Deutschland AG 2.0

A Federated Transformation Architecture for Industrial AI, Sustainability, Security and Resilience

From Legacy Coordination to High-Performance Cooperative Ecosystems across Germany's Metropolitan Regions

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Abstract

Germany faces a coupled transformation problem. Population ageing constrains labour supply and increases pressure on social systems. Climate change requires mitigation and adaptation. Geopolitical conflict has renewed the importance of defence capability, energy security and resilient supply chains. Cyber threats increasingly affect operational technology and critical infrastructure. At the same time, frontier artificial intelligence is accelerating the automation of knowledge work and enabling agentic software, Industrial AI and what this paper uses as the working term Physical AI: AI-enabled systems that perceive and act in the physical world.

These pressures interact. They cannot be governed effectively through isolated sector policies or disconnected regional programmes. This conceptual and normative policy-design paper proposes Deutschland AG 2.0 as a federated transformation architecture. The concept does not seek to restore the closed ownership and board networks associated with the historical Deutschland AG. It defines an open, competitive and accountable form of cooperation among metropolitan regions, industrial firms, the Mittelstand, start-ups, research institutions, public authorities, investors, labour organisations and European partners.

The paper synthesises research on sustainability transitions, mission-oriented innovation, ecosystems, collaborative governance and polycentric governance. It compares seven regional capability profiles: Stuttgart, Munich, Berlin-Brandenburg, the Ruhr Metropolis within the wider Rhine-Ruhr industrial corridor, Hamburg and Northern Germany, Frankfurt/Rhine-Main, and Central Germany with Saxony. The comparison is purposive rather than exhaustive. It is used to identify complementary assets, common dependencies and governance requirements; it does not constitute a regional ranking or causal evaluation.

The paper develops six design propositions, five cross-regional transformation missions, a reference architecture for agentic cyber-physical systems, a model of high-performance cooperative leadership and a Transformation Velocity Scorecard. Recent investment and deployment evidence from the United States and China indicates that Physical AI is becoming a capital-intensive platform and infrastructure competition. This asymmetry strengthens the case for shared European capabilities and for a differentiated, verifiable trust layer for industrial autonomy. The central argument is that Germany already possesses many relevant industrial and technological capabilities, but combines them too slowly. Sustainability, security, productivity and social legitimacy should therefore be treated as mutually dependent conditions of competitiveness. The required institutional result is not central control.

It is coordinated acceleration based on clear missions, open interfaces, distributed execution, verifiable evidence and bounded risk.

Keywords. Deutschland AG; Industrial AI; Physical AI; agentic systems; cyber-physical systems; sustainability transitions; metropolitan regions; cooperative governance; defence innovation; cyber resilience; digital trust.

Contents

1 Introduction

Germany's present challenge is often described as an automotive transition, an energy transition, a digital transition, a demographic transition or a security transition. This separation is analytically convenient but operationally misleading. Germany is facing all these transitions at the same time.

Population ageing changes labour supply, public finances and the organisation of care. Climate change affects infrastructure, health, industrial locations, energy systems, agriculture and supply chains. Geopolitical fragmentation creates new dependencies and security requirements. Defence and civil preparedness require greater industrial capacity. Cyberattacks threaten companies, public authorities and critical infrastructure. Frontier AI models are becoming more capable and less expensive, while AI agents are moving from information generation towards the execution of tasks. The next stage connects AI agents with machines, sensors, vehicles, robots, energy systems and industrial processes.

The result is a coupled transformation problem. A demographic shortage increases the need for automation. Automation increases dependency on digital and cyber-physical systems. This dependency raises the importance of cybersecurity, safety and digital trust. Electrification links industrial competitiveness to grids, storage, software and data. Defence readiness depends on semiconductors, energy, cloud infrastructure, logistics, autonomous systems and secure supply chains. Climate adaptation depends on the same public planning, construction and digital capabilities that are already scarce.

Germany cannot address this problem by protecting every existing industrial structure. It also cannot solve it through isolated technology programmes. The speed of coordination, deployment and scaling has itself become a strategic national capability.

The term **Deutschland AG 2.0** is used in this paper as an institutional design concept. It is not a proposal for a legal entity. It is not a call to restore cross-shareholdings, closed board networks or incumbent-centred industrial policy. The historical German company network supported coordination and long-term relationships, but it also concentrated influence. Its capital links and strategic coordination weakened substantially from the 1980s onwards and especially after 2000 [1].

> **Deutschland AG 1.0 coordinated established institutions for stability. Deutschland AG 2.0 must now coordinate diverse capabilities for rapid transformation in a fiercely competitive geopolitical environment.**

This change requires a different structure. Closed networks must become open ecosystems. Permanent consensus processes must become time-bounded decision processes. Industrial hierarchies must be complemented by modular partnerships. Regional competition must be combined with national and European interoperability. Public funding must lead to deployment. Cooperation must preserve competition rather than replace it.

The analysis is organised around four research questions.

- RQ1 asks why incremental adaptation is insufficient under the combined pressure of demographic change, climate risk, geopolitical conflict, cyber threats and frontier AI.
- RQ2 asks how Germany's metropolitan regions and industrial areas can combine complementary capabilities without losing regional autonomy.
- RQ3 examines which governance mechanisms can turn Germany's capacity for coordination into measurable transformation speed.

- RQ4 examines which technology, security and trust infrastructures are required for an economy based increasingly on Industrial AI, Physical AI and agentic cyber-physical systems.

The paper makes four contributions. First, it interprets Germany's current challenge as a set of coupled transformation pressures rather than separate policy fields. Second, it treats the country's distributed industrial geography as a potential advantage when specialised regions can connect through common missions and infrastructures. Third, it identifies the capital and deployment asymmetry created by US platform investment and China's coordinated Physical AI strategy. Fourth, it defines high-performance cooperative leadership as a proposed governance construct that aligns autonomous actors while preserving clear decision rights, competition, accountability and entry for new participants.

2 Conceptual Foundations and Method

2.1 From the historical Deutschland AG to a new institutional model

For more than a century, the German company network was an important part of organised corporate governance. Banks, industrial firms, ownership links and supervisory boards created dense relationships. At its height, this network gave central actors a broad view of national industrial interests. Changes in financial markets, corporate strategy and taxation later weakened the network. The erosion of capital ties also reduced the degree of strategic coordination between major German companies [1].

The historical system supported long-term investment relationships, institutional knowledge, industrial depth, employer–employee cooperation, stable supplier structures, coordinated vocational training and the management of gradual change.

Its limits were equally material. Influence was concentrated among established actors; barriers to entry remained high; existing structures were protected; capital and talent were reallocated slowly; start-ups and new technology firms had limited access; and successful legacy technologies were rarely challenged before external pressure became acute.

The OECD's analysis of Germany shows why these limits matter today. High administrative burdens and regulatory barriers have weakened business dynamism, innovation and productivity. Industrial and labour-market policies have often favoured incumbents and slowed the movement of resources towards younger and more productive firms. Weak adoption of digital technology has also reduced firm-level productivity growth [2].

Deutschland AG 2.0 must therefore preserve long-term orientation without preserving market closure. It must combine reliability with contestability. It must enable cooperation on shared infrastructure, standards and systemic risks while maintaining competition on products, technologies and execution.

2.2 Sustainability transitions and transformative innovation

Sustainability transitions are not simple substitutions of one product for another. They involve changes in technology, infrastructure, regulation, markets, user practices and institutional arrangements. Transition research shows that established socio-technical systems can remain stable because their components support one another. New technologies require aligned changes in several parts of the system before they can scale [3, 4].

This insight has direct relevance for German industry. An electric vehicle is not only a different drivetrain. It is connected to charging infrastructure, grids, batteries, software, semiconductors, recycling systems, service models and new supply chains. Industrial hydrogen requires production, transport, storage, certification, demand and long-term investment. Autonomous production requires robots, models, sensors, process data, safety systems, connectivity, identity and clear authority.

Transformative innovation policy adds a directional requirement. Innovation policy should not focus only on research expenditure or the performance of individual sectors. It must support changes in systems and address societal problems. This includes experimentation, market formation, regulation, infrastructure and the controlled decline of technologies that no longer meet public objectives [5].

Mission-oriented innovation provides a related policy model. Missions give direction to public and private investment. They connect different sectors around a measurable objective. They also require bottom-up experimentation and feedback rather than a single state-defined technical solution [6].

2.3 Ecosystem structure and interdependence

An ecosystem is more than a group of organisations with a common label. It exists when a value proposition depends on several actors whose activities must be aligned. These relationships cannot always be reduced to bilateral supplier contracts. A failure by one participant can prevent the whole system from delivering the intended result [7].

This distinction is important for Industrial AI and Physical AI. An autonomous industrial operation may depend simultaneously on chips and compute, AI models, industrial data, process context, sensors and actuators, robot and machine control, connectivity, cybersecurity, functional safety, legal authority, product and organisational identities, audit evidence, energy and physical infrastructure.

No single firm is likely to control all these components across an industrial ecosystem. Germany's strategic issue is therefore not only the quality of individual companies. It is the alignment of complementary capabilities.

2.4 Network and polycentric governance

Collaborative governance can support cross-boundary problems, but it is not automatically effective. Research identifies prior relationships, incentives, power imbalances, leadership and institutional design as important conditions. Small, observable successes can build trust and commitment [8].

Network-governance research distinguishes participant-governed networks, lead-organisation models and dedicated network administrative organisations. Their effectiveness depends on the number of participants, the degree of trust, the need for central coordination and the level of agreement on objectives [9].

Polycentric governance adds another principle. Complex systems can be governed through several decision centres operating at different levels. These centres retain autonomy but use common rules, learning mechanisms and conflict-resolution processes. This model is relevant to a federal country with strong Länder, municipalities, metropolitan regions and sector institutions [10].

Deutschland AG 2.0 should therefore be federated rather than centralised. Regional and sectoral actors retain operational autonomy; national missions define measurable common outcomes; shared infrastructures and standards reduce duplication; dedicated mission organisations manage cross-boundary dependencies; and transparent performance evidence supports learning and accountability.

2.5 Working definitions

Several terms in this paper are emergent or used differently across disciplines. The definitions below are analytical conventions for this paper, not claims of settled standardisation.

Table 1: Working definitions

Term	Working definition and boundary
Frontier AI	The highest-capability general-purpose models available at a given point in time. The category is dynamic and should not be equated with reliable performance in a specific industrial setting.
Agentic AI	AI systems that can plan, select tools and execute multi-step tasks under defined objectives and permissions. Agency is bounded by architecture, policy and oversight.
Industrial AI	AI applied to industrial engineering, production, operations, maintenance, logistics or energy systems, using domain context and operational constraints.
Physical AI	A working term for AI-enabled systems that perceive and act in the physical world through robots, vehicles, machines, sensors or infrastructure. The term is not yet standardised.
Agentic cyber-physical system	A system in which software agents use models, data, tools and delegated authority to affect digital or physical processes through connected machines, infrastructure or organisational workflows.
Federated transformation architecture	A governance arrangement in which autonomous regional and sectoral nodes execute common missions through interoperable infrastructure, shared rules and evidence-based coordination.
Mittelstand	Small and medium-sized enterprises and, in the German context, many larger owner-led or specialised firms characterised by long-term orientation and deep domain capability.

2.6 Method, scope and evidence boundaries

This paper follows a conceptual design and policy-analysis approach. It combines peer-reviewed literature with official demographic, economic, security, climate, technology and regional sources available by 31 August 2026. The regional comparison covers Stuttgart, Munich, Berlin-Brandenburg, the Ruhr Metropolis within the wider Rhine-Ruhr corridor, Hamburg and Northern Germany, Frankfurt/Rhine-Main, and Central Germany with Saxony. Cases were selected purposively for differences in legacy assets, transformation exposure and emerging capability; they are not a statistically representative sample.

These regions are analytical nodes, not closed territories. Their value chains extend into rural industrial districts, energy locations, ports, university towns and European networks. The paper separates evidence from design proposals where possible. Official sources support the quantitative claims; company examples are illustrative; and the proposed governance architecture, missions and scorecard are normative constructs that require empirical testing. Recent financing examples draw on issuer disclosures and Reuters reporting. Announced funding rounds, company-wide R&D expenditure, general AI infrastructure plans and operating investments are distinct categories; they are not aggregated or treated as a comparable investment ranking. No causal inference is made.

2.7 Design propositions

Table 2: Design propositions

Proposition	Statement
P1: Simultaneous-transition proposition	Germany faces several coupled transitions. Policies optimised separately for climate, AI, defence, cyber, labour or regional development are likely to underperform.
P2: Regional-complementarity proposition	Germany's distributed industrial geography becomes an advantage when specialised regions can combine capabilities through common missions and infrastructure.
P3: Coordination-to-acceleration proposition	Coordination supports transformation only when decision rights, deadlines, competition and measurable outcomes are explicit.
P4: Ecosystem-completeness proposition	No single organisation controls the complete stack required for agentic cyber-physical systems. System performance depends on complementary actors and interfaces.
P5: Trust-at-scale proposition	Digital identity, delegated authority, provenance, cybersecurity, safety and verifiable evidence become operational infrastructure when agents act across organisational boundaries.
P6: Sustainable-resilience proposition	Decarbonisation, climate adaptation, energy security, cyber resilience and defence readiness must be treated as connected dimensions of industrial competitiveness.

3 The Six Transformation Clocks

3.1 The demographic clock

Germany's demographic structure creates a hard constraint. Destatis projects that one person in four will be aged 67 or older by 2035. Depending on life-expectancy assumptions, the number of people aged 67 and over is expected to reach between 20.5 million and 21.3 million by 2038. All main variants also show a marked decline in the working-age population, although the scale depends on migration and participation assumptions [11].

This development reduces the labour available to industry, construction, logistics, public administration, health and care. It also increases pension, health and long-term-care expenditure, puts pressure on tax and contribution bases, raises the urgency of knowledge transfer as experienced workers retire and intensifies competition for skilled labour across regions and sectors.

The response cannot be reduced to replacing people with machines. Germany needs higher labour-force participation, skilled migration, better education, longer and more flexible working lives, and greater productivity. AI and automation should augment scarce human capabilities.

They should reduce unsafe, repetitive and administratively burdensome work. They should also support older workers and enable faster transfer of industrial knowledge.

A credible social contract is required. Productivity gains must support investment, wages, public services and the financing of social systems. Workers must have access to training and real transition opportunities. The correct objective is not the protection of every current job description. It is the protection of employability, participation and social stability during structural change.

3.2 The productivity and implementation clock

Germany's economic weakness is not explained by one recent crisis. The OECD identifies weak investment, a shrinking working-age population, declining productivity growth, administrative burdens and regulatory barriers as structural problems. It also finds that resources have become locked into less productive firms and that digital adoption within companies has been weak [2].

Public implementation capacity is part of the same problem. The KfW Municipal Panel 2026 reports a perceived municipal investment backlog of €231.2 billion. It also notes that municipalities have historically realised only around two thirds of intended investment volumes. Complex approval and procurement procedures, building rules and staff shortages are identified as important non-financial barriers [12].

This creates a severe timing mismatch. Frontier AI models can improve within months, start-ups require rapid customer validation and industrial plants operate for decades, while planning, approval, education and infrastructure cycles often extend over many years.

Transformation policy must therefore address time-to-capability. Funding announcements are not an adequate measure. Relevant measures include the time from research to industrial use, from application to approval, from pilot to recurring procurement and from company formation to a first major industrial customer. Implementation capacity is no longer only an administrative issue. It is part of industrial policy and national resilience.

3.3 The climate clock

Climate change is already affecting Germany. The Federal Environment Agency's national risk assessment evaluated 102 climate impacts across 13 fields of action and found that many areas of life are already affected. Germany has repeatedly experienced heatwaves, droughts, heavy rainfall and flooding. The July 2021 floods caused 190 flood fatalities in Germany; insurers later reported €8.5 billion in insured losses from the event [13–16].

The policy response must include both mitigation and adaptation.

Mitigation requires lower greenhouse-gas emissions, renewable energy, energy efficiency, electrification, circular material flows and new industrial processes.

Adaptation requires heat-resilient cities, water management, flood protection, resilient transport, stronger energy systems, adapted buildings, ecosystem protection and continuity planning for companies and supply chains.

The green transformation must be a core competitiveness strategy for Deutschland AG 2.0. It should not be treated as an external cost imposed on industry. Energy efficiency reduces exposure to price shocks. Circularity reduces resource dependencies. Renewable electricity can support long-term industrial planning. Climate-resilient infrastructure reduces disruption and losses. Product information and digital product passports can support maintenance, repair, recycling and compliance.

Technology policy must remain scientifically grounded. It should not defend technologies because of historical investment or political identity. Alternatives should be evaluated against lifecycle greenhouse-gas emissions, energy-conversion efficiency, infrastructure and material requirements, land use, safety, total system cost, time to industrial scale, resilience to import dependencies and compatibility with climate targets.

Direct electrification should be prioritised where it is technically and economically feasible. Renewable hydrogen and hydrogen-derived fuels should be focused on harder-to-electrify applications and on roles where hydrogen is a necessary feedstock, storage medium or process input. This follows the European energy-system logic of direct electrification for efficient end uses and indirect electrification for selected difficult-to-electrify demand [17].

The required discipline is neither unconditional technological neutrality nor political prohibition. Public decisions should use transparent system criteria, disclose assumptions and revise support when evidence changes. Once a pathway is selected, infrastructure and market formation must proceed at industrial speed.

3.4 The geopolitical and defence clock

Germany's industrial model was built under conditions of comparatively stable trade, affordable imported energy and a security environment in which defence capacity received limited economic attention. These assumptions no longer hold.

Germany's National Security Strategy defines security in integrated terms. It connects military defence with cyber resilience, critical supplies, raw materials, energy, climate risk and resilient supply chains [18].

At the 2025 Hague Summit, NATO allies committed to invest 5 per cent of gross domestic product annually in defence and defence- and security-related areas by 2035. The commitment comprises at least 3.5 per cent for core defence requirements and up to 1.5 per cent for wider security, resilience, critical infrastructure and innovation. The European Commission's 2025 White Paper for European Defence—Readiness 2030 likewise calls for larger production capacity, collaborative procurement, interoperability and faster innovation [19, 20].

This shift has direct industrial implications. Defence capability depends on semiconductors and electronic components, secure communications, drones and autonomous systems, aerospace, cyber defence, software, energy, logistics, repair capacity, trusted suppliers and resilient manufacturing.

Many of these capabilities are dual-use. They also support civil protection, disaster response, infrastructure monitoring, industrial inspection and logistics.

Defence policy should not be separated from industrial and innovation policy. It should, however, remain subject to democratic control, international law, procurement transparency and clear ethical requirements. Security urgency must not become a general exemption from accountability.

Germany also requires a new procurement logic. Defence and security customers must be able to test and purchase new capabilities more rapidly. Start-ups and medium-sized firms need realistic access to programmes and contracts. Interoperability with European partners must be designed from the start.

3.5 The cyber clock

The BSI assessed Germany's IT security situation in 2025 as continuing to be tense. Growing digitalisation increases the number of attack surfaces. Geopolitical conflict and organised cybercrime add further pressure [21].

Cybersecurity is no longer confined to office information technology. It affects operational technology, factories, energy grids, storage, water systems, hospitals, logistics, vehicles, public administration, telecommunications, data centres and autonomous machines.

Germany's KRITIS umbrella law entered into force on 17 March 2026. It introduces nationwide, cross-sector minimum standards for the physical protection and resilience of critical infrastructure and complements existing IT-security rules. Covered sectors include energy, transport, finance and insurance, health, drinking water, wastewater, municipal waste, information technology and telecommunications, food, space and public administration [22].

Agentic and cyber-physical systems change the risk model. An AI agent can read, decide, communicate and invoke tools. When connected to industrial systems, it may also change configurations, order materials, approve transactions, control machines or direct autonomous equipment. The system must therefore identify the responsible legal person, verify the agent's mandate, restrict permissions, validate decision evidence, record material actions, support human takeover and escalation, fail safely and permit rapid revocation.

A technically authenticated agent is not automatically authorised to perform a business or physical action. An authorised agent may still lack sufficient evidence. Cybersecurity, authority, provenance, safety and operational control must therefore be designed together.

3.6 The frontier AI clock

Frontier AI is advancing faster than conventional industrial planning cycles. The Stanford AI Index 2026 reports that industry produced more than 90 per cent of notable frontier models in 2025. On OSWorld, a structured benchmark for computer-use agents, performance rose from roughly 12 per cent to 66.3 per cent. This progress is substantial, but the benchmark result still implies failure in about one third of tasks and does not establish reliability in open industrial environments [23].

At the same time, quality-adjusted prices for text-to-text models fell rapidly. OECD analysis reports a decline of nearly 80 per cent between January 2024 and April 2026, alongside increased numbers of models and providers. The same analysis warns that competition risks remain concentrated in compute, chips, cloud, data and skills. Effective deployment also requires complementary investment in data quality, organisational redesign, cybersecurity, safety and workforce capability [24].

Four strategic consequences follow. The model layer will remain dynamic, so industrial architectures should be model-agnostic and avoid permanent dependency on one provider. Value will shift towards integration with domain knowledge, industrial processes, machines and trusted data. Concentration risks in chips, cloud, compute and data require European capacity and contestable access. Finally, AI governance must move beyond model documentation towards runtime identity, authorisation, policy enforcement, monitoring, signed evidence, human escalation and incident response.

The frontier AI clock therefore changes the pace of the other five clocks. It can improve productivity, climate modelling, engineering, defence, cyber defence and public administration. It can also accelerate attacks, increase dependencies and create new safety risks.

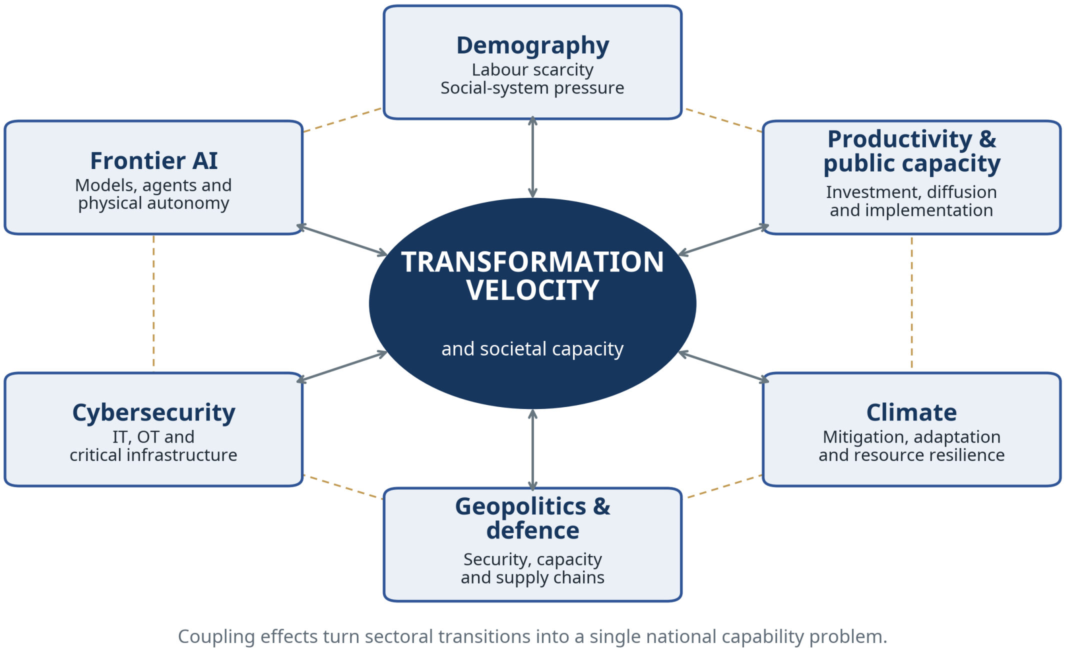

Figure 1: Coupled transformation pressures and feedback loops. Source: author's conceptual synthesis.

Table 3: Transformation clocks: principal pressure and required response

Transformation clock	Principal pressure	Required response
Demography	Labour scarcity and fiscal pressure	Productivity, participation, skills and human-centred automation
Productivity and public capacity	Slow implementation and weak diffusion	Faster approval, procurement, deployment and scaling
Climate mitigation and adaptation	Physical risks and decarbonisation pressure	Electrification, circularity and resilient infrastructure
Geopolitics and defence	Security competition and dependency	Secure capacity, supply chains and dual-use innovation
Cybersecurity	Attacks on connected industrial systems	Zero trust, resilience, bounded autonomy and evidence
Frontier AI	Rapid automation and agentic capability	Organisational adoption, control and trusted integration

The six clocks reinforce one another. They should therefore be governed as one transformation system rather than six separate programmes.

4 Metropolitan Germany as a Federated Transformation System

Germany is not organised around one dominant metropolis. Its industrial strength is distributed. This can support resilience and specialisation. It can also produce fragmentation, duplication and slow coordination.

The OECD warns that green and digital transformation may widen regional disparities. It calls for stronger coordination between place-based, industrial, infrastructure and innovation policies. It also identifies intermunicipal cooperation, shared procurement and joint infrastructure planning as ways to improve administrative capacity [25].

Deutschland AG 2.0 should not attempt to turn every region into a full-stack technology centre. It should build cross-regional missions around complementary strengths.

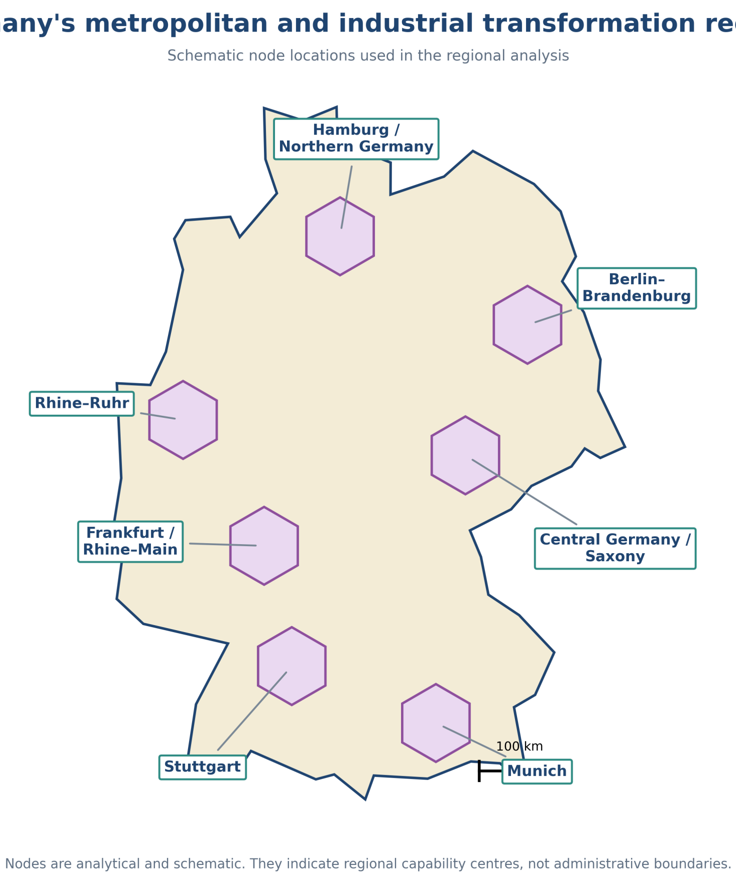

Figure 2: Germany's metropolitan and industrial transformation regions. Source: author's conceptual synthesis using Natural Earth country geometry and schematic regional node locations.

Table 4: Regional transformation profiles

Region	Established strengths	Main transformation exposure	Proposed Deutschland AG 2.0 mission
Stuttgart	Automotive, mechanical engineering, automation, industrial R&D	Electrification, software-defined vehicles, supplier transition	Software-defined mobility, robotics and AI-enabled production

Table 4: Regional transformation profiles

Region	Established strengths	Main transformation exposure	Proposed Deutschland AG 2.0 mission
Munich	Deep tech, AI, aerospace, defence, research, corporate headquarters	Scaling research and start-ups into production	Autonomous systems, aerospace, defence and industrial deep tech
Berlin-Brandenburg	AI start-ups, software, venture capital, public institutions, creative industries	Weak links to industrial deployment and manufacturing scale	Frontier AI, agentic software and national industrial integration
Ruhr Metropolis / wider Rhine-Ruhr corridor	Steel, chemicals, energy, logistics, infrastructure	Carbon-intensive production, long-lived assets and fragmented governance	AI-enabled low-carbon heavy industry and industrial infrastructure
Hamburg and Northern Germany	Port, logistics, maritime, aviation, wind energy	Decarbonisation of transport and energy-intensive infrastructure	Autonomous and climate-neutral logistics, ports and aviation
Frankfurt/ Rhine-Main	Finance, logistics, data centres, internet infrastructure	Energy demand, digital concentration and infrastructure dependency	Trusted compute, financial infrastructure and agentic commerce
Central Germany and Saxony	Semiconductors, manufacturing, chemistry, energy and logistics	Coal exit, supply-chain exposure and industrial restructuring	Semiconductor capacity and resilience, green chemistry and advanced production

4.1 Stuttgart: from automotive concentration to intelligent production systems

The Stuttgart region combines major industrial assets with high transition exposure. The 2023 Structural Report estimated 220,500 employees in the regional automotive cluster in 2022, just over 17 per cent of regional employment. This is an estimate for the cluster rather than a current headcount, but it demonstrates the scale of regional dependence [26]. The 2025 Structural Report characterises the region as being at a critical turning point shaped by electrification, digitalisation, international competition and workforce change [27].

This concentration has created wealth, knowledge and strong supplier networks. It also creates systemic risk. Electrification changes component demand. Software-defined vehicles shift value towards software, chips, data and digital services. Automated driving and shared mobility may change products and business models. Suppliers specialised in combustion-engine components face declining markets.

The correct response is not a simple replacement of the combustion vehicle with an electric vehicle. Stuttgart should combine software-defined mobility, industrial AI, robotics and flexible automation, power electronics, battery systems, circular production, industrial cybersecurity and digital engineering into a broader intelligent-production mission.

The region's machine builders and automation companies provide a bridge beyond passenger vehicles. Existing production knowledge can serve commercial vehicles, industrial equipment, energy systems, defence, medical technology and aerospace.

The leadership task is to connect companies with shrinking legacy markets to growing technology fields. This requires transparent capability mapping, supplier-conversion programmes, shared test environments and faster access to first customers. It also requires early decisions. Delayed structural adjustment does not protect employment. It increases the risk of abrupt adjustment later.

4.2 Munich: deep tech, aerospace and defence industrialisation

The Munich metropolitan region has strong capabilities in deep tech, artificial intelligence, green technology, medical technology, mobility and defence technology. Its research institutions, established companies, investors and start-up networks provide favourable conditions for research-based ventures [28].

Munich's central challenge is industrialisation. Research quality and venture financing do not automatically create high-volume production, secure supply chains or exportable systems.

The region should lead cross-regional missions in aerospace and space systems, defence technology, autonomous flight and mobility, advanced sensors, quantum technologies, AI engineering, semiconductor design and high-assurance software.

Munich should connect more systematically with Saxon semiconductor production, Stuttgart manufacturing, Hamburg aviation, Berlin software and Rhine-Ruhr industrial capacity. Procurement by defence, space and public-security customers should support rapid but controlled industrial validation.

4.3 Berlin-Brandenburg: connecting frontier AI with industrial scale

Berlin is Germany's largest concentration of AI start-ups. Berlin Partner reported 283 AI start-ups, representing about 30 per cent of the German total. The city is also developing a defence-technology ecosystem connecting research, industry and public institutions [29].

Berlin's strength is the rapid creation of software, models, business concepts and international teams. Its weakness is the limited local base of high-volume industrial production. Many start-ups remain separated from Germany's industrial value chains.

Berlin-Brandenburg should therefore serve as a national translation layer between frontier AI and industrial application. Relevant capabilities include agent development, multimodal models, AI tooling, cybersecurity, public-sector AI, simulation, geospatial intelligence, health technology, defence software and regulatory expertise.

Cross-regional programmes should place Berlin AI teams inside industrial environments in Stuttgart, the Ruhr, Hamburg and Saxony. Conversely, industrial experts should shape model evaluation, data requirements and safety processes from the start.

The intended result is not the transfer of every start-up out of Berlin. It is a denser national market for industrial AI.

4.4 Ruhr Metropolis and the wider Rhine-Ruhr corridor: low-carbon heavy industry

The Ruhr Metropolis combines steel, chemicals, energy, logistics, engineering and a dense research landscape within the wider Rhine-Ruhr industrial corridor. Regionalverband Ruhr defines the Ruhr Metropolis as 53 municipalities with more than 5.1 million inhabitants. The distinction matters because the statistical entity is the Ruhr Metropolis, not the whole Rhine-Ruhr conurbation [30].

Its transformation is difficult because major assets are capital-intensive and long-lived. Industrial decarbonisation affects electricity demand, hydrogen, carbon management, process heat, material flows and transport infrastructure. Individual firms cannot build the full enabling system.

The region should become a large-scale operating environment for AI-optimised energy and material flows, low-carbon steel and chemicals, industrial electrification, justified hydrogen applications, circular feedstocks, predictive maintenance, autonomous inspection, industrial carbon accounting and resilient water and transport infrastructure.

Existing projects already demonstrate the value of partnerships between industrial firms, energy technology companies, research organisations and public authorities. The regional hydrogen ecosystem also shows the importance of aligning producers, users, infrastructure and start-ups [30].

The region's municipal fragmentation makes governance important. Cross-city infrastructure should not depend on dozens of uncoordinated processes. Dedicated mission organisations should bundle planning, procurement and evidence management.

4.5 Hamburg and Northern Germany: autonomous and sustainable logistics

The Hamburg metropolitan region combines maritime business, logistics, ports, aviation, renewable energy, chemicals, machinery and information technology [31].

These capabilities create a natural mission around climate-neutral and autonomous logistics. Ports and airports are complex cyber-physical systems. They connect vehicles, cargo, customs, infrastructure, energy, workers and international supply chains. They are also security-sensitive.

The region should focus on autonomous port and yard operations, trusted cargo and product data, lower-emission shipping and aviation, offshore-wind integration, selected renewable fuels, drone and robotic inspection, resilient logistics, cyber-secure operational technology and digital product and transport documentation.

Northern renewable-energy assets can support industrial decarbonisation elsewhere in Germany. This requires grid capacity, storage, demand flexibility and predictable market rules. Hamburg should therefore connect with Rhine-Ruhr industrial demand, Frankfurt financial infrastructure and national energy orchestration platforms.

4.6 Frankfurt/Rhine-Main: the infrastructure of the agentic economy

Frankfurt/Rhine-Main combines finance, logistics, telecommunications, data centres and major internet infrastructure. An official regional study identified 76 data-centre locations in Frankfurt/Rhine-Main, of which 55 were in Frankfurt, and estimated that Frankfurt hosted close to 30 per cent of German data centres. These figures describe locations in the study and should not be read as a full measure of national computing capacity [32].

This gives Frankfurt a central role in AI and agentic commerce. However, compute infrastructure also creates high electricity and land demand. The region must connect digital expansion with energy-system planning, heat use, grid resilience and public acceptance.

Its Deutschland AG 2.0 mission should combine trusted compute, cloud and data-centre resilience, financial infrastructure for industrial transformation, machine-to-machine payments, business and agent identities, regulated data exchange, digital compliance, cyber insurance and scale-up finance.

As AI agents begin to negotiate, procure and transact, legal authority will become a core infrastructure question. Financial institutions, business wallets, company registers, identity providers and industrial platforms must create a verifiable chain from the legal person to the human or machine acting on its behalf.

4.7 Central Germany and Saxony: semiconductors, energy and advanced production

Saxony has developed a major European microelectronics and information-technology cluster. Silicon Saxony describes a regional value chain that connects manufacturers, suppliers, research institutions, universities and start-ups. The cluster's significance lies not only in fabrication but also in design, equipment, materials, software and skills [33].

The wider Central German region combines mobility, logistics, energy, environmental technology, chemicals and information technology. Its transformation challenge links the coal phase-out, chemical-industry decarbonisation, automotive change and the need for new energy and digital infrastructure. Public claims about firm and employment counts vary by territorial definition and are therefore not used here as comparative performance indicators.

The region should connect semiconductor and sensor capacity and resilience, energy and storage technology, green chemistry and circular materials, and AI-enabled advanced manufacturing.

Its role is critical because every other regional mission depends on chips, sensors and power electronics. Semiconductor policy should not focus only on fabrication capacity. It should address design, equipment, chemicals, packaging, software, cybersecurity, energy and skilled labour.

4.8 From regional clusters to cross-regional capability networks

Germany does not need seven attempts to reproduce Silicon Valley. It needs a connected system of specialised regions.

Illustrative capability flows include Berlin models combined with Stuttgart industrial processes, Saxon chips integrated into Munich autonomous systems, Hamburg logistics connected with Ruhr materials, Frankfurt compute and finance supporting agentic commerce, Northern renewable electricity serving industrial demand, Stuttgart automation supporting Central German chemistry and Munich defence systems using software and manufacturing capabilities from other regions.

Metropolitan regions should therefore be treated as **mission nodes**, not isolated brands. Their performance should be measured partly by what they contribute to other regions.

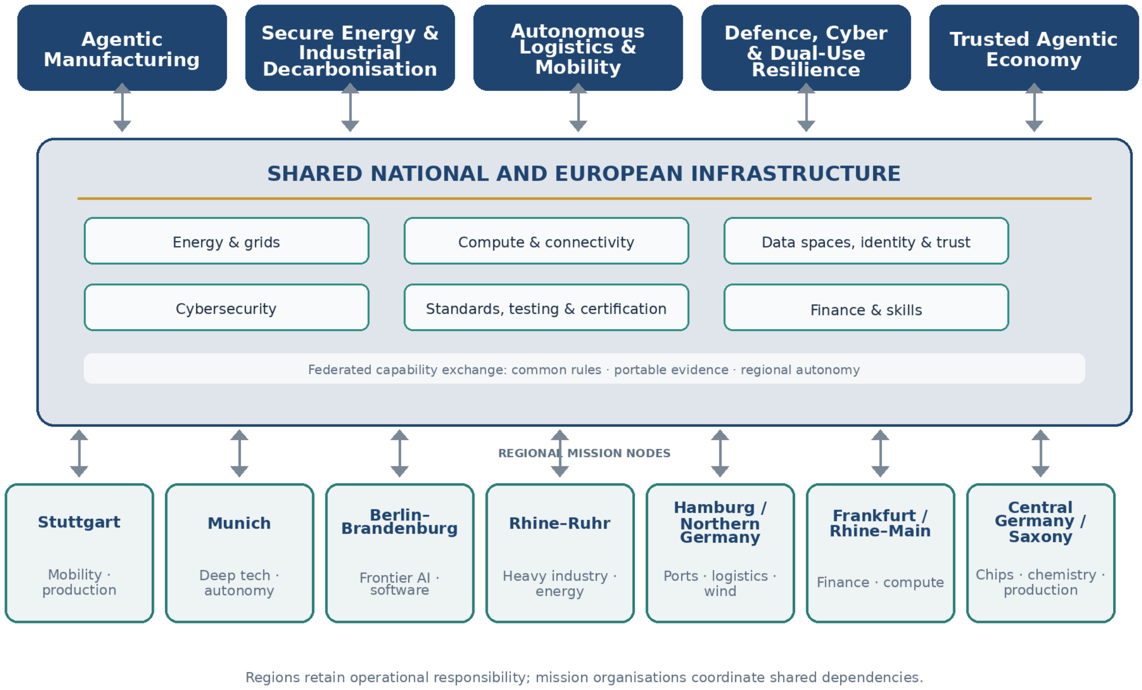

Figure 3: Federated regional mission architecture. Source: author's conceptual synthesis.

5 The Technology Architecture of Deutschland AG 2.0

5.1 From digitalisation to agentic cyber-physical systems

Traditional digitalisation records and communicates information. Industrial AI interprets industrial context and supports decisions. Agentic systems can plan and execute multi-step actions. Physical AI, used here as an emerging working term, connects perception and reasoning with machines and physical environments. These categories overlap and should not be treated as mutually exclusive technology classes.

An **agentic cyber-physical system** is defined here as:

> A system in which software agents use models, data, tools and delegated authority to affect digital or physical processes through connected machines, infrastructure or organisational workflows.

Examples include energy agents controlling distributed batteries, production agents rescheduling machines and materials, logistics agents ordering transport and directing autonomous equipment, maintenance agents diagnosing equipment and procuring parts, defence systems coordinating sensors and autonomous platforms, compliance agents checking product evidence and grid agents activating flexibility under defined rules.

These systems require more than a capable model. They require a layered architecture.

5.2 Complementary German technology capabilities

A 2026 editorial selection by the author illustrates the breadth of the required stack. It includes 1KOMMA5°/Heartbeat AI, Black Forest Labs, Celonis, Helsing, n8n, NEURA Robotics, Parloa,

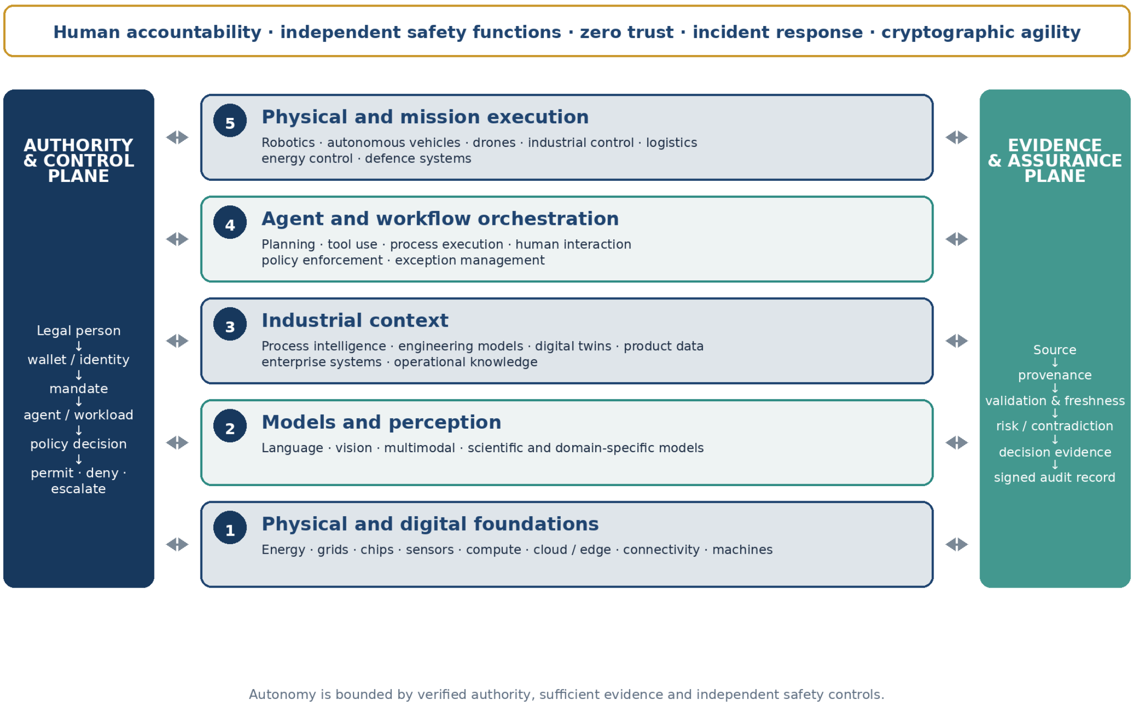

Figure 4: Reference architecture for agentic cyber-physical systems. Source: author's conceptual synthesis.

Quantum Systems, Sereact and Spherity. The selection is alphabetical and capability-oriented; it is not a valuation ranking, an exhaustive market map or an independent comparative assessment. Together with established industrial anchors such as Siemens, Bosch, SAP, Infineon, Deutsche Telekom and Schwarz Digits, the examples illustrate complementary capabilities across AI, energy, software, robotics, autonomy and digital trust [34].

Table 5: Illustrative technology capability exemplars

Company	Main capability	Relevance to Deutschland AG 2.0
1KOMMA5° / Heartbeat AI	Distributed energy orchestration	Connects buildings, generation, storage, tariffs and grid-responsive operation
Black Forest Labs	Frontier visual AI models	Supports perception, design, simulation, inspection and multimodal interaction
Celonis	Process intelligence and enterprise context	Provides structured understanding of business processes and operational inefficiency
Helsing	Defence AI and mission systems	Connects AI, sensors, command systems and autonomous defence capabilities
n8n	Workflow and agent orchestration	Enables integration of tools, data and agent-based process execution
NEURA Robotics	Cognitive and humanoid robotics	Brings AI into flexible physical work and industrial environments
Parloa	Enterprise conversational agents	Supports controlled interaction between organisations, employees and customers

Table 5: Illustrative technology capability exemplars

Company	Main capability	Relevance to Deutschland AG 2.0
Quantum Systems	Software-defined autonomous systems	Integrates aerial platforms, sensors, software and mission intelligence
Sereact	Physical AI for robotic manipulation	Enables robots to handle variable objects and less structured tasks
Spherity	Organisational, product and agent trust infrastructure	Illustrates verifiable organisational, product and agent identity, mandates and provenance; included with disclosed author conflict of interest.

The table is not a claim that these companies alone can supply the complete stack. It demonstrates the opposite. Each firm solves a part of the system.

The strategic question is how these capabilities are combined with industrial engineering, production assets, supply-chain access, European standards, public procurement, safety certification, energy and compute, sector knowledge and scale-up finance.

5.3 Global capital and deployment competition in Physical AI

Physical AI is becoming a platform and infrastructure competition rather than a narrow robotics segment. Systems that perceive, reason and act require frontier models, world and action models, simulation, synthetic and operational data, robot hardware, component supply chains, manufacturing, test environments, safety engineering and repeated deployment feedback. Capital requirements therefore arise at several layers at once, and advantages can compound when one firm or ecosystem combines compute, models, cloud services, operational fleets and customer access.

Recent US activity illustrates the scale, while requiring careful comparison. OpenAI participated in Physical Intelligence's US$400 million 2024 financing round to develop general-purpose robot software. OpenAI and SoftBank also announced the Stargate project, which intends to invest US$500 billion over four years in US AI infrastructure, beginning with US$100 billion. Stargate is not a Physical AI budget; it illustrates the compute, energy and construction base available to frontier-model development. In January 2026, OpenAI's domestic-manufacturing request for proposals explicitly included critical inputs for advanced robotics, including gearboxes, motors and power electronics [35–37].

An even broader estimate points to the surrounding capital base. Bridgewater Associates projected that Alphabet, Amazon, Meta and Microsoft would collectively invest about US$650 billion in AI-related infrastructure in 2026, up from US$410 billion in 2025. The estimate, reported by Reuters, is forward-looking and is neither audited actual expenditure nor a Physical AI budget. It nevertheless indicates the scale of compute, energy and data-centre investment from which robotics and industrial AI ecosystems can benefit [38].

NVIDIA combines substantial financial capacity with a vertically integrated development stack. It reported US$18.5 billion in company-wide R&D expenditure for fiscal 2026; this figure must not be interpreted as spending solely on robotics. Its Physical AI stack links Cosmos world models, Isaac simulation and GR00T robot models with partner deployments. On 26 August 2026, AWS and NVIDIA announced plans to deploy two million additional NVIDIA GPUs across AWS infrastructure in 2027–2028 and to expand Amazon Robotics' use of NVIDIA's Physical AI platform across simulation, synthetic-data generation, robot training, route optimisation, functional safety and real-to-sim validation. The GPU plan is forward-looking and has no disclosed Physical AI budget, but it illustrates the infrastructure scale available to robotics development and deployment [39–41].

US platform firms also combine venture finance with models, cloud services and operating environments. NVIDIA participated in Figure AI's Series C, which exceeded US$1 billion in 2025, and, through NVentures, in Skild AI's US$1.4 billion Series C in 2026. Google DeepMind released the Gemini Robotics 2 family for whole-body control, task orchestration and multi-robot collaboration and maintains a strategic relationship with Apptronik; Apptronik reported more than US$935 million in Series A financing by February 2026. Amazon separately announced more than €10 billion to expand and modernise European fulfilment centres with next-generation robotics. These commitments are not directly additive because they represent venture rounds, company-wide R&D, planned infrastructure capacity and operating investment. Taken together, they show the resource and deployment base available to leading US technology ecosystems [42–46].

China is pursuing a different, strongly coordinated state–market model. Embodied AI appeared among the industries of the future in the 2025 and 2026 government work reports and in priorities for the Fifteenth Five-Year Plan. The National Development and Reform Commission reported more than 150 humanoid-robot companies and announced work on standards, evaluation systems, shared infrastructure and market entry and exit mechanisms, while warning that technology paths, business models and application scenarios remain immature. In August 2026, XPENG's robotics business raised more than US$900 million. The company described this as the largest single-round private financing in China's embodied-AI sector and stated that the proceeds would support hardware and software R&D, Physical AI model training, high-quality data generation, mass-production facilities and international expansion. Reuters also reported a US$455 million pre-Series A round for TARS Robotics in April 2026 [47–51].

Public mobilisation is also material. Reuters' analysis of Chinese procurement records found at least US$230 million in government purchases of humanoids and related items during the first half of 2026, up from US$62 million one year earlier. It also reported a US$1 billion State Grid programme for AI-enabled humanoids, dual-arm robots and robot dogs, and a requirement for ten provinces to identify at least twenty real-world training sites each. These figures concern purchases and announced programmes rather than audited national R&D expenditure. They indicate coordinated demand and deployment infrastructure, while the same evidence points to subsidy dependence, overcapacity and limited general-purpose reliability [52].

China also uses large public competitions as coordinated testing and mobilisation environments. The second World Humanoid Robot Games in Beijing attracted 666 teams and 2,056 robots from 16 countries and regions across 51 events and 1,301 matches. Twenty-one scenario-based contests addressed factories, hotels, homes and logistics facilities. The event does not establish that general-purpose humanoid robotics has reached industrial reliability. Its strategic value lies in concentrated testing, rapid iteration, supplier visibility, talent formation and public attention around deployment-oriented tasks [53].

This evidence creates a capital, infrastructure and coordination challenge for Germany and Europe. The European Investment Bank reports that EU scale-ups raise, on average, 50 per cent less capital than US counterparts during their first ten years. The Draghi report records that EU companies spent about €270 billion less on research and innovation than US companies in 2021, with the gap driven mainly by US technology-sector investment. Few German start-ups or Mittelstand firms can reproduce the budgets described above. Even large European industrial groups rarely combine hyperscale cloud infrastructure, frontier-model platforms, venture portfolios, operating fleets and global customer access within one balance sheet [54, 55].

The response should not be technological retreat or a claim that regulation alone creates competitiveness. Germany and Europe must retain capability in models, robotics, chips, compute and industrial deployment. They should concentrate resources where industrial depth and European institutions can create differentiated system value: safety-assured and, where applicable, certified Industrial and Physical AI; integration with machinery, energy and logistics systems; shared simulation, data-collection and hardware-in-the-loop test infrastructure; access to representative industrial environments and governed data; and rapid certification and procurement pathways. Germany's installed base of factories, machines, energy assets and logistics systems is itself strategic training and deployment infrastructure, provided that firms can access it under workable technical, commercial and legal conditions.

A verifiable Trust Infrastructure for AI should bind legal-person, machine and agent identity to mandates, provenance, policy enforcement, signed runtime evidence, digital product passports, Business Wallets, revocation, incident records and auditability. This can provide a distinctive European system-level competitive advantage—a European USP—especially in regulated and safety-critical sectors. It is a complement to, rather than a substitute for, capability in core AI, robotics, semiconductors and compute.

Germany cannot rely on isolated national champions or fragmented pilots. Shared compute, simulation, robot-data facilities, certification environments, procurement and cross-regional industrial testbeds allow smaller balance sheets to create larger system capability. High-performance cooperative leadership is therefore not only a governance preference. It is the mechanism by which Germany and Europe can pool infrastructure, combine specialised firms and convert industrial assets and trusted governance into a competitive Physical AI ecosystem.

> Europe should not attempt to win a balance-sheet contest firm by firm. It should build a federated industrial system in which shared infrastructure, industrial deployment and verifiable trust amplify specialised capabilities.

5.4 The role of established industrial anchors

Large German companies remain central. Siemens, Bosch, SAP, Infineon, Deutsche Telekom and Schwarz Digits provide industrial systems, enterprise software, components, connectivity, cloud infrastructure, customer access and international scale.

Deutschland AG 2.0 should not create an artificial choice between established firms and start-ups. Start-ups contribute speed, focused technology and new architectures; the Mittelstand contributes specialised industrial knowledge and export capability; large firms contribute scale, integration, global sales and production systems; research institutions contribute scientific depth; public institutions create infrastructure, rules and lead markets; investors provide risk and growth capital; and employees contribute operational knowledge and social legitimacy.

Large firms should help smaller companies industrialise rather than only absorb them. Start-ups should challenge established designs rather than remain in permanent pilot programmes. Public authorities should assess outcomes rather than company size.

5.5 Trust infrastructure as a production factor

Cross-company autonomy requires verifiable trust. Traditional enterprise systems assume that users, machines and data remain within a controlled organisational boundary. Agentic ecosystems cross these boundaries continuously.

A robust trust architecture should include two connected planes.

5.5.1 The authority and control plane

This plane establishes:

> **legal person → organisational wallet → mandate → human or AI agent → policy decision → permitted, denied or escalated action**

The authority and control plane answers who operates the agent, which organisation is legally responsible, who delegated authority, what scope, duration and monetary or physical limits apply, whether authority can be revoked and which policy governs the action.

5.5.2 The evidence and assurance plane

This plane establishes:

> **source → provenance → validation → freshness → risk assessment → decision evidence → signed audit record**

The evidence and assurance plane answers where the data originated, whether the source is authentic and current, whether sources conflict, which model and tools were used, which decision rule applied and whether the action can be reconstructed.

Business wallets, verifiable credentials, digital product passports, product identities, organisational identities and signed evidence records can support this architecture. They are not administrative additions. They reduce the cost and risk of cross-company automation.

6 Requirements for Deutschland AG 2.0

6.1 Open and contestable ecosystems

Deutschland AG 2.0 must remain open to new participants. Membership in publicly supported ecosystems should not depend on existing corporate relationships.

Open participation requires published technical interfaces, clear admission criteria, interoperable standards, portable data and credentials, transparent procurement, non-discriminatory access to test facilities, clear intellectual-property rules and credible exit and switching options.

This is also a competition requirement. OECD analysis warns that high entry barriers and incumbent protection weaken productivity and innovation. AI markets create additional concentration risks around chips, cloud and data [2, 24].

Cooperation should be strongest where fragmentation creates common costs: standards, identity, security, testing, infrastructure and workforce development. Competition should remain strong where alternative solutions can improve cost, quality and performance.

6.2 Mission orientation with measurable outcomes

A mission is not a general field such as “AI” or “hydrogen”. It is a measurable outcome that requires several actors.

A suitable mission should address a recognised public and industrial need, require cross-sector cooperation, permit several technical approaches, include a defined deployment environment, use measurable milestones, create a path beyond a single pilot and support European scale.

Mission governance should specify who decides, who funds, who procures, who executes and who evaluates. It should also define conditions for stopping or redesigning an unsuccessful programme.

6.3 Shared infrastructure

Shared transformation infrastructure includes electricity grids and flexibility markets, compute and data-centre capacity, secure connectivity, industrial data spaces, organisational and product identity, cybersecurity services, testing and certification facilities, regulatory sandboxes, digital product passport services, Business Wallet infrastructure, public digital services and training capacity.

Physical AI adds requirements for pooled compute, world-model and simulation capacity, robot data collection, hardware-in-the-loop testing, safety and cybersecurity validation, certification and representative industrial deployment sites. Shared access can reduce duplication of capital-intensive facilities while preserving competition at the solution layer.

Shared infrastructure does not require one central operator. It requires interoperability, service levels and clear governance.

6.4 Public procurement as a transformation instrument

Public procurement can create early demand in defence, mobility, energy, health, administration and critical infrastructure. It should move from specification-heavy procurement towards controlled outcome-based procurement where appropriate.

Procurement reform should include smaller initial contract modules, faster qualification, common templates, joint procurement across municipalities, staged contracts from test to deployment, interoperability requirements, evidence-based cybersecurity and sustainability criteria, and realistic access for start-ups and SMEs.

A pilot that cannot lead to procurement is not a transformation instrument. It is an experiment without a market path.

6.5 Industrialisation and scale-up finance

Germany has many research and pilot programmes. The more difficult phase is industrialisation. Companies need finance for production facilities, certification, working capital, international sales and long procurement cycles.

This gap is particularly serious for Physical AI, where firms must finance models, data, hardware, training facilities and production before broad recurring revenue. The EIB reports that EU scale-ups raise, on average, about half as much capital as US counterparts during their first ten years. The evidence supports a combined response: deeper European capital markets, mission-linked procurement, pooled infrastructure and cross-border growth finance [54].

Deutschland AG 2.0 should combine private risk capital, growth equity, project finance, guarantees, advance procurement commitments, infrastructure funds, strategic European instruments and corporate customer commitments.

Public support should be conditional on milestones and additional private investment. It should not remove commercial discipline.

6.6 Security, safety and trust by design

Cybersecurity and safety must be part of system architecture from the beginning. This is particularly important for AI connected to physical systems.

Minimum requirements should include:

- Hardware, workload and organisational identity, supported where appropriate by attestation.
- Least privilege, network segmentation and policy-based access control.
- Signed software, secure update processes and supply-chain security.
- Model and agent monitoring, including drift, misuse and tool-call anomalies.
- Bounded autonomy with human takeover, escalation and independent safety functions.
- Safe degraded operation, incident reporting and forensic evidence.
- Revocation, cryptographic agility and long-term evidence retention.

For agentic commerce and cross-company automation, these measures must be supplemented by verifiable organisational authority and transaction evidence.

6.7 A science-based sustainability transition

Deutschland AG 2.0 must accept the scientific evidence on climate change and act on it. Climate mitigation and adaptation are not optional political narratives. They are requirements for public safety, economic continuity and intergenerational responsibility.

A constructive transition culture should distinguish three questions: which physical and environmental outcome is required; which technology can deliver it at scale; and which transition path protects social stability without preserving obsolete structures indefinitely.

Public support should prioritise technologies that can demonstrate credible performance against lifecycle and system criteria. Legacy investments should not create a permanent right to protection. At the same time, existing industrial knowledge should be redirected rather than discarded where possible.

Workers in affected sectors need early information, recognised training, income security during qualification and access to new employment. Regions need investment before large job losses occur.

6.8 Skills and social legitimacy

Transformation will fail without social legitimacy. This does not mean that every decision requires unanimous agreement. It means that affected groups must have a real role in shaping implementation.

Relevant measures include regional skills forecasting, portable training credentials, modular further education, cooperation among vocational schools, universities and firms, worker participation in AI deployment, transparent impact assessments, support for geographic and occupational mobility, and transition agreements between shrinking and growing sectors.

The demographic transition makes training capacity especially important. Germany cannot afford to lose experienced workers because qualification systems are too slow or rigid.

6.9 European integration

Germany's industrial system is European. Supply chains, standards, energy markets, research, defence and regulation cross national borders.

Deutschland AG 2.0 should therefore be designed as a German contribution to European capability. Its infrastructures should support European identity standards, data spaces, product rules, cybersecurity requirements and defence interoperability. Cooperation must remain compatible with EU competition and state-aid law, protect the integrity of the Single Market and avoid national access barriers.

The objective is not national technological isolation. It is European capacity with reduced critical dependency and the ability to act under adverse conditions.

Table 6: From Deutschland AG 1.0 to Deutschland AG 2.0

Deutschland AG 1.0	Deutschland AG 2.0
Closed corporate relationships	Open, rule-based ecosystems
Capital and board interlocks	Technical and operational interoperability
Incumbent-centred coordination	Incumbents, Mittelstand, start-ups, science and public actors
National corporate network	Federated regional and European capability network
Stability of existing structures	Adaptability and transformation
Long planning cycles	Continuous experimentation with fixed decision points
Supplier hierarchy	Modular ecosystem roles
Internal information control	Governed cross-company evidence exchange
Broad risk avoidance	Bounded experimentation and safe scaling
Protection of existing jobs	Protection of employability and transition capacity
Technology programmes	Measurable missions
Informal influence	Transparent governance and accountability
Coordination centred on stability	Coordination as a means to accountable acceleration

7 High-Performance Cooperative Leadership

7.1 Definition

High-performance cooperative leadership is the capacity to align autonomous organisations around a measurable mission while preserving clear accountability, competition and operational speed.

It differs from traditional hierarchy. No participant controls the whole system.

It also differs from loose networking. Participants have defined commitments, interfaces, deadlines and performance obligations.

Its purpose is not harmony. Its purpose is coordinated delivery.

7.2 Principles of high-performance cooperative leadership

High-performance cooperative leadership is proposed here as a design construct rather than a validated scale. It combines shared purpose with distributed authority and treats cooperation as an operating discipline, not as a substitute for competition or responsibility.

Table 7: Principles of high-performance cooperative leadership

Principle	Operational requirement
1. Shared mission, distributed execution	Agree the outcome and non-negotiable constraints; allocate execution to actors with relevant capability.
2. Clear decision rights	Define authority over scope, architecture, funding, procurement, security acceptance, milestones and termination. Avoid universal vetoes.
3. Time-bounded alignment	Set deadlines for consultation and use agreed escalation routes when issues remain unresolved.
4. Subsidiarity	Decide at the lowest level with sufficient information and capability; coordinate nationally only where dependencies require it.
5. Open interfaces and entry	Publish requirements and prevent mission leaders from becoming permanent gatekeepers.
6. Reciprocal capability building	Use complementary roles: incumbents support industrialisation, start-ups provide new options, research transfers methods, public bodies create pathways and labour actors support transition.
7. Evidence-based accountability	Demonstrate progress through deployment, performance, security, sustainability, cost and workforce evidence.
8. Stop–revise–scale learning	Use fixed decision gates to stop weak approaches, revise promising ones and scale systems with demonstrated operational value.

The central leadership challenge is no longer to control the entire value chain. It is to make an organisation reliable, interoperable and accountable within an ecosystem whose performance depends on several autonomous actors.

7.3 Appropriate governance form

A dedicated mission organisation is often preferable when many organisations participate and no single actor has legitimate control. Network-governance research describes such a structure as a network administrative organisation [9].

For Deutschland AG 2.0, each mission organisation should have a small executive team, a public mandate, industrial and technical competence, representatives of affected regions, worker and societal participation, independent security and sustainability assurance, published objectives and metrics, and a limited mandate and review date.

The organisation should not become another permanent funding bureaucracy. Its mandate should end, change or move to operational institutions once the mission has been delivered.

7.4 Competition within cooperation

High-performance cooperation requires boundaries.

Participants may cooperate on interoperability, infrastructure, research, safety, cybersecurity, skills, standards, and common evidence formats.

They should compete on technical solutions, products, service quality, cost, delivery, and business models.

Competition authorities should be involved early where major incumbents coordinate markets or infrastructures. Public support must not enable price fixing, customer allocation, tying, exclusionary access or the strategic withholding of interfaces. The same principle applies to data and AI infrastructure: cooperation on common goods must not create a private gatekeeper over downstream markets.

7.5 Leadership culture

The required leadership culture is direct and practical.

Leaders should state constraints openly, share relevant evidence, admit capability gaps, ask for help early, give partners credit, protect dissent, decide after sufficient evidence, accept responsibility for outcomes, and avoid symbolic cooperation without operational commitment.

A high-performance ecosystem cannot be built through institutional self-promotion. It depends on mutual reliability.

8 A Deutschland AG 2.0 Operating Model

8.1 The Transformation Compact

Germany should establish a **Deutschland AG 2.0 Transformation Compact**.

The Compact should include federal ministries, Länder, metropolitan regions, municipalities, major industrial firms, the Mittelstand, technology start-ups, universities and research organisations, investors and financial institutions, trade unions and works councils, cybersecurity and standards bodies, and relevant European partners.

The Compact should not attempt to govern every transformation activity. It should select a limited number of missions that require cross-regional coordination.

8.2 Five proposed transformation missions

The missions below are proposed as cross-regional deployment portfolios. They define outcomes and dependencies but deliberately leave room for competing technical solutions.

Table 8: Five proposed transformation missions

Mission	Objective	Illustrative regional contributions	Expected outcomes
1. Agentic Manufacturing	Deploy secure Industrial AI, robotics and agentic production systems across German manufacturing, including SMEs.	Stuttgart production; Munich deep tech; Berlin agents; Saxon chips; Ruhr industrial environments.	Productivity, safer and more flexible production, faster engineering change and transferable SME solutions.
2. Secure Energy and Industrial Decarbonisation	Combine renewable electricity, grids, storage, flexibility, efficient electrification and justified hydrogen use.	Northern renewables; Ruhr industry; Central German energy and chemistry; Frankfurt finance.	Lower emissions, less congestion, stronger energy resilience and faster industrial connections.
3. Autonomous Logistics and Mobility	Deploy secure autonomous systems across ports, warehouses, industrial sites and selected transport environments.	Hamburg ports; Stuttgart mobility; Munich autonomy; Berlin AI; Ruhr logistics.	Safer operations, higher asset utilisation, lower emissions and interoperable systems.
4. Defence, Cyber and Dual-Use Resilience	Increase German and European capacity in drones, sensors, secure communications, cyber defence, repair and critical-infrastructure protection.	Munich and Berlin defence technology; Saxon semiconductors; Hamburg aerospace; nationwide manufacturing.	Shorter procurement cycles, greater capacity, secure supply chains, European interoperability and civil-resilience benefits.
5. Trusted Agentic Economy	Create identity, authority, evidence and transaction infrastructure for agents and machines acting across organisational boundaries.	Frankfurt finance and compute; Berlin software; industrial use cases across all regions; national trust providers.	Verifiable legal-person identity, bounded mandates, trusted product evidence, machine-readable compliance and auditable transactions.

Each mission should begin with deployment environments that have a real owner, budget and procurement pathway. A mission without a conversion route from experiment to recurring operation should not receive long-term transformation funding.

8.3 Governance layers

The operating model uses five governance layers. The Transformation Compact Council sets mission objectives and common principles. Dedicated mission organisations manage dependencies, funding, procurement and evidence. Regional mission nodes coordinate local companies, research, skills and infrastructure. Shared service providers operate interoperable energy, compute, identity, data, cyber and test services. Independent assurance reviews competition, security, safety, sustainability, public value and fundamental rights.

8.4 Transformation Velocity Scorecard

Germany should measure the rate at which capabilities become operational.

Table 9: Transformation Velocity Scorecard

Metric	Purpose
Time from research result to industrial deployment	Measures technology-transfer speed
Time from pilot completion to procurement decision	Measures market-conversion speed
Time from application to infrastructure approval	Measures public implementation capacity
Share of pilots converted into recurring operation	Identifies pilots without operational conversion
Number of cross-regional deployments	Measures federation rather than local isolation
SME adoption rate	Measures diffusion beyond major corporations
Private investment mobilised per public euro	Measures additionality, subject to counterfactual and deadweight analysis
Productivity effect	Tests operational economic value against a documented baseline
Lifecycle emissions and resource intensity	Tests sustainability
Energy and supply-chain resilience	Tests continuity under stress
Cyber incidents and recovery time	Tests operational resilience
Workers trained and successfully transferred	Tests social transition capacity
Export and European deployment	Tests international scale
Number of interoperable suppliers	Tests contestability and ecosystem health

Metrics must be adapted to each mission. They should not create incentives to optimise simple numbers at the expense of safety or quality.

8.5 Thirty-six-month mobilisation path

The thirty-six-month horizon is a mobilisation period, not a claim that structural transformation can be completed in three years. Its purpose is to demonstrate movement from strategy to operational capability within a relevant technology cycle.

Table 10: Thirty-six-month mobilisation path

Period	Primary task	Required outputs and decision gate
Months 0–12: connect and define	Establish the Compact, appoint accountable mission leaders, map capabilities and select real deployment environments.	Published baselines, architecture and evidence requirements; identified regulatory and procurement barriers; funded first deployments.
Months 12–24: deploy	Launch cross-regional operational projects, establish shared test, identity and cybersecurity services, fund industrialisation and begin workforce programmes.	Operational evidence against the scorecard; first recurring procurement decisions; revise or stop weak approaches.
Months 24–36: scale	Scale proven systems nationally and into European programmes, standardise repeatable components and open ecosystems to additional suppliers.	Transition from project funding to recurring markets; documented interoperability; independent security, competition and sustainability review.

After 36 months, each mission should face an explicit continuation decision based on operational value, social and environmental effects, ecosystem health and European scalability.

9 Risks, Safeguards and Research Limitations

9.1 Principal risks and safeguards

A cooperative transformation architecture can reproduce the defects it seeks to correct. The principal risks are institutional capture, additional bureaucracy, over-centralisation, unequal regional effects, technology hype, greenwashing, excessive securitisation, autonomous-system failure and loss of social legitimacy. These risks require ex ante controls rather than retrospective statements of intent.

Table 11: Principal risks and safeguards

Risk	Failure mode	Required safeguards
Incumbent capture	Large firms use standards, funding or mission roles to close markets.	Open membership, competition oversight, transparent procurement, published interfaces, switching rights and independent governance.
Additional bureaucracy	New bodies create meetings and reporting without faster deployment.	Small mission organisations, limited mandates, common reporting, automatic review dates and operational metrics.

Table 11: Principal risks and safeguards

Risk	Failure mode	Required safeguards
Over-centralisation	National coordination suppresses regional initiative and domain knowledge.	Subsidiarity, distributed budgets, regional mission nodes, common standards rather than common operational control.
Regional divergence	Strong regions attract further capital while exposed regions lose capability.	Cross-regional value-chain requirements, infrastructure investment, distributed training and evaluation of distributional effects.
Technology hype	AI, hydrogen, autonomy or other technologies receive support without credible system value.	Problem-led missions, lifecycle and system assessment, operational demonstrations, milestone finance and stop decisions.
Greenwashing	Sustainability claims are disconnected from material climate, resource or adaptation outcomes.	Transparent baselines, independently verified lifecycle evidence, product-level data and material biodiversity and adaptation indicators.
Securitisation without limits	Security urgency weakens democratic, legal or human-rights control.	Parliamentary oversight, legal review, procurement accountability, dual-use governance and bounded handling of classified information.
Autonomous-system failure	Agents or machines take unsafe, unauthorised or irreconstructible actions.	Verified authority, bounded autonomy, independent safety functions, human takeover, simulation, runtime monitoring, revocation and forensic evidence.
Loss of social legitimacy	Workers and communities experience transformation as imposed and unfair.	Early participation, credible transition plans, training rights, transparent allocation of costs and benefits, regional investment and income protection.

9.2 Research limitations and agenda

This paper is conceptual and normative. It does not test whether the proposed architecture would outperform existing programmes. Regional descriptions are selective, metropolitan boundaries differ and important capabilities exist outside the seven nodes considered. The company examples derive partly from an earlier author publication and do not constitute an independent market ranking.

The framework should therefore be treated as a set of testable design propositions. Priority research should include:

- network analysis of actual inter-company and inter-regional capability links;
- interviews with industrial, public, labour, research and civil-society actors;

- comparative study of transformation missions in other federal and European economies;
- case studies of pilot-to-procurement conversion and cross-regional deployment;
- quantitative testing of the Transformation Velocity Scorecard and its possible gaming effects;
- governance analysis of legal-person identity, delegated agent authority and digital evidence;
- assessment of distributional, labour, climate, competition and fundamental-rights outcomes.

10 Conclusion and Call to Action

Germany should not rebuild the old Deutschland AG. It should establish a new capacity for cooperative execution. The central challenge is not a complete absence of technology, industry or regional expertise. It is the speed, openness and reliability with which complementary capabilities are combined under demographic, climate, security, cyber and AI pressure.

US platform-scale investment and China's coordinated state–market mobilisation show that Germany cannot treat Physical AI as a conventional firm-by-firm technology contest. It must compete as a connected industrial system, pool scarce infrastructure and make verifiable trust a practical advantage in regulated and safety-critical markets.

The federal government, Länder, metropolitan regions, industry, the Mittelstand, start-ups, research institutions, investors and labour organisations should establish a Deutschland AG 2.0 Transformation Compact. Its first task should be to select a small number of cross-regional missions with accountable leadership, real deployment environments, procurement pathways, shared infrastructure and published performance evidence.

The first mission portfolio should cover agentic manufacturing; secure energy and industrial decarbonisation; autonomous logistics and mobility; defence, cyber and dual-use resilience; and the trusted agentic economy. These missions should remain open to competing solutions and European partners. They should be assessed against operational capability, productivity, lifecycle emissions, resilience, social transition, competition and European scalability.

The call to action is specific. Within twelve months, Germany should connect existing ecosystems and appoint accountable mission organisations. Within twenty-four months, it should operate cross-regional systems with real users and budgets. Within thirty-six months, it should stop weak approaches, scale credible ones and move successful architectures into recurring national and European markets.

The governing principle is simple: connect faster, decide clearly, deploy safely and scale what works. Mutual assistance is not a soft addition to industrial policy. In a system built from complementary capabilities, it is a productive capacity.

> Germany's next industrial model needs to make make regions and firms stronger by making them more capable of contributing to, governing and scaling within shared ecosystems.

Declarations

Conflict of interest

The author is founder and managing director of Spherity GmbH. Spherity is included as one of ten illustrative capability exemplars discussed in Section 5. The selection derives from a prior author publication and is not an independent ranking.

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Data and materials

The paper uses publicly available academic, governmental, corporate and regional sources. No original personal data were collected. The evidence cut-off is 31 August 2026.

Use of generative AI

Generative AI tools supported source discovery, language editing, structural revision and the prototyping of conceptual figures. The author reviewed the evidence, resolved editorial decisions and remains responsible for the paper's claims, interpretations and final text.

Author responsibility

The design propositions, figures, missions, governance model and scorecard are the author's conceptual synthesis. They should be tested through empirical research and practical deployment.

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