IEEE Standards for Scaled Learning Engineering

Goodell, J.

Co-Design
Design Patterns
learning engineering
Models
Modular Open Systems Architecture
Standards

Learning Engineering Toolkit introduces systems engineering principles for scaled implementation of learning solutions. An important mindset for scalable implementation of learning engineering is recognizing learning as a complex non-linear system that includes learners and learning context as part of the system. Engineers use systems models of various degrees of fidelity and design patterns—repeatable solutions to commonly occurring engineering problems. They build resilient, scalable systems using modular components with standard interfaces, defining the operating conditions, constraints, and tolerances for each module and the system as a whole. The Total Learning Architecture is a collection of IEEE standards for learning technology. These standards provide the necessary technical specifications and constraints that allow the modules of learning solutions developed by learning engineering teams to become physically and functionally interchangeable for scaled implementation. This poster will examine how IEEE standards support translation of research and application of learning sciences into scalable learning solutions.

Introduction

Systems engineering plays a critical role in learning engineering (Goodell, 2023). This is particularly relevant to scaled solutions. An important mindset for scalable implementation of learning engineering is recognizing learning as a complex non-linear system that includes learners and learning context as part of the system. Engineers use systems models of various degrees of fidelity and design patterns—repeatable solutions to commonly occurring engineering problems. They build resilient, scalable systems using modular components with standard interfaces, defining the operating conditions, constraints, and tolerances for each module and the system as a whole. The Total Learning Architecture (Smith, 2021) is an approach to building scalable data-informed systems and ecosystems for learning that draws on a collection of IEEE standards for learning technology (IEEE 2022, IEEE 2023, IEEE 2024, IEEE 2025, IEEE n.d., IEEE n.d.). These standards provide the necessary technical specifications and constraints that allow the modules of learning solutions developed by learning engineering teams to become physically and functionally interchangeable for scaled implementation. The poster shown in figure 1 examines IEEE standards used to support modern systems, including intelligent tutoring systems, for scaled learning.

Figure. 1.

Poster showing IEEE standards in the context of data flows of the Total Learning Architecture.

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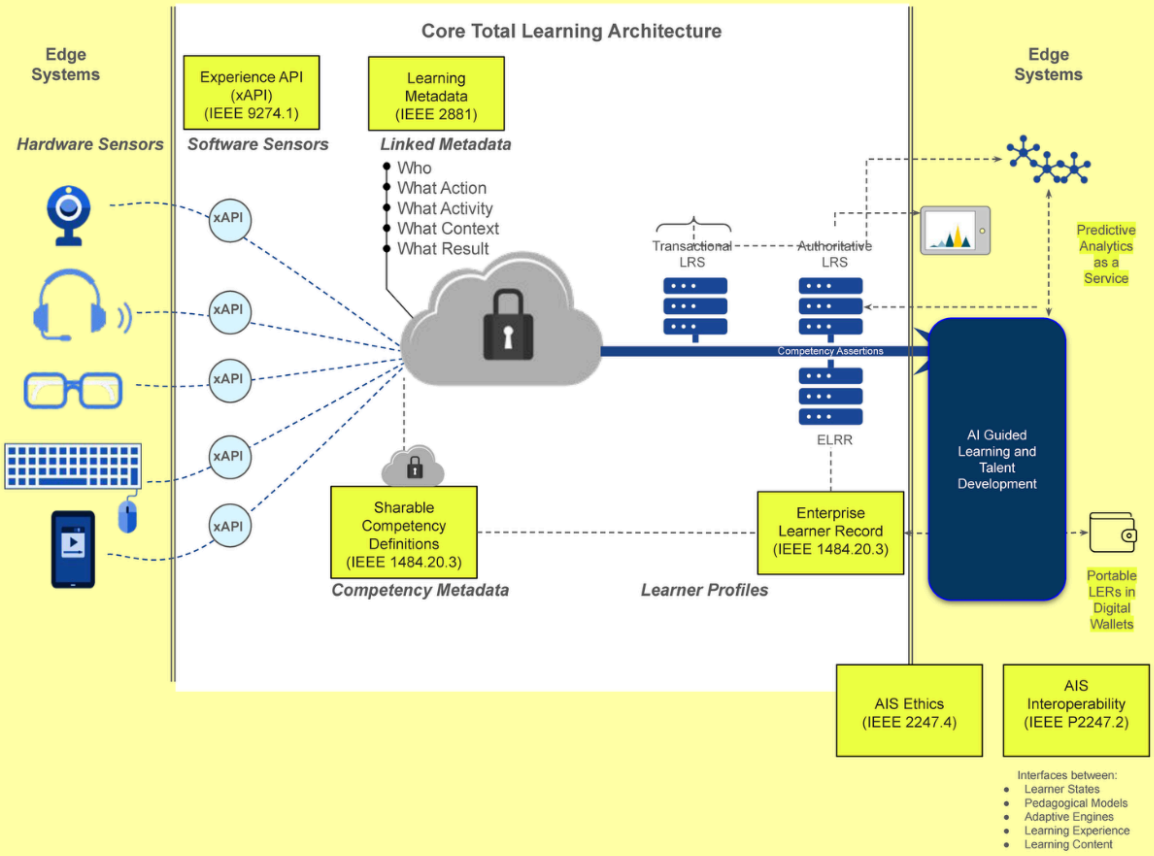

https://sagroups.ieee.org/ltsc/

Discussion and Conclusion

The existing standard can be used to support the learning engineering of scalable and cost-effective systems that leverage advanced technologies, such as LLMs. In fact, the introduction of standard structured metadata via MCP in formats defined by standards such as IEEE 2881-2025 and IEEE 1484.20.3-2022 can help overcome current challenges, such as hallucinations and interactions that are less than pedagogically sound when using general purpose LLMs for tutoring. However, more research and standards development is needed to extend the existing standard to fully take advantage of recent advancements in AI, including large language models and agentic AI.

References

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