

0.1 Abstract

Taking “architecture” —an engineering concept spanning two millennia—as its starting point, this paper systematically traces the conceptual history from Vitruvius’ s triad to the architecture-description ontology of ISO/IEC/IEEE 42010, and establishes a unified horizontal benchmark framework across five industry cross-sections: automotive electrical/electronic (E/E) architecture, smartphones/consumer electronics, internet/cloud, robotics, and embodied artificial intelligence. The study completes a cross-domain benchmark along five dimensions—**hardware, software, data/AI, ecosystem, and safety**—and identifies three architectural archetypes: the **vertically integrated closed-loop** type (Tesla), the **cross-device ecosystem** type (Huawei, Xiaomi), and the **platform-enablement** type (Google/Waymo, NVIDIA, Mobileye, Bosch, Aptiv). It analyzes in detail their underlying philosophical differences, reuse mechanisms, and constraints.

The central thesis of this study is that **architecture across contemporary industries is undergoing a two-layer evolution: convergence at the infrastructure layer, divergence at the layer of control semantics and burden of proof**. Atop a shared foundation (heterogeneous SoCs, virtualization, service-oriented interfaces, model-training pipelines, OTA pipelines, digital twins), automotive and robotics will long retain independent failure philosophies, safety enclosures, and liability-attribution layers; consumer electronics and cloud will continue to be dominated by fail-soft and rapid recovery. The paper further proposes the **AR0—AR5 architectural capability-threshold framework**, analogous to SAE J3016’ s autonomous-driving levels, but explicitly emphasizing “capability thresholds rather than a timeline—lower tiers do not disappear but coexist with higher tiers over the long term.” On this basis, the paper introduces **Architecture Intelligence (AI²)** as an overarching research paradigm, and proposes the **AI²-ML (Architecture Intelligence Maturity Levels)** framework—a 5-level $\times$ 5-dimension evaluation—as an independent measure of the maturity of architectural tools and methodology.

Keywords: architecture ontology; electrical/electronic architecture; software-defined vehicle; embodied artificial intelligence; architecture maturity; failure philosophy; Architecture Intelligence