講演番号 071

Transition of Model-based Development Technology Technical Committee based on International Standard Description

Junichi Ichihara [1)]

1) AZAPA CO., LTD, 2F Nishiki 2-4-15, Naka-ku, Nagoya,Aichi 460-0003,Japan
(Junichi-ichihara@azapa.co.jp)

KEY WORDS: common infrastructure, CAD/CAM/CAE, simulation/modeling, model-based development [A1]

1. Introduction and Background
The automotive industry is undergoing a historic transformation toward Electrification (xEV) and Software-Defined Vehicles (SDV). In xEV development, integrated management of power electronics—such as batteries and inverters—is crucial. Since electrical and thermal characteristics interact closely, multi-domain simulation has become essential. However, the proliferation of vendor-specific simulation tools has created "toolchain silos," hindering efficient model exchange between OEMs and suppliers. To address this, establishing a Model-Based Development (MBD) environment using international standard descriptions is vital for industry competitiveness.

2. Technical Superiority of VHDL-AMS
While the Functional Mock-up Interface (FMI) is widely used for model exchange, this committee prioritizes **VHDL-AMS (IEEE 1076.1)** for several technical reasons: **White-box vs. Black-box:** FMI often acts as a black-box format dependent on the exporter's solver. VHDL-AMS is a standardized white-box language where physical equations are explicit, ensuring consistent reproduction across different vendors' simulators.**Physical vs. Signal Coupling:** FMI primarily uses "signal coupling" (input/output exchange). In contrast, VHDL-AMS enables "physical coupling" based on conservation laws (e.g., Kirchhoff's Laws). By directly describing non-linear Differential Algebraic Equations (DAE), it avoids numerical instability and provides high-precision simulation for coupled electrical and thermal phenomena.
Vendor Independence: VHDL-AMS serves as a "common language," allowing suppliers to utilize various solvers without relying on expensive, specific commercial tools.

3. Evolution of the Technical Committee
Established in 2012, the committee initially focused on the "how-to" of model distribution. Over time, it shifted toward practical application in design processes. Current activities are driven by three key Working Groups (WGs):
Digital Certification Protocol WG: Collaborates with international bodies to establish virtual testing (VT) procedures for Off-Cycle Credits (OCC) and electrification certification.**Electronic Components and Thermal Design WG:** Focuses on DX for mass-production design, achieving digital twins by aligning physical prototypes with multi-domain simulations (circuit, thermal, and EMC).**MBD Promotion WG:** Partners with organizations like JAMBE to transfer expertise to the wider industry and train the next generation of engineers.

4. Addressing Intellectual Property (IP) and IT Evolution
Model distribution involves a trade-off between IP protection and model granularity.
OEM-Tier 1: Requires system-level models for energy flow. The focus is on transparency for "virtual testing" and certification.**Tier 1-Tier 2:** Requires high-granularity physical models. Here, VHDL-AMS's ability to support source-code-level encryption is essential to protect supplier know-how while maintaining interface compatibility.
The rise of **Cloud Computing and Generative AI** has revolutionized this landscape. Cloud platforms now allow "utilization without ownership," where companies can perform joint simulations via secure environments without exchanging physical files. Furthermore, Generative AI excels at automating modeling tasks and detecting anomalies when paired with structured, standard languages like VHDL-AMS.

5. Conclusion and Future Outlook
After 14 years, the committee has evolved from a technical forum into a driver of social implementation. Looking toward 2050, the committee is focused on achieving carbon neutrality through deepened 1D-CAE expertise and building a robust digital certification infrastructure. By maintaining a foundation in tool-independent international standards, the committee continues to bolster the global competitiveness of the Japanese automotive industry.