Parallel Organizations for Agentic Societies: From Embodied Intelligence to Autonomous Intelligence for AI Agents and Digital Humans

We are living through an epochal shift in the nature of work, collaboration, and collective action. AI agents, digital humans, and physical robots are no longer auxiliary tools but autonomous, goal-directed participants in organizational life—capable of long-task execution, cross-agent communication, workflow orchestration, and adaptive decision-making at scale. AI systems can now reliably complete tasks of roughly two hours in length, doubling in capability every four months since 2024; up to 57% of current work hours in the United States are technically automatable, with virtual agents covering 44% and physical robots 13% [1]. By 2030, this transformation could unlock approximately $2.9 trillion in annual economic value [2]. Yet despite this explosive technological progress, organizational theory has failed to keep pace. We continue to rely on frameworks designed for human-only hierarchies [3], markets [4], and networks [5]—structures ill-suited to govern hybrid collectives of humans, digital agents, and robotic actors. To situate this challenge, the 2025 issue of the Journal of Cyber-Physical-Social Intelligence (CPSI) brings together a set of articles that collectively reflect several key dimensions of intelligence, coordination, and governance in the emerging agentic society.

Building on these contributions, this editorial introduces the conception of **Parallel Organizations for Agentic Societies (POAS)**: a unified, theoretically grounded, and operationally actionable framework for designing, governing, and evolving organizations in the age of autonomous AI agents and digital humans. POAS is a paradigm built for agentic societies from first principles. It integrates advances in parallel intelligence with the ACP approach [6]: Artificial societies, Computational experiments, Parallel execution, continuous organizational forms, distributed governance, cyber movement mobilization, and embodied-to-autonomous intelligence evolution. In doing so, it resolves four interconnected gaps that have fragmented research and practice: ontology, coordination, governance, and mobilization. Against this backdrop, the core thesis is straightforward: *the future of intelligence is not individual but organizational*. The transition from embodied, task-specific intelligence to generalized, autonomous intelligence in AI agents and digital humans will not be achieved in isolated systems, but through parallel organizations that enable virtual–real coevolution, continuous experimentation, and emergent collective wisdom.

I. SCANNING THE ISSUE

Multi-scale Group Decision-Making Employing Large Language Model for Sentiment-Oriented Grouping *by JOSÉ RAMÓN TRILLO, MANUEL JESUS COBO, IGNACIO JAVIER PÉREZ, JUAN ANTONIO MORENTE-MOLINERA, FRANCISCO JAVIER CABRERIZO, AND ENRIQUE HERRERA-VIEDMA*

The first article develops a multi-scale group decision-making framework that incorporates a large language model to analyze expert comments and support sentiment-oriented grouping. By combining structured decision theory with contextual language understanding, the study improves the interpretability and effectiveness of consensus formation in heterogeneous decision environments.

Integrating Cyber-Physical-Social Intelligence for Safer and Smarter Transportation Systems: A Comprehensive Literature Review *by MD. SADMAN ISLAM, AHMED IMTIAZ ZAMEE, AND MOHAMMAD JALAYER*

The second article presents a broad literature review of CPSI in transportation, synthesizing how cyber, physical, and social layers interact across safety, mobility, and infrastructure applications. It surveys enabling technologies, deployment barriers, and future research directions for safer and smarter transportation systems.

Small-Large Model Collaboration in Public Opinion Topic Discovery: A Case Study with the Pager Bomb Attack *by BAOYU ZHANG, TAO CHEN, WEISHAN ZHANG, TAO WANG, QINGHUA NI, FEI LIN, LINYUAN LV, JUANJUAN LI, AND FEI-YUE WANG*

The third article studies multilingual public opinion surrounding the pager bomb attack and proposes a collaborative framework that combines large and small models for continuous topic discovery. Beyond topic analysis, it also connects public sentiment, market signals, and governance concerns around the trustworthiness of electronic-device supply chains.

Trustworthy Governance of Agentic Societies Based on DePIN and VLA *by XIAOLONG LIANG, RUI QIN, JUANJUAN LI, AND FEI-YUE WANG*

The fourth article addresses the governance of agentic societies by proposing an endogenous contribution-evaluation framework built on decentralized physical infrastructure networks and vision-language-action models. The work links physical-world activity, on-chain identity, and verifiable contribution assessment in support of trustworthy digital-physical governance.

Parallel Exhibition: An ACP-Based Framework for Organization and Management of MICE Systems *by SANG-*

TIAN GUAN, SIJI MA, JUN HUANG, AND WEN DING

The fifth article extends parallel intelligence into the MICE domain and proposes a parallel exhibition framework for the organization and management of complex exhibition systems. By combining artificial systems, computational experiments, and parallel execution, it offers a closed-loop management paradigm for large temporary organizations with strong social and spatial dynamics.

Parallel Scenarios: A New Paradigm and Evolution Path for Scenario-Based Applications of Artificial Intelligence
by HUI ZHANG, QIAO SUN, XUAN LI, AND YI WEN

The sixth article proposes parallel scenarios as a new paradigm for scenario-based AI applications. Grounded in the ACP framework, it connects real, experimental, and ideal scenarios into a dynamic closed loop for sensing, simulation, implementation, and feedback, thereby offering a broader evolution path from scenario engineering toward autonomous intelligence.

II. PARALLEL ORGANIZATIONS FOR AGENTIC SOCIETIES: FROM EMBODIED INTELLIGENCE TO AUTONOMOUS INTELLIGENCE FOR AI AGENTS AND DIGITAL HUMANS

A. THE PARADIGM SHIFT: FROM INDUSTRIAL TO DIGITAL TO AGENTIC ORGANIZATIONS

Organizational paradigms evolve alongside technological revolutions. Each era redefines the unit of production, the structure of coordination, and the nature of the workforce.

In the agricultural and craft era before the 1800s, work centered on small teams of artisans and farmers. Governance was direct and local; technology consisted of hand tools and animals; value creation was physical and localized.

The industrial era (1800s–1980s) introduced functional hierarchies, mass production, and factory-based labor. Machines amplified physical work; efficiency and scale drove competitive advantage; roles were narrowly specialized; workflows were linear and repeatable [7].

The digital era (1990s–2020s) shifted to modular platforms, cloud infrastructure, and cross-functional agile teams [8]. Speed and customer access became decisive; knowledge work expanded; IT systems moved from monoliths to microservices; data became a critical asset.

Today, the **agentic era** is unfolding. Its defining feature is the rise of autonomous AI agents—virtual and physical—that can plan, execute, collaborate, and learn without continuous human supervision [9]. This represents the largest organizational paradigm shift since the industrial and digital revolutions. The agentic organization integrates humans, virtual AI agents, and physical robots to create value at near-zero marginal cost [10]. Workflows are reimagined as AI-first; humans move "above the loop" to supervise, steer, and handle exceptions; proprietary multimodal data becomes a core competitive moat.

Yet a paradox defines our moment: technology has outpaced theory. McKinsey reports that 89% of organizations remain trapped in industrial-era structures, and fewer than 40% of companies investing in AI capture measurable gains [1]. The problem is not technical—it is organizational [11]. We lack frameworks to answer: How should teams be designed when 2–5 humans can supervise 50–100 specialized agents? How should governance operate when agents make real-time decisions that affect customers, revenue, and risk? How should skills evolve when AI fluency is the fastest-growing competency in job postings? How should collective action emerge when actors include humans, digital humans, software agents, and robots? Parallel organizations resolve this paradox by providing a unified language and architecture for the agentic society.

B. CONCEPTUAL FOUNDATIONS: AGENTS, INTELLIGENCE, AND PARALLELISM

1) Agentic Societies

An agentic society is a social and economic system in which autonomous, goal-oriented AI agents (virtual), digital humans, and physical robots participate as legitimate actors alongside human beings [12], [13]. These non-human agents can decompose complex tasks into executable steps, maintain persistent memory and context across interactions, communicate and collaborate via agent-to-agent protocols [14], adapt to unstructured environments and unexpected events, and act with meaningful autonomy under human supervision. In agentic societies, work is a skill partnership—not human vs. machine, but human $\|$ agent $\|$ robot, or:

$$\text{Parallel Human} = \text{Natural Human} \parallel \text{Digital Human} \parallel \text{Robotic Human}$$

2) From Embodied Intelligence to Autonomous Intelligence

A central arc of this editorial is the evolution from embodied intelligence to autonomous intelligence in AI agents and digital humans.

Embodied Intelligence is rooted in physical or virtual form, tied to specific tasks, environments, or data. It reacts well but has limited generalization. Examples include rule-based robots, narrow virtual assistants, scripted digital humans.

Autonomous Intelligence refers to generalized, adaptive, and goal-oriented intelligence that can operate across domains, learn from experience, and pursue objectives with minimal human intervention. Examples include self-improving workflow agents, digital humans with persistent identity and memory, robots that handle unstructured physical tasks.

The transition is not binary but continuous. Parallel organizations accelerate this transition by providing a parallel training and operational environment where agents can rehearse, experiment, and evolve in virtual worlds before acting in the physical world.

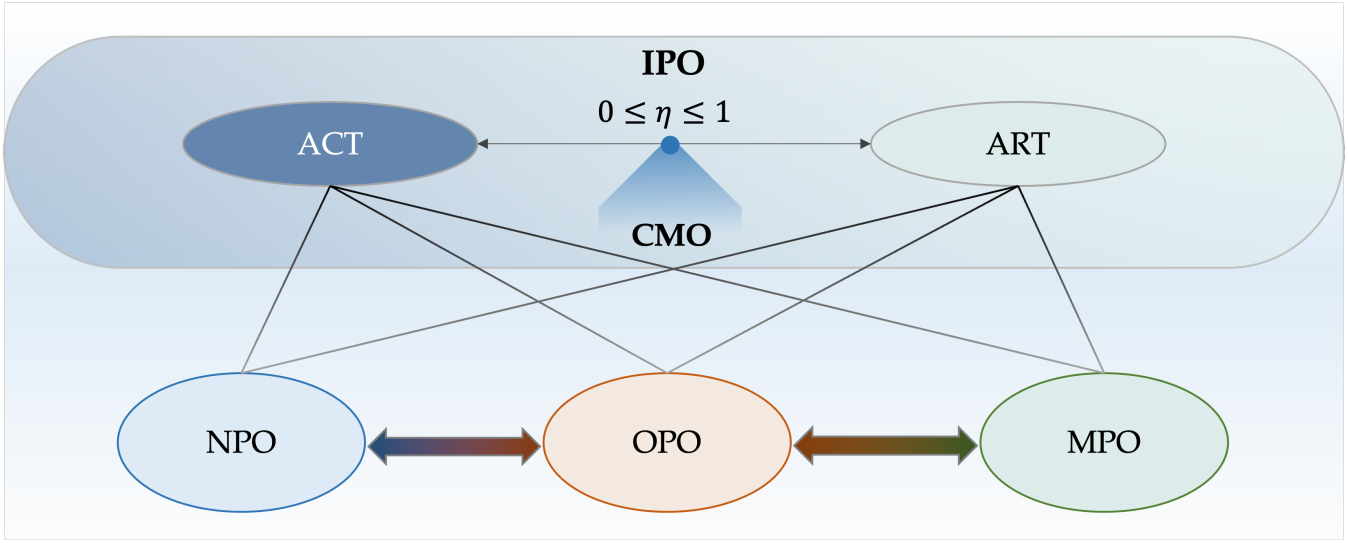

FIGURE 1: The POAS Architecture

3) AI Agents, Digital Humans, and Robots

We adopt clear, consistent definitions aligned with parallel intelligence theory:

- **AI Agents**: Non-physical actors that automate large-scale cognitive, informational, and transactional work independently or collaboratively in cyberspace.
- **Digital Humans**: Virtual human-like agents with identity, emotion, personality, voice, and visual form; they specialize in social interaction, customer experience, education, and healthcare.
- **Robots**: Embodied actors that automate physical work in the physical world—drones, mobile manipulators, humanoids, and autonomous vehicles.
- **Natural Humans**: Biological actors providing expert experience, ethical judgment, social networking, creativity, and ultimate accountability.

4) Parallel Organizations

A **parallel organization** is a dual-mode system that operates simultaneously in:

- **ACT** (Actual / Action)—real-world execution in physical and social spaces;
- **ART** (Artificial / Rehearsal)—computational simulation, experimentation, "if-then" rules and "what-if" planning in artificial organizational models.

Guided by the ACP approach, parallel organizations use artificial systems to describe reality, computational experiments to test policies and to learn by reinforcement, and parallel execution to optimize real operations with real-virtual feedback and closed-loop. This makes them uniquely resilient to diversity, uncertainty, and complexity (DUC)—the three core challenges of modern activity systems.

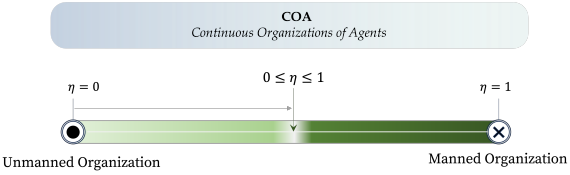

FIGURE 2: Illustration of Continuous Organizations for Agents

C. THE POAS FRAMEWORK: A FOUR-LAYER ARCHITECTURE FOR AGENTIC SOCIETIES

As shown in FIGURE 1, we now present the POAS framework—a four-layer integrated architecture that unifies ontology, coordination, governance, and mobilization.

1) Layer 1: COA — Continuous Organizations of Agents

As illustrated in FIGURE 2, the foundational layer resolves the **ontological gap** by replacing discrete organizational types with a continuous spectrum parameterized by $\eta \in [0, 1]$, representing the degree of human involvement and control. Several specific organizations will emerge with respect to the change of η:

- **NPOs** (No-Person Organizations, $\eta \approx 0$): Fully or mostly automated and autonomous organizations run by agents, digital humans, and robots.
- **OPOs** (One-Person Organizations, $0 < \eta < 1$): Hybrid systems where a single human orchestrates a large fleet of agents, digital humans and robots.
- **MPOs** (Multi-Person Organizations, $\eta \approx 1$): Traditional human-centric teams augmented by agentic tools.

COA (continuous organizations of agents) claims that NPOs, OPOs, and MPOs are not separate categories but points on a continuous spectrum [6]. Organizations can dy-

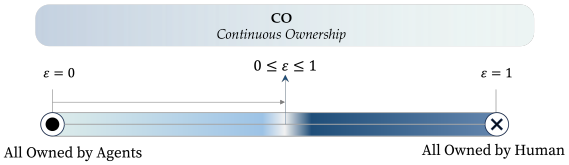

FIGURE 3: Illustration of Continuous Ownership

namically shift along this spectrum based on task, risk, trust, and regulation.

2) Layer 2: CO — Continuous Ownership

As shown in FIGURE 3, the second layer resolves the **governance gap** by introducing a CO (continuous ownership) parameter $\varepsilon \in [0, 1]$, governing rights, incentives, and accountability across human and non-human actors. At $\varepsilon \approx 0$, agent-dominated governance operates with human oversight. At $0 < \varepsilon < 1$, hybrid contribution-based ownership emerges; agents earn rights based on performance. At $\varepsilon \approx 1$, traditional human ownership prevails; agents serve as tools.

Continuous Ownership (CO) moves beyond token-based DAO models to contribution-aligned governance, where influence reflects value added—not just capital held. This is critical for fair and stable agentic organizations.

3) Layer 3: IPOs — Intelligent Parallel Organizations

The third layer operationalizes parallelism in cyber-physical-social systems (CPSS) and resolves the **coordination gap**. IPOs are the container architecture that supports dual-mode operation: ACT for real execution in physical and social spaces, and ART for computational rehearsal in artificial organizations. The parameter η balances real-world action and virtual experimentation and simulations.

In parallel execution, ART continuously feeds optimizations to ACT, while ACT data improves ART models. This closed-loop learning enables organizations to turn DUC into focus, agile, convergence (FAC)—the core objective of parallel system design. IPOs integrate multi-agent collaboration and task orchestration [14], software-defined robots that bridge virtual and physical, digital humans that operate consistently across ACT and ART, and human supervisors who set goals and values.

4) Layer 4: CMOs — Cyber Movement Organizations as Middleware

The fourth layer resolves the **mobilization gap**. CMOs act as dynamic middleware that activates and coordinates actors across ACT and ART via three mechanisms: **Participation** to motivate and manage human engagement; **Selection** to enable agents to autonomously align with tasks and leaders; and **Invitation** to recruit new actors across human, agent, and robot populations.

CMOs were originally developed to study large-scale online collective action [15]. Transposed to agentic organizations, they explain how static blueprints become living, adaptive systems. Without CMOs, parallel structures remain inert; with CMOs, they self-assemble, self-organize, self-coordinate, and self-evolve.

5) Integrated POAS Logic

Together, the four layers form a complete system (Fig. 1): COA defines what form the organization takes; CO defines who owns and governs it; IPOs define how it operates in virtual–real parallel; and CMOs define how it mobilizes actors into collective action. This integration makes POAS a proper framework that simultaneously addresses ontology, coordination, governance, and mobilization for the oncoming agentic societies.

D. INTELLECTUAL FOUNDATION: THE ACP APPROACH AND PARALLEL INTELLIGENCE

POAS is grounded in parallel intelligence and the ACP approach [16], developed for complex systems that are too large, risky, or dynamic for direct experimentation.

1) ACP for Organizations

Artificial Societies (A) means building high-fidelity artificial organizational models that mirror real humans, agents, processes, and environments [17]. **Computational Experiments** (C) involve testing strategies, policies, and structures in simulation at scale—including stress tests, long-tail cases, and long-term forecasts. **Parallel Execution** (P) means running artificial and real organizations in parallel, using insights from experiments to optimize real operations, while utilizing the real-world feedback to calibrate the artificial models.

2) From DUC to FAC

A core motivation for parallel organizations is overcoming DUC: **Diversity** as overwhelming choice of goals, paths, and partners; **Uncertainty** as unexpected events, delays, and failures; **Complexity** as interlocking technical, economic, and social constraints [18].

Parallel systems transform DUC into FAC: **Focus** to align all activity toward clear goals; **Agile** to respond rapidly and autonomously to change; **Convergence** to steer reliably toward intended outcomes. This transformation is the core objective of parallel system design [19]. At scale, this logic applies to every organizational process.

3) Three Worlds, Three Humans

POAS extends parallel intelligence to a three-world, three-human vision, where robotic humans for the physical worlds, digital humans for the artificial worlds, and natural humans for the mental worlds. This structure enables embodied intelligence in robotic humans and autonomous intelligence in digital humans and AI agents to evolve in lockstep within the framework of parallel organizations [20].

E. CONCLUSION: THE ORGANIZATIONAL INTELLIGENCE IMPERATIVE

We stand at a historic inflection point. For the first time, non-human actors can participate in organizations with

meaningful autonomy. This is an opportunity to reimagine collective intelligence at scale [21]. Yet this opportunity will be wasted if we continue to impose outdated, human-only organizational blueprints on agentic societies.

The POAS framework presented here offers a path forward. The initiative originated in 2014, marking the commencement of long-term strategic planning for decentralized autonomous systems. In 2015, this vision culminated in the establishment of the world's inaugural agentic society, known as the Association for the Globalization of Intelligent Science and Technology (AGIST). Building upon these foundations, the research transitioned into intensive study and practical implementation of parallel organizations within the Chinese Association of Automation (CAA) starting in 2021 [22].

The defining insight of parallel intelligence is this: the most powerful intelligence is not in individual agents, but in the organization of agents. In the agentic era, competitive advantage will belong not to those with the strongest AI or the most robots, but to those who can orchestrate humans, digital humans, agents, and robots into parallel organizations that learn, adapt, and evolve faster than the world around them. The agentic society is not coming—it is here. Parallel organizations are its natural form. The task ahead is to build them wisely, ethically, and ambitiously.

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