Background and Introduction

- A typical Cyber-Physical System (CPS) such as the modern automotive includes not only the physical domains such as mechanics, chemistry, etc., but also cyber domains such as Software, Hardware, control and communication.
- More than 70 ECUs
- More than 5 bus systems
- More than 10,000,000 lines of code
- 2000 individual functions
- 40% of the costs due to cyber domain development
- Current CPS design methods start directly from the architecture models or simulation models
- Locally optimized solution
- We propose to start from the functional models to automatically explore the globally optimized solution

Functional Model

- Functional models provide a higher-level of abstraction to specify the systems dynamics systematically to perform a broad design space exploration to select various optimized architectures
- What the system does?
- Unified system representation
- Inter-disciplinary communication
- Visual syntax and well defined semantics
- Multi-disciplinary representation
- Functions and flows
- Standard practice in automotive
- Functional Basis language
- Well defined vocabulary by NIST
- Three flow categories: Material, energy, signal
- 18 flow types
- 32 elementary functions
- Execution flows from left-to-right

Architecture models and simulation models

- Architecture model: Architecture models define the allocation of physical structures to functionality.
- State-of-the-art architecture modeling techniques: CyPhyML; Ptolemy; AADL; Acme; etc.
- Simulation model: Simulation models are component-based executable multi-domain models
- State-of-the-art multi-domain simulation tools: Simulink; AMESim; etc.