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BUSINESS PROCESS AUTOMATION USING AI AGENT ORCHESTRATION SYSTEMS

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Abstract. This article analyzes approaches to business process automation based on AI agent orchestration systems. The study examines the theoretical foundations of agent-oriented systems, architectural orchestration models, and the specific features of integrating intelligent agents into corporate processes. It is shown that AI agent orchestration enhances the adaptability, scalability, and intelligence of automated operations, particularly in scenarios characterized by high information intensity and cross-system coordination. Practical application examples are discussed, including IT service management, customer request handling, and supply chain management. Special attention is given to issues of reliability, decision interpretability, and the controllability of agent environments. The article concludes by highlighting the potential of orchestration as a system-forming layer in the digital transformation of business processes.

АВТОМАТИЗАЦИЯ БИЗНЕС-ПРОЦЕССОВ С ИСПОЛЬЗОВАНИЕМ СИСТЕМ ОРКЕСТРАЦИИ AI-АГЕНТОВ

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Ключевые слова: AI-агенты, оркестрация, автоматизация процессов, многокомпонентные системы, адаптивность, масштабируемость, интеллектуальные системы.
Аннотация. В статье проводится анализ подходов к автоматизации бизнес-процессов с использованием систем оркестрации AI-агентов. Рассматриваются теоретические основы агентно-ориентированных систем, архитектурные модели оркестрации, а также особенности интеграции интеллектуальных агентов в корпоративные процессы. Показано, что оркестрация AI-агентов позволяет повысить адаптивность, масштабируемость и интеллектуальность автоматизируемых операций, особенно в сценариях с высокой степенью информационной насыщенности и межсистемной координации. Приводятся практические примеры применения, включая ITSM, обработку клиентских запросов и управление поставками. Особое внимание уделяется вопросам надежности, интерпретируемости решений и управляемости агентной среды. Делается вывод о потенциале оркестрации как системообразующего слоя в цифровой трансформации бизнес-процессов.

Introduction

Modern organizations operate in conditions of high environmental dynamism, increasing complexity of business models, and continuous growth in the volume of processed information. Business process automation is no longer solely a matter of improving operational efficiency, but rather it has transformed into a prerequisite for sustainable development and ensuring competitiveness on a long-term basis. Traditional approaches to automation relying on rule-driven workflow systems, BPM platforms, and robotic process automation reveal poor adaptability in situations where the business context, objectives, or input data are changing. Such limitations create demand for more flexible and intelligent mechanisms of process management able to operate under uncertainty and complex interdependencies within organizational systems.

Therefore, with the development of advances in AI technologies, especially multi-agent systems and large language models, a new type of solutions was born: AI agents that enable autonomy, interactions among agents, and contextual decisions. However, using single agents alone does not produce any systemic effect on the “enterprisewide” process. In this regard, AI agent orchestration systems gain particular importance, as they provide coordination of agent actions, role distribution, and alignment of individual agent behavior with business objectives. Orchestration acts as an intermediary layer between an organization’s strategic goals and the operational activities implemented within an agent-based environment.

The purpose of this study is to analyze the theoretical and architectural foundations of business process automation using AI agent orchestration systems, as well as to identify their distinguishing characteristics in comparison with traditional process management approaches. The article examines the conceptual principles of AI agent orchestration, the key architectural models of such systems, and their potential application for enhancing the adaptability, scalability, and intelligence of business processes in modern organizations.

Main part. Theoretical foundations of AI agent orchestration

In the scientific literature, an AI agent is traditionally defined as an autonomous computational entity capable of perceiving the state of its environment, making decisions, and performing actions to achieve specified goals based on internal models and behavioral rules [1]. Unlike classical software modules, AI agents exhibit properties of adaptivity, context awareness, and, in some cases, learnability, which enables them to operate under conditions of incomplete information and uncertainty. Contemporary AI agents are increasingly implemented using machine learning methods and large language models, significantly expanding their cognitive and communicative capabilities.

According to a global McKinsey survey, 23% of organizations already scale agentic AI within selected business functions, while an additional 39 % remain at the experimental stage of adopting AI agents [2]. At the same time, Gartner forecasts that by 2028 agentic AI will be embedded in approximately 33 % of enterprise software applications, thereby increasing the share of routine decisions made autonomously in everyday organizational activities (fig. 1).

It’s worth noting, however, that the diagram shown above points to a gradual trend from low-level agency, automatic behavior to an advanced level of agency, including adaptivity, proactive planning, and decision-making. While the gap between human and machine agency is being closed, the capabilities of an intelligent system to act within a dynamic, intricate environment, as well as to set and decompose goals into subgoals, are emphasized. The attainment of these properties at the level of individual AI components creates the prerequisites for the emergence of more complex architectures in which autonomy and interaction become the key organizing principles.

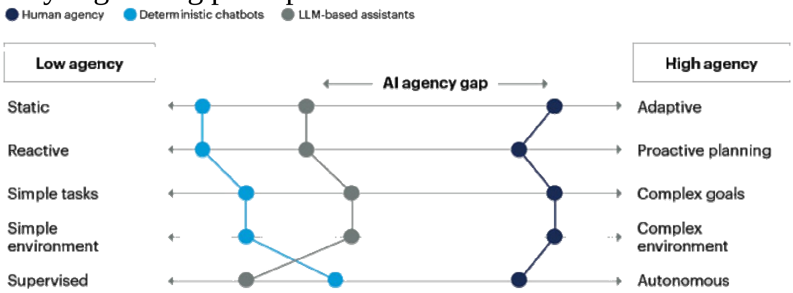

Fig. 1. Hierarchy of agency levels in intelligent systems with varying degrees of autonomy, based on Gartner data [3]

Multi-agent systems represent a collection of interacting AI agents, each performing specialized functions, while their coordinated activity is directed toward achieving a common system-level objective [4]. In an applied and architectural context, multi-agent systems can be characterized by a set of technical parameters that define agent interaction mechanisms, coordination models, decision-making approaches, and infrastructure requirements (tab. 1).

Tab. 1. Core technical characteristics of multi-agent systems [5, 6]

Characteristic	**Technical description**
System architecture	Decentralized or hybrid topology (peer-to-peer / hub-and-spoke) with loosely coupled agents and well-defined interaction boundaries.
Decision-making model	Local policy/model-driven decisions (rules/ML/LLM) with optional global coordination via distributed planning, consensus, or negotiation protocols.
Coordination & orchestration	Task decomposition, role assignment, and execution control via an orchestration layer (workflow engine / scheduler) or fully distributed coordination protocols.
Communication substrate	Asynchronous messaging and event-driven interaction (message broker, pub/sub, event bus) with API-based calls for synchronous control paths.
State & context management	Distributed state store for agent context, conversation/task memory, and intermediate artifacts; consistency model explicitly defined (eventual/strong).
Scalability & elasticity	Horizontal scaling through dynamic agent replication and load-aware routing; supports burst handling and backpressure mechanisms.
Resilience & fault tolerance	Failure isolation per agent, retries/timeouts/circuit breakers, idempotent actions, and compensating transactions for long-running workflows.
Observability & auditability	End-to-end tracing, structured logs, metrics/SLOs, and decision/action audit trails (including tool calls and data lineage) for compliance and debugging.

Therefore, from the above technical features, it is verified that multi-agent systems represent complex and distributed systems in terms of their inherent features in which the autonomy of individual agents is linked with coordination requirements. The larger the number of agents increases, the more interaction logic will be complex, and the higher the degree of autonomy correspondingly intensifies the role of orchestration mechanisms to ensure purposeful task allocation, action synchronization, execution control, and alignment of agent behavior with business constraints. In this context, AI agent orchestration should be understood not as an auxiliary management tool, but as a system-forming layer that links individual agent autonomy with the goals, structure, and operational resilience of enterprise business processes.

Architectural models of AI agent orchestration in enterprise systems

Viewing AI agent orchestration as a system-forming layer of control makes it possible to move from the general theoretical aspects of multi-agent systems to the analysis of concrete architectural solutions for their implementation in enterprise IT environments. As agent autonomy increases and the logic of their interactions becomes more complex, the architectural organization of orchestration gains critical importance, since architecture defines the boundaries of controllability, scalability, and resilience of the agent-based environment. In this context, different architectural models of AI agent orchestration represent alternative approaches to aligning individual agent behavior with business process objectives and corporate governance requirements (tab. 2).

Tab. 2. Architectural models of AI agent orchestration in enterprise systems

Orchestration model	**Engineering-level characteristics**
Centralized control plane	Single orchestration service responsible for maintaining global state and executing planning, scheduling, and policy enforcement, with coordination of agent execution; strong consistency and auditability but limited horizontal scalability.
Distributed control plane	Orchestration logic is replicated across coordinating agents by means of consensus or negotiation protocols; improved fault tolerance, better scalability, higher synchronization overhead.
Hybrid control architecture	Centralized goal definition and policy enforcement, while decentralized execution and adaptation at agent level in runtime.
Event-driven orchestration	Reactive coordination via event streams and state transitions; loose coupling, eventual consistency, and high responsiveness to external signals.
Policy-enforced orchestration	Runtime enforcement of access control, business constraints, and safety guardrails during the execution of agent decisions by means of RBAC/ABAC, policy engines, etc.
Federated orchestration	Multiple domain-specific orchestrators coordinate through inter-domain protocols, allowing both organizational and system-level decomposition.
AI-assisted orchestration	Planning, prioritization, and anomaly detection are augmented by ML/LLM components that enable adaptive and predictive control behaviors.

The presented architectural models of AI agent orchestration demonstrate that the management of an agent-based environment extends beyond the coordination of individual computational components and acquires the character of a system-level mechanism that determines how business logic is realized in distributed intelligent systems. The choice of orchestration architecture directly affects the degree of agent autonomy, process controllability, and the system's ability to adapt to changes in the external environment. In applied terms, this implies that architectural decisions in the field of orchestration form the foundation for practical business process automation by defining principles of task decomposition, dynamic execution management, and the integration of intelligent components into enterprise operational activities.

Agent-oriented automation of enterprise processes in an orchestration environment

Business process automation based on AI agent orchestration systems relies on a fundamentally different approach to the formalization and management of process logic compared to traditional methods (tab. 3).

Tab. 3. Comparison of traditional process automation and agent-oriented orchestration

Dimension	Traditional automation (BPM / workflow / RPA)	Agent-oriented automation (AI agent orchestration)
Process representation	Predefined sequences, rules, and branches.	Goal- and constraint-driven task models.
Execution logic	Static, scenario-based execution.	Dynamic planning and runtime replanning.
Control mechanism	Workflow engine executing fixed logic.	Orchestrator as control plane coordinating autonomous agents.
Variability handling	Model complexity increases with exceptions.	Variability handled through agent decision-making within policies.
System integration	Connectors, ESB/iPaaS, scripted automation.	Tool-use layer with policy-governed access and contextual data use.
State & context	Instance-based process state.	Distributed state and task/context memory with defined consistency.
Quality control	Scenario testing and rule validation.	Runtime validation, policy gates, and human-in-the-loop control.
Evolution of processes	Redesign required for logic changes.	Adaptation via goal, policy, and role updates without full redesign.

The practical applicability of agent-based automation in enterprise systems is most evident in business processes characterized by a high share of knowledge-intensive work, multiple data sources, and the need for cross-system coordination. Such processes include IT incident and request management (ITSM), customer request handling, financial and accounting operations, supply chain and procurement management, as well as analytical support for managerial decision-making [7]. In these scenarios, agent orchestration enables the automation not only of individual operations but also of action sequences that involve context analysis, strategy selection, and interaction with multiple enterprise systems.

Within the framework of agent-oriented automation, it is appropriate to propose a model of AI agent interaction aimed at optimizing complex business processes through role distribution, dynamic coordination, and adaptive execution management. A business process is represented as a set of interrelated tasks, the achievement of which is ensured by the coordinated activity of execution, analytical, and monitoring agents under the control of an orchestrator. The orchestrator establishes a global control layer by defining goals, constraints, and performance metrics, while individual agents carry out specific actions, exchange results, and adapt their behavior based on context and intermediate outcomes. Such a model enables a transition from linear process execution to multi-level optimization that accounts for both local and system-wide performance indicators (tab. 4).

Tab. 4. Application of the AI agent interaction model in enterprise business processes [8, 9]

Business process	Effect of agent orchestration	Key performance metrics
IT service management (ITSM)	Automated incident classification, diagnosis, and coordinated resolution based on contextual data.	Mean time to resolution (MTTR), first-contact resolution rate, SLA compliance.
Customer request handling	Context-aware interpretation of requests and coordinated actions across channels and systems.	Average handling time (AHT), deflection rate, customer satisfaction (CSAT).
Financial and accounting processes	Cross-system data reconciliation, anomaly detection, and decision support.	Process cycle time, error rate, cost per transaction.
Procurement and supplier management	Demand analysis, contract compliance monitoring, and coordination with external suppliers.	Lead time, on-time delivery rate, contract variance.
Management analytics and reporting	Data aggregation, interpretation, and generation of recommendations and scenarios.	Decision latency, forecast accuracy, recommendation utilization rate.
Cross-functional processes	Dynamic task coordination across organizational units.	Process throughput, rework rate, coordination overhead.

The quantitative impact of agent-based automation is most clearly observed in processes where a substantial share of time is spent on information retrieval, document preparation, and coordination of actions across systems. For example, in the SMB finance and accounting segment, **Intuit** has reported that 45 % of users adopting AI-powered functionality in QuickBooks (based on agent-driven workflows) save approximately 12 hours per month on routine monthly bookkeeping tasks. In addition, the company noted the potential to accelerate payment collection by an average of up to five days through the automation of payment and accounts receivable workflows [10].

For IT operations and service management, **ServiceNow reports** internal efficiency gains from Now Assist through automation of incident documentation. In particular, the generation of resolution notes within seconds reduces the time required for creating incident resolution notes by approximately 80 %, as agents primarily review and refine the generated text. This illustrates how orchestration-enabled assistance can accelerate end-to-end execution chains by compressing documentation and handoff steps in incident workflows [11].

These general observations are consistent with empirical evidence from industrial implementations. Taken together, the presented data and practical examples demonstrate that agent-oriented automation based on orchestration systems is capable of delivering measurable operational benefits across a wide range of enterprise business processes, particularly in scenarios characterized by a high share of knowledge-intensive work and cross-system coordination. At the organizational level, the effectiveness of such systems is closely linked to the quality of digital communication, transparency of automated decision-making, and the degree of trust established between users and intelligent systems, which has been shown to be a critical factor in the adoption of advanced digital tools in both developed and emerging markets [12]. At the same time, the transition from deterministic workflow models to dynamically managed agent-based environments significantly increases the complexity of control, verification, and predictability of process execution. Agent autonomy, the use of learning-based models, and adaptive replanning introduce new requirements for decision interpretability, risk management, and compliance with regulatory constraints, making the analysis of limitations and potential risks of AI agent orchestration a necessary next stage of the study.

Risks and limitations of agent-oriented business process automation

Despite the practical value of AI agent orchestration for the dynamic management of complex processes, agent-oriented automation in enterprise environments faces a range of limitations that are both engineering- and governance-related. A critical challenge is that, unlike deterministic workflow systems, the behavior of an agent-based environment emerges from a combination of planning, contextual interpretation, and tool-mediated actions, making it more difficult to ensure reproducibility, formal verifiability, and guaranteed predictability of end-to-end execution outcomes. In practice, this results in **increased requirements for autonomy control mechanisms,** state management, and the quality of integration with enterprise systems, since errors within an agent's action chain can propagate and lead to cascading effects across the entire business process.

Limitations in reliability and "execution accuracy" of agent-based systems are confirmed by the results of recent benchmarks that model multi-step tasks in interactive environments. For example, the OSWorld benchmark, designed to evaluate "computer-based" agents operating in real operating system environments and applications, reveals a similar gap between human and agent performance. According to the project's reported results, human participants successfully complete more than 72.36% of tasks, whereas the best baseline agent evaluated at the time of publication achieves only about 12.24% success. The primary bottlenecks identified include GUI grounding and insufficient operational knowledge required for executing multi-step actions in realistic environments [13].

Special attention must also be given **to security and corporate governance risks**, as an agent with access to tools and data becomes an active execution entity rather than a passive software module. As agent autonomy increases, the risks of mishandling confidential information, context manipulation, input poisoning in multi-step workflows, and privilege escalation due to misconfigured access policies also increase. Under these conditions, orchestration should incorporate policy gates, tool isolation, privilege separation, mandatory validation loops, and human-in-the-loop controls for high-criticality operations, since model confidence is not equivalent to assurance.

Conclusion

Generally, AI agent orchestration systems represent a promising direction in the evolution of business process automation, enabling a transition from prescriptive and static management models to adaptive and intelligent coordination mechanisms. Their application makes it possible to align the autonomous behavior of AI agents with organizational objectives, dynamically adjust process execution logic, and integrate analytical and cognitive functions within a unified control framework. Despite existing limitations related to interpretability, security, and the verifiability of agent-based systems, the continued development of theoretical and architectural approaches to AI agent orchestration provides a foundation for the formation of resilient, scalable, and context-aware business processes under conditions of digital transformation.

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