systems, Software tool box, Pre-embodiment design, System manifestation features (SMFs), Warehouses, Database schemata, SMF genotypes, SMF phenotypes, SMF instances, Information schema constructs

Corresponding author: Shahab Pourtalebi

E-mail: [shahab60p@gmail.com](mailto:shahab60p@gmail.com)

 ORCID: <http://orcid.org/0000-0003-3482-5492>

# Motivation

The objective is to develop a software toolbox for pre-embodiment design of complex and heterogeneous systems, such as cyber-physical systems (CPSs).

The novelty of this toolbox is that it uses system manifestation features (SMFs) for transdisciplinary modeling of CPSs.

The main challenges of implementation of the toolbox are:

- Functional design- and language-independent computational realization of the warehouses;
- Systematic development and management of the evolving implements of SMFs (genotypes, phenotypes, and instances).

# Main idea

The central concept of SMFs is that they are very high-level, transdisciplinary, adaptive, and smart modeling entities.

They capture architectural and operational semantics and may smartly assist the collaboration of disciplinary designers .

An information schema construct (ISC) based approach is proposed to create the associated warehouse databases of SMFs.

ISCs support the logical arrangement of the data contents of SMF implements in a set of relational tables of varying semantics.

They make the data relationships transparent and increase the efficiency of the database development process.

# Focus of the reported research

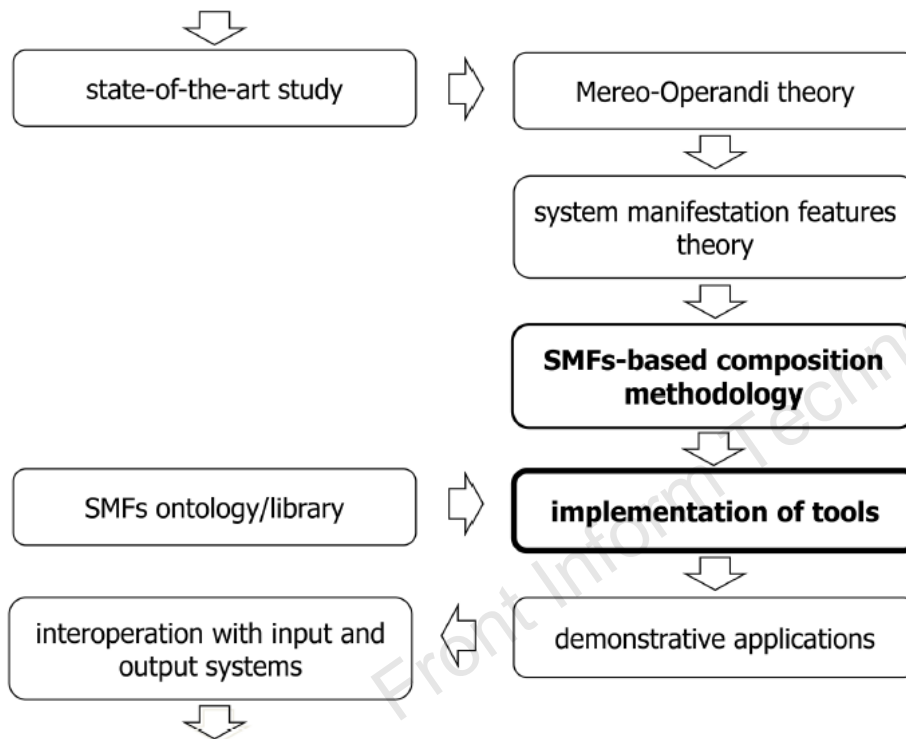


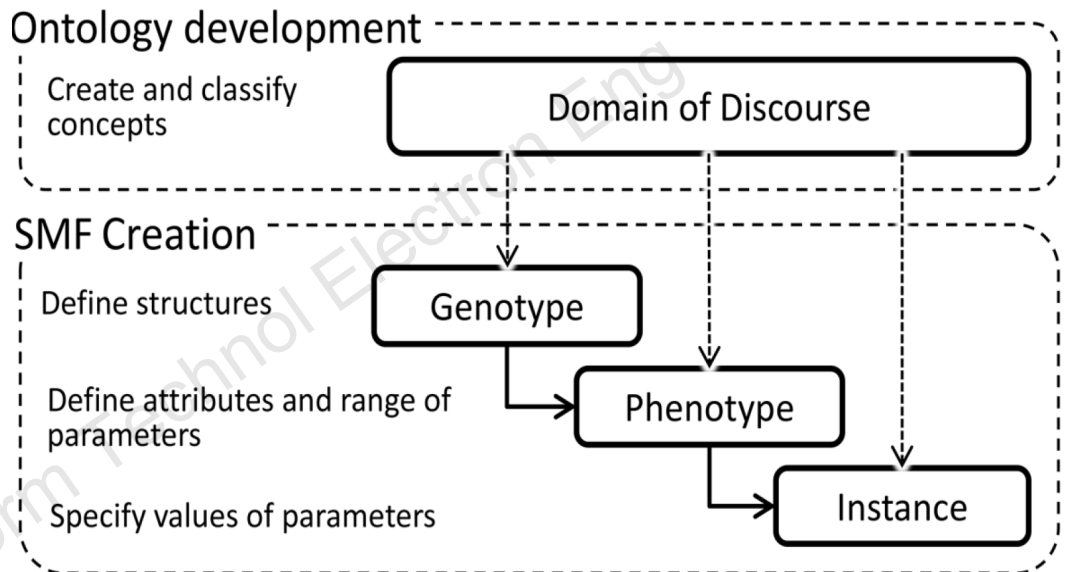
Fig. 1 Focus of the research reported in this paper

- This research extends the results of our forerunning research conducted according to the shown workflow.
- The ISCs necessary for creation of genotypes and phenotypes of SMFs are presented in this article.
- The interrelated ISCs form a web that specifies the data access routes for computation.

# Procedural aspects

The process of creating SMF implements is shown in the figure.

The SMFs implements are specified from both architectural and operational aspects.



Methodologically, a multistage mapping should be supported by the toolbox, which involves:

- Creating and storing of genotypes of SMFs in the warehouse;
- Deriving specific phenotypes from relevant genotypes;
- Instantiating phenotypes for modeling a particular CPS.

# Discussion

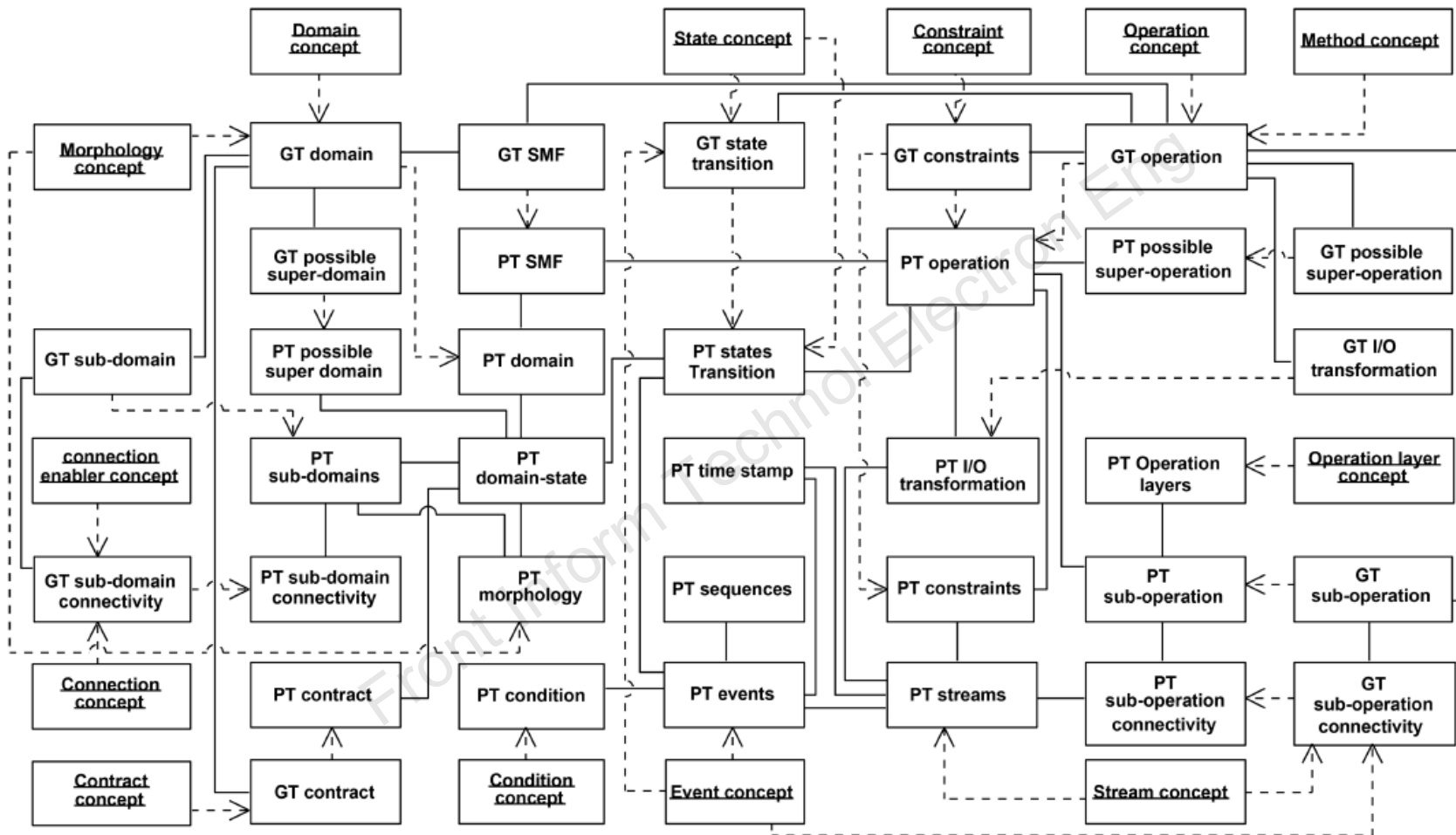


Fig. 4 Interrelationships of the chunks of information required for creation of genotypes and phenotypes

The contents and interrelations of ISCs shown in the figure have been validated from computational and design points of view.

# Conclusions

- Implementation of SMFs started out from information structures.
- Warehouse databases were designed for the specification and handling of genotypes and phenotypes of SMFs.
- It was supported by the introduction and operationalization of the concept of information schema constructs in this context.
- The proposed ISCs are able to couple chunks of information concerning operations and architecture.
- They proved to be efficient at mapping these attributes of SMFs implements to relational data tables of warehouse databases.
- Future research should show that they are also efficient and achieve a high-level synergy in CPS modeling.