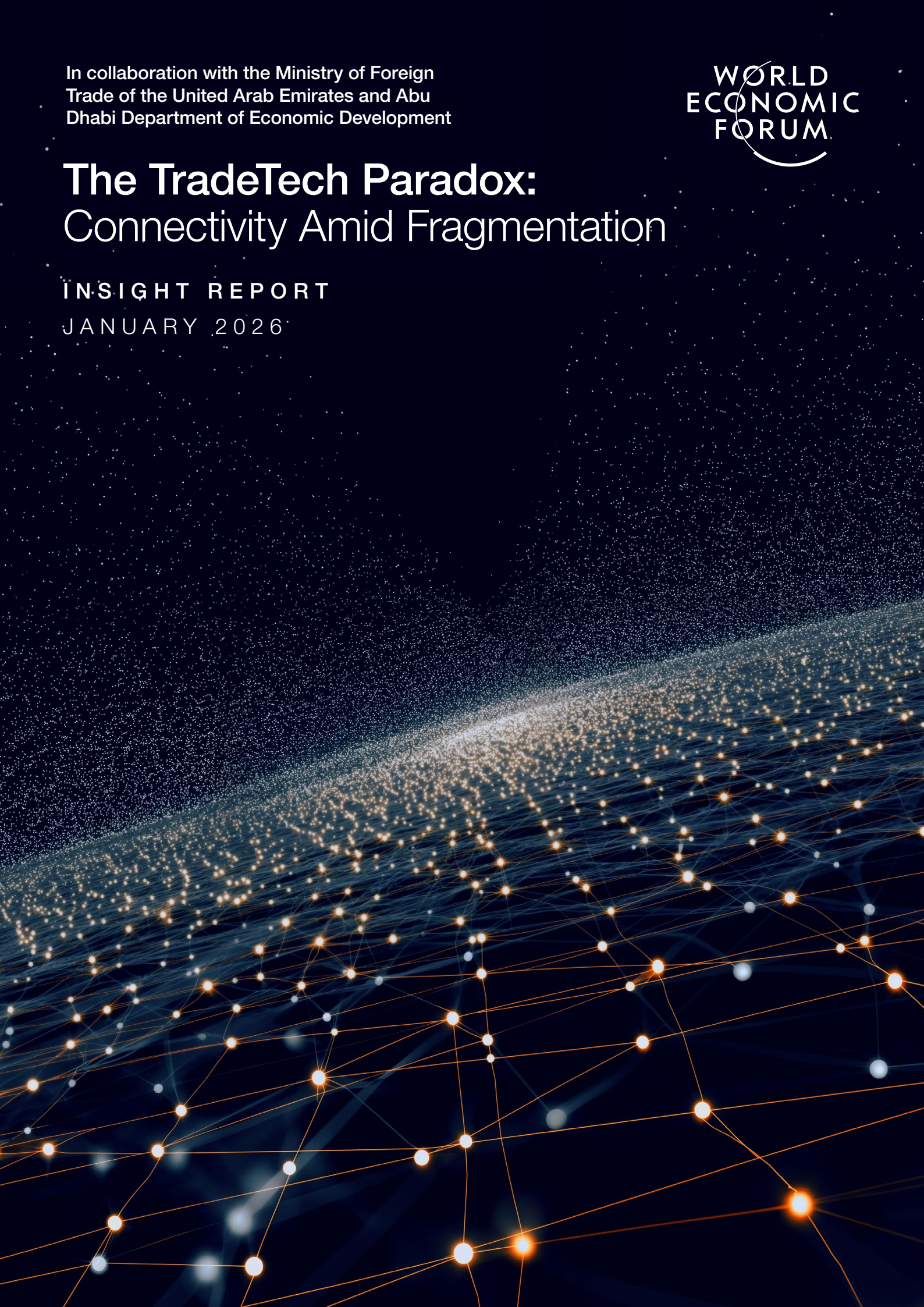
In collaboration with the Ministry of Foreign Trade of the United Arab Emirates and Abu Dhabi Department of Economic Development

WORLD ECONOMIC FORUM

The TradeTech Paradox: Connectivity Amid Fragmentation

INSIGHT REPORT

JANUARY 2026



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The world is entering a period of profound transformation in global trade. Shifting geopolitical alignments and evolving supply patterns are reshaping global flows, redefining how economies connect and compete and redrawing the map of international commerce. Trade technology has emerged as a source of stability and progress, reinforcing trust and continuity, helping global supply chains remain connected amid rapid change.

This year's report showcases catalytic efforts designed to responsibly scale innovations, including the TradeTech Regulatory Sandbox, helping technology solutions increase trust and efficiency in global trade.

At the core of this year's work lies a new conceptual lens: the tradetech stack. This reveals how trade is linked across global institutions, national regulators, enablers and enterprises through a single, integrated digital continuum. Within this structure, technology is not a separate component, it functions as the connective infrastructure that integrates every layer, ensuring that commerce remains efficient, predictable and inclusive, even in challenging times.

The report underscores that technology's potential is best realized when it is guided by collaboration. Tradetech both requires collaboration between governments, industry and technology partners, and enables it – turning complexity into opportunity.

Through the TradeTech Global Initiative, the United Arab Emirates Ministry of Foreign Trade, the Abu Dhabi Department of Economic Development and the World Economic Forum continue to advance this vision, positioning technology as a strategic bridge between economies and a catalyst for shared prosperity.

We invite all stakeholders to join us in shaping a future where trade is not divided by disruption but strengthened by collaboration, and where technology serves as the enduring backbone of a more resilient global economy.

Executive summary

In an era of geopolitical fracture, the future of trade depends on how technology connects, protects and endures.

Although geopolitics has always influenced global trade, the scale and speed of today's shifts signify a more profound transformation. Specifically, the global order underpinning trade, notably the rules, alliances and systems that have governed exchange for decades, is being actively rewritten. Yet one truth remains constant: the global economy thrives the most when some level of stability and direction is present. As the world fragments and rebuilds, the critical question becomes: how can trade remain stable, connected and resilient?

Technology offers part of the answer. The modern integration of digital infrastructure across every layer of the trading system has allowed global commerce to transform from a series of transactions into an interconnected, adaptive network capable of withstanding disruption. From smart logistics to digital trade finance, technology enables visibility, trust and agility across borders, helping global trade evolve even in turbulent times.

Concrete examples throughout the report demonstrate how emerging technologies are already enabling new efficiencies and inclusion across the trade ecosystem, such as:

- Agentic artificial intelligence (AI) and intelligent assistants empowering small and medium-sized enterprises (SMEs) to compete globally
- Digital trade finance platforms widening access to liquidity and accelerating time-to-cash
- Blockchain and digital documentation tools strengthening compliance
- The internet of things (IoT), data platforms and digital twins increasing transparency and predictability across complex supply chains

However, technology alone cannot safeguard the system it powers. As digital infrastructure becomes a bargaining chip in geopolitical competition, relying on technology as the sole solution risks deepening vulnerability. Thus, resilient trade requires more than innovation; it requires strong governance, collaboration and human capability.

This report introduces a new way to visualize this relationship: the tradetech stack. The tradetech stack illustrates how institutions, technology and the people who drive them interact as a living framework, one that is constantly evolving to remain effective. However, unlike the role of governments, international organizations or enterprises, in the tradetech stack, technology is not a fixed layer; it is a dynamic tool that connects every single individual and institution. It is the connecting fabric of trade.

Thus, to ensure that trade remains stable, technology must be enabled. This year's analysis highlights three reinforcing pillars essential to strengthening the connecting fabric of global trade:

1. **Collaborative governance**
2. **Cross-layer partnerships**
3. **Human capacity**

Ultimately, the resilience of technology amid geopolitical shifts depends not only on digital innovation but on human collaboration. By reinforcing both the digital and human layers of the global trading system, technology, as an integral part of the tradetech stack, provides a pathway towards a more inclusive, efficient and adaptive era of global commerce.

Introduction

Geopolitics is reshaping trade and technology, yet digital tools can sustain flows, deepen resilience and expand collaboration across borders.

Since the end of World War II, international trade has been anchored by a rules-based system and institutions that reduced trade barriers and expanded markets. The General Agreement on Tariffs and Trade (GATT), succeeded by the World Trade Organization (WTO), provided the framework for the gradual liberalization of global exchange, which resulted in a 4,300% growth in world trade levels since 1950.[1] Technological developments played a key role in this growth; containerization, digital networks and data-driven operations empowered businesses to build complex supply chains across borders.

This trade growth is now threatened by heightened geopolitical risk.[2] Global merchandise trade volume is forecast to grow by only 2.4% in 2025, down from 2.8% in 2024, and slow even further in 2026 to just 0.5% as a result of higher tariffs and trade policy uncertainty.[3] Discriminatory trade policies have seen a remarkable increase, rising from 55 in 2019 to 2,752 in 2024.[4]

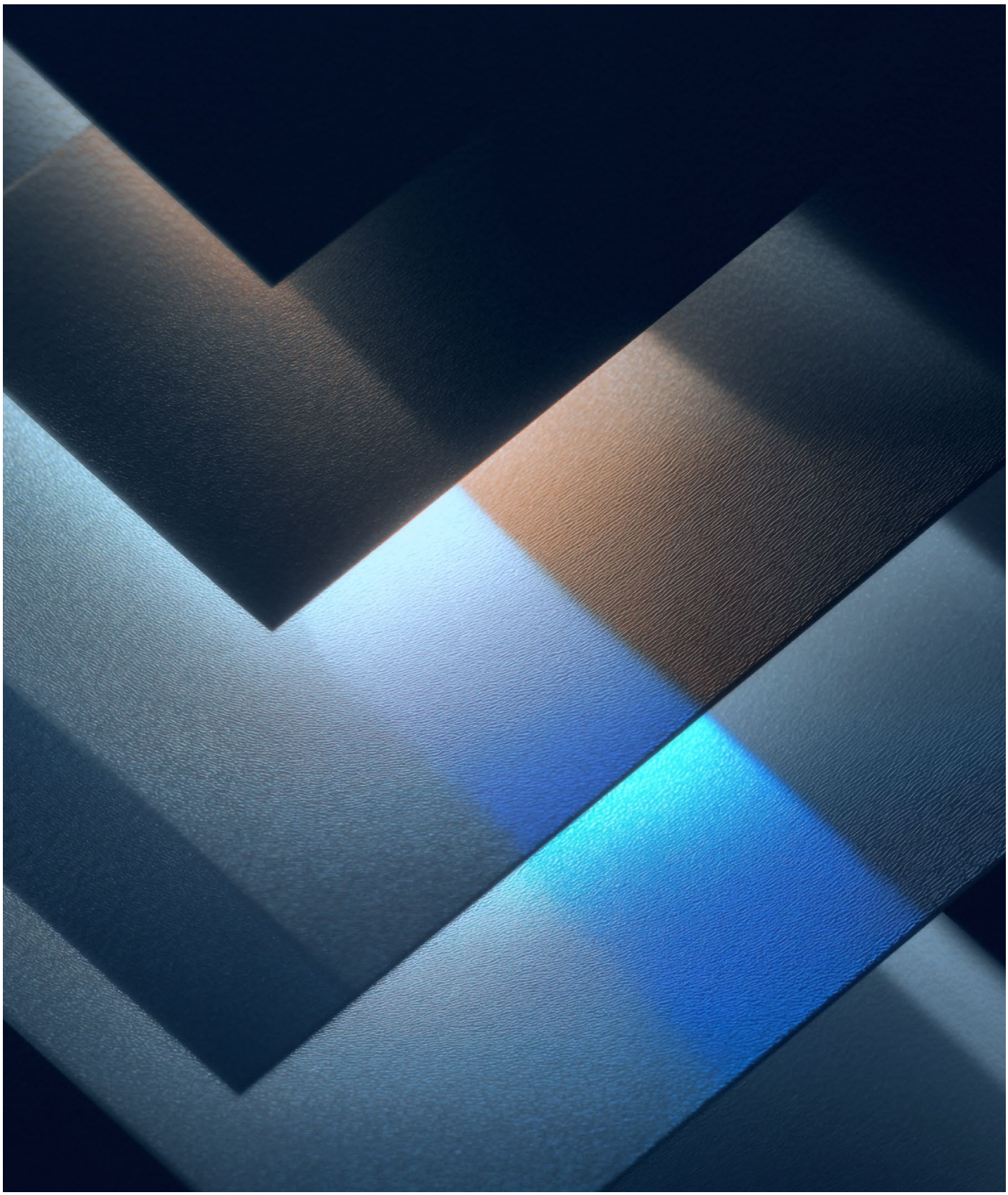
This uncertain trade environment is making it more difficult for both governments and businesses to operate. Policy-makers are trying to balance security, resilience and competitiveness while firms must reorganize their supply chains and comply with an increasing number of trade rules.

Technology is also affected by these geopolitical shifts, notably through export controls, data sovereignty and market access restrictions. Today, technology sits at the intersection of national security and competitive advantage. Technology can enable the movement of goods, money and data, creating new avenues for collaboration between all actors in the system, while also deepening strategic competition, as nations seek to secure technological supremacy.

In this context, global trade is increasingly shaped by a tradetech paradox: geopolitical tensions on one hand, and unprecedented technological connectivity on the other. Political divergence and strategic rivalries are pulling supply chains apart, while technological innovations are enabling new forms of collaboration and connection.

1 The trade stack

The trade stack is a living framework that reveals how institutions and businesses come together to shape modern commerce.



Because international trade involves many overlapping systems and actors, it is difficult to capture in a simple, cohesive framework. The trade stack offers a way to organize and understand the complex web of modern international trade. It provides a framework that groups the many actors and institutions involved in global commerce into several connected layers. Each layer represents a different function of how trade is governed, enabled and created.

The stack is not a strict hierarchy or a complete description of reality, but a tool for understanding how the system fits together. Because trade is deeply interconnected, there will always be overlap between layers, and some organizations or systems may operate across more than one. Others may not fit neatly into any single layer. This overlap is intentional: it shows that the global trading system is not a set of separate parts, but a network where policy, facilitation and production constantly interact.

1.1 Global foundational framework

The global foundational framework defines the institutional and normative base of the trade system. It consists of international organizations, multilateral agreements and standard-setting bodies that establish the rules, norms and shared commitments guiding global commerce.

This layer doesn't move or produce any goods but instead decides the circumstances under which global trade can function.

TABLE 1 **Global foundational framework**

Roles	Examples of participating actors
Establish **international trade and economic frameworks** that govern cross-border exchange, competition and cooperation.	Multilateral organizations such as the WTO, International Monetary Fund (IMF), World Bank, United Nations Trade and Development (UNCTAD); regional trade blocs such as the European Union, Association of Southeast Asian Nations (ASEAN), and the African Continental Free Trade Area (AfCFTA); plurilateral economic partnerships
Develop **global standards and norms** for product quality, safety, data governance and interoperability across borders.	International standards bodies such as the International Organization for Standardization (ISO), International Telecommunication Union (ITU), and World Customs Organization (WCO); data governance alliances
Coordinate **multilateral agreements** and dispute settlement mechanisms to ensure stability and fairness in global trade.	WTO committees and dispute panels, international arbitration courts, regional economic councils
Provide **global financing, development assistance, and technical capacity-building** for trade infrastructure and digital transformation.	Development banks such as the World Bank, Asian Development Bank (ADB), African Development Bank (AfDB); UN agencies; donor alliances
Define and promote **sustainability, labour and human rights frameworks** that guide ethical and inclusive global commerce.	The United Nations Framework Convention on Climate Change (UNFCCC), the International Labour Organization (ILO), the Global Reporting Initiative (GRI)
Convene **research, knowledge and data platforms** that generate shared evidence and policy insight for international trade governance.	Academic consortia, think tank networks, intergovernmental research bodies

1.2 National governance layer

The national governance layer translates global frameworks into domestic policy and regulation. It includes national governments, ministries and agencies that craft and enforce trade laws, customs procedures, fiscal instruments and digital governance policies. These actors ensure compliance with international obligations while protecting national interests and fostering innovation and competitiveness.

TABLE 2 **National governance layer**

Roles	Examples of participating actors
Set and enforce **national trade, economic and industrial policy** to guide competitiveness, innovation and sustainable growth	Ministries or departments of trade, economy and industry; national planning commissions
Regulate **customs, tariffs and border management** to ensure compliance with trade laws and international agreements.	Customs and border protection agencies, ministries of finance or revenue, tariff authorities
Implement and enforce **domestic regulation for product safety, standards and certification** to align with global norms or national priorities.	Standards and metrology organizations, accreditation bodies, food and drug authorities, product safety agencies
Negotiate and administer **trade agreements and international commitments**, representing national interests in global forums.	Ministries of foreign affairs and trade negotiation units, permanent missions to international organizations
Develop and implement **digital and data governance policies** to regulate cross-border data flows, digital trade and cybersecurity.	Ministries of digital transformation and information technology (IT), data protection authorities, cybersecurity agencies
Oversee **environmental, labour and social compliance frameworks**, ensuring that production and trade align with sustainability and ethical standards	Ministries of environment, labour and social welfare; sustainability and climate agencies
Design and administer **fiscal and financial mechanisms that enable trade and industrial activity**, including subsidies, incentives and export finance	Ministries of finance, export-import banks, investment promotion agencies

1.3 Trade enabler layer

The trade enabler layer is the operational engine of trade: the ecosystem that moves, finances, verifies and connects goods, services and data across borders. It includes logistics and transport providers, financial intermediaries, certification and inspection agencies, and sustainability verifiers, among others.

TABLE 3 **Trade enabler layer**

Roles	Examples of participating actors
Transport and distribute **goods across borders** through maritime, air, rail and land networks, ensuring the efficient and reliable movement of trade flows.	Shipping lines and carriers, air cargo operators, trucking and rail freight companies, freight forwarders and third-/fourth-party logistics providers, port and terminal operators
Operate and manage **physical trade infrastructure** – such as ports, airports and special economic zones – that connect markets and enable trade capacity.	Port authorities, airport operators, inland terminals and dry ports, free zones and industrial parks, infrastructure development and management agencies
Provide **logistics technology and supply chain visibility solutions** that digitize, optimize and track global trade operations.	Supply chain software providers, digital freight platforms, internet of things (IoT) and sensor networks, cargo visibility and tracking services, digital twins and logistics analytics companies
Provide **secure digital infrastructure** that connects trade systems, trade data exchange and operational cybersecurity.	Telecoms, satellite providers, internet exchange points, cloud-service operators, identity-authentication services, application programming interface (API) and blockchain network providers
Facilitate **customs clearance, certification, and compliance** to enable compliant and efficient cross-border trade.	Customs brokers, certification service providers, trade compliance and consulting firms
Enable **trade finance, insurance and payments**, providing liquidity, risk management and settlement mechanisms for global transactions	Banks and trade finance institutions, fintech platforms, payment service providers (PSPs), insurance and reinsurance companies, blockchain-based trade finance networks

1.4 Enterprise layer

The enterprise layer represents the productive and innovative core of the global economy – the actors who create what is traded. Enterprises include producers, manufacturers, innovators and service providers who transform resources, ideas and knowledge into tradable goods, services and technologies.

TABLE 4 **Enterprise layer**

Roles	Examples of participating actors
Grow, extract or harvest **natural resources, agricultural goods and energy resources** that form the foundations of international goods trade	Farmers and agricultural cooperatives, agribusinesses, fisheries and forestry operators, mining and extractive industries, energy producers, commodity producers and exporters
Manufacture, by **converting raw or intermediate goods into finished products** that are traded globally	Industrial manufacturers, assemblers and processors, equipment and machinery producers, consumer goods producers, food and beverage processors, and industrial small and medium-sized enterprises (SMEs) and contract manufacturers
Innovate, research and develop **new technologies, tools, digital systems and processes** that are used across sectors	Technology enterprises, R&D labs, engineering and design firms, start-ups and scale-ups, software and IT service companies
Deliver knowledge and professional service-based solutions, including consulting, legal, healthcare, education and digital services	Professional service providers (law, accounting, audit, finance, healthcare), consulting and advisory firms

1.5 Interactions between layers

The strength of the trade stack lies in these points of connection, where collaboration and technologies allow the entire system to interact, adapt and evolve together.

The layers of the trade stack are designed to clarify roles within the complex web that is the interconnected global trading system, not to create rigid boundaries. Regulated by policy, the flow of trade, data and money means that actors often operate across layers. For example:

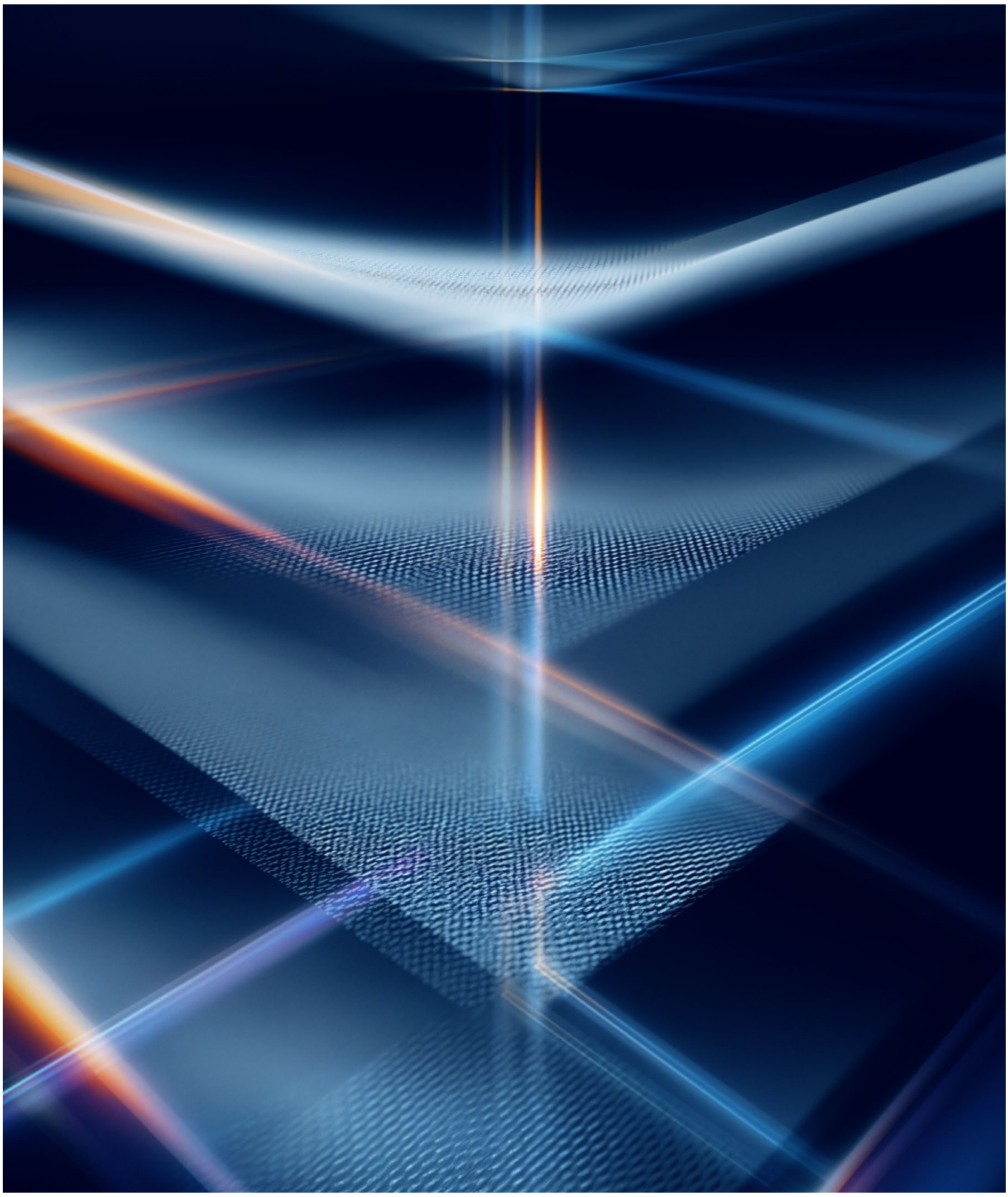
- A tech company might build digital infrastructure that supports enterprises and enables trade
- National governments participate in global policy-making while regulating and enforcing rules at the national level
- Logistics firms, banks and digital platforms frequently act as both enablers and innovators

The trade “stack” and “layer” metaphors recognize that each part of the system has its primary functions, but interacts continuously with the others. The strength of the trade stack lies in these points of connection, where collaboration and technologies allow the entire system to interact, adapt and evolve together.

None of these layers exists in isolation, and each is being reshaped by a changing geopolitical landscape that is redefining trade relationships, investment flows and the technologies that connect the entire system. For some, this fragmentation and policy divergence are adding friction, uncertainty and duplication. For others, this shift is creating new opportunities: connector countries are emerging as neutral hubs, digital infrastructure is opening new pathways for collaboration and cooperation, and firms are innovating faster to meet new demands. The trade stack reflects this reality: it is not a static structure, but a living system evolving under the pressure of geopolitics and global change. Amid these shifts, technology is playing an enabling role by facilitating connection, trust and collaboration within and across all layers.

2 The tradetech stack

Technology and data form the digital fabric of the trade stack, connecting every layer by enabling trust, visibility and collaboration.



Serving as the connecting fabric of this framework, technology and data are enabling new forms of coordination across governments, enablers and enterprises.

The trade stack introduced the many actors that shape international trade, but understanding **who** the actors are and **what** they do is only the first part. The real transformation comes from **how** these layers connect and exchange information. As trade systems become more complex and interconnected, technology and data are the common language that binds them together.

Across ports, borders, financial institutions and digital marketplaces, technology and data now provide the shared infrastructure and networks that are transforming trade from a series of transactions into a connected global system. This evolution marks the shift from the traditional trade stack to the emerging tradetech stack, a system where digital capabilities are embedded in every layer of global commerce. Serving as the connecting fabric of this framework, technology and data are enabling new forms of coordination across governments, enablers and enterprises. From digital ports and blockchain networks to supply chain tools and fintech innovations driven by artificial intelligence (AI), these technologies are powering a more connected, cooperative and resilient global trading system.

FIGURE 1 **The tradetech stack**

Note: This figure provides an overview of the trade stack, showing how technology acts as the connecting fabric between each layer.

Given the strain on each layer as a result of geopolitical realignments and growing economic fragmentation, the connecting fabric is more important than ever. The digital platforms, data-sharing systems and intelligent tools outlined in the rest of this section demonstrate how technology is increasing visibility, predictability and collaboration across borders, thus strengthening the trade stack.

2.1 Single-layer connections: innovations within layers

Single-layer innovations empower and connect actors within layers. They serve one layer's workflows without creating cross-layer governance or co-managed processes.

Augmenting human capital

This type of innovation can be particularly useful for small and medium-sized enterprises (SMEs), which face resource challenges relative to larger enterprises. According to research from Alibaba.com, an estimated 40% of global SMEs operate as solo entrepreneurs, and they have historically struggled to compete due to limitations in time, finance, personnel and industry know-how. At the same time, 63% of SMEs are actively exploring ways to harness AI for global trade, given their potential.

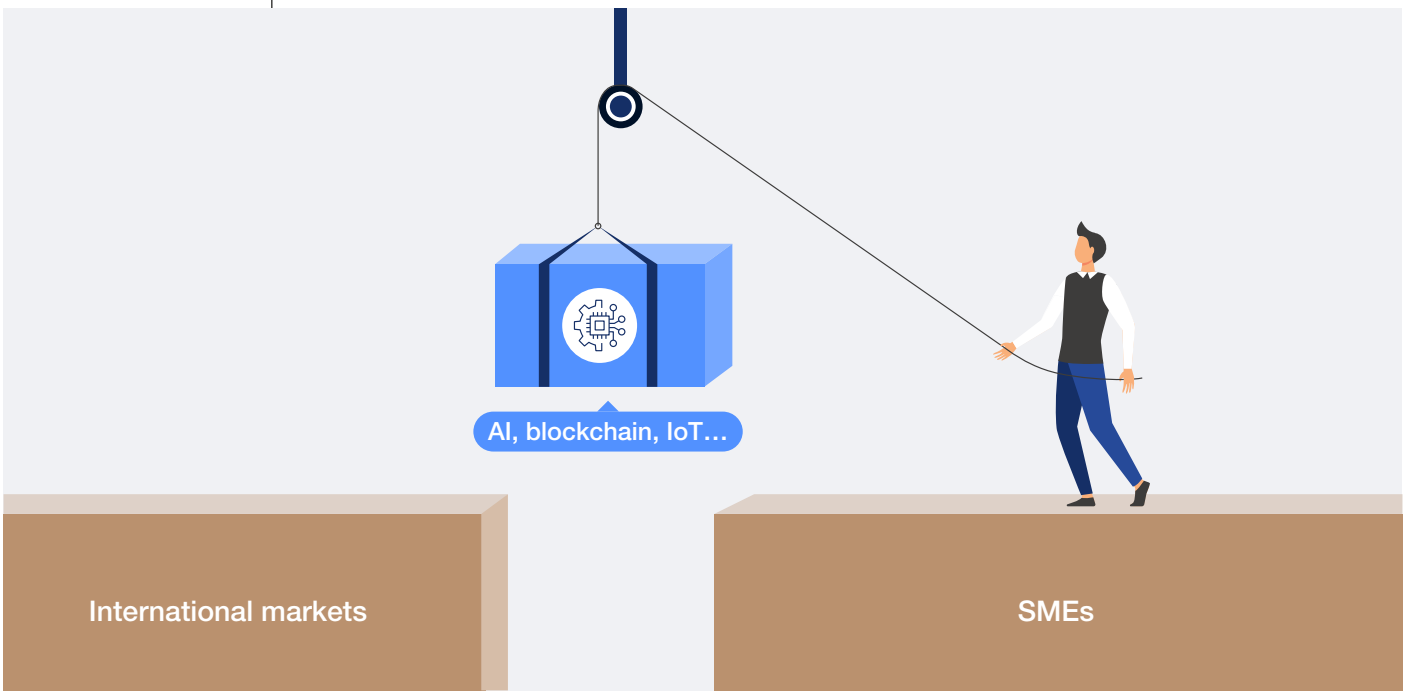
TABLE 5 **A comparative assessment of large enterprises and SME competitiveness in global trade networks**

Area of advantage	Large businesses	SMEs	Why this places SMEs at a disadvantage
Capital and financing	Access to substantial capital reserves, global investors and favourable lending terms	Limited access to affordable credit, higher risk perception by lenders	Constrains ability to scale operations, invest in infrastructure or absorb trade shocks
Economies of scale	Achieve lower per-unit costs through bulk production and logistics efficiencies	Smaller volumes lead to higher per-unit costs and weaker supplier leverage	Results in uncompetitive pricing and lower profit margins in global markets
Technology and infrastructure	Invest in automation, AI analytics, blockchain tracking and advanced logistics systems	Lack resources for digitalization and advanced supply chain tools	Leads to inefficiencies, slower delivery and limited visibility in cross-border trade
Global networks	Established partnerships, subsidiaries and long-term supplier relationships	Often rely on local or regional markets with limited export networks	Restricts market access and diversification opportunities, increasing vulnerability
Regulatory compliance	Dedicated legal teams manage customs, tariffs and international standards	Fewer resources for compliance and certification	Non-compliance risks exclude SMEs from high-value or regulated markets

Over the past few years, competition among major AI developers has narrowed performance differences between large language models (LLMs), making powerful AI tools more widely accessible. However, general-purpose or "horizontal" AI often lacks the specialized analysis and contextual understanding required for complex business operations. Thus, for SMEs, the challenge is not just accessing information; it is also having the capacity to transform it into actionable decisions that enhance their ability to compete against larger companies in the global market.

This is where agentic AI comes in. Unlike specialized AI, agentic AI is designed to complete specific tasks with precision and accuracy, allowing SMEs to access high-quality, technical skills rather than simply information.

FIGURE 2 **Bridging the gap for SMEs through technology**



BOX 1 | **Alibaba's Accio agent for SMEs**

Using agentic AI, Accio automates about 70% of the global sourcing workflow. All at once, Accio can play the role of designer, engineer, market researcher, sourcing expert and financial adviser, allowing solo entrepreneurs to move from concept to sourcing plan with minimal manual input, complete with market validation, supplier recommendations and compliance checks. This allows small businesses to access capabilities they couldn't afford to hire otherwise, allowing them to compete with larger businesses.

One year after its launch, Accio, an AI-native app, has 3 million monthly active users, many of whom are small business owners from developing countries.

This shift is especially critical as recent tariff hikes and geopolitical frictions have stretched SMEs' resources thin. Tools like Accio help offset these pressures by allowing small businesses to identify reliable partners, navigate compliance and access market insights at a fraction of traditional costs – increasing transparency and inclusion in global markets.

Source: Alibaba.com.

Trade finance solutions

SMEs also face challenges in accessing trade finance, which is one of the biggest barriers for SMEs to trade internationally. A 2023 Asian Development Bank (ADB) survey estimated the global trade financing gap at $2.5 trillion.[5] Shifts in sourcing and supply routes as a result of geopolitics, including the "China+1" strategy, nearshoring in North America, and the growth of South-South trade, have the potential to further strain SMEs and their access to credit:

- Lenders have less historical data on new corridors, the different parties involved and legal environments, which raises how lenders perceive risk and therefore raises costs.
- Compliance burdens rise with new rules of origin, labour and environmental due diligence, as well as varied customs procedures, which all increase audit costs and documentation requirements.

Additionally, payment terms of 90–120 days are not uncommon in business-to-business (B2B) transactions, creating liquidity pressures precisely when flexibility is most critical.[6] However, enabler-led digital trade finance solutions are beginning to demonstrate tangible impact, widening access to working capital for SMEs through the use of AI tools and data-led trust.

BOX 2 | **Drip Capital – enabling SMEs in the new era of global trade**

Drip Capital has facilitated over $9 billion in trade transactions, providing exporters and importers with fast, collateral-free liquidity. Its platform uses AI tools (optical character recognition, LLMs and anomaly detection) to process thousands of trade documents daily and assess creditworthiness. As a result, median time-to-cash is under 24 hours, with stable default rates even as transaction volumes expand.

As an example, an Indian mid-sized rice exporter has grown its turnover from around $20 million to over $80 million, with projections above $90 million by 2026, without regular access to traditional credit since 2018. The exporter estimates that every additional $1 million in financing capacity supports more than $7 million in incremental annual exports.

Source: Drip Capital.

Digital payment connections

The global payments landscape has long been complex, fragmented and costly for businesses. SMEs face high transaction fees, compliance burdens and limited access to international systems, restricting their growth. Yet, opportunity is expanding fast; cross-border e-commerce revenues reached $1.14 trillion in 2024 and are projected to hit $1.84 trillion by 2030.[7] As digital financial services evolve, access to global markets is no longer limited by geography, scale or uncertainty.

BOX 3 | **PayPal World – enabling global growth for merchants**

By partnering with payment systems and digital wallets worldwide, PayPal World makes cross-border transactions effortless, inclusive and trusted, with built-in risk, fraud and compliance management.

Through a single integration, merchants can reach over 1 billion consumers across local wallets, eliminating the need to manage multiple systems or navigate complex regulations. This connectivity helps businesses of all sizes expand internationally while maintaining control over payments and cash flow.

For SMEs, PayPal World levels the playing field by simplifying access to global markets, giving merchants the infrastructure to scale sustainably and compete globally. A craft jeweller in Mexico using MercadoPago can sell seamlessly to international buyers, while an SME in India can use a unified payments interface (UPI) to accept QR payments securely from a US traveller using PayPal.

Source: PayPal.

Platforms like PayPal World demonstrate how global payments systems can greatly expand reach for merchants by connecting digital wallets. These new payment systems can also be integrated with treasury, logistics and business services, aiming to lower barriers for smaller firms, especially in emerging markets.

BOX 4 | **Ant International – full suite of digital payments, finance and marketing solutions for SMEs to thrive**

Alipay+, Ant International's unified wallet gateway, is a great example of how they facilitate global connectivity and interoperability by linking over 37 e-wallet/banking app partners (together serving 1.8 billion mobile payments users) to over 100 million merchants globally (90% are SMEs). By enabling seamless cross-border payments and mobile innovations, local SMEs have a better chance of tapping into the global travel spend in their countries and regions.

SMEs can scale their businesses and market access through Antom's comprehensive payment gateway solutions of more than 300 payment channels to grow their business both online and offline. Antom Payment Orchestration, a unified payment management platform, and Antom Copilot, an AI-powered 24/7 business assistant, streamline payment integration and reduce time-to-market for new payment options by 90%. Together, they lower technical and operational barriers for merchants and SMEs, support increased transaction success and provide seamless access to advanced payment features, enabling scalable international growth through efficient global payment management.

Merchants can also use the unified global account provided by WorldFirst, which improves cash flow, lowers costs and ensures same-day processing. Serving mostly microbusinesses, many in their first year and from emerging markets, WorldFirst enables sellers to efficiently receive marketplace payments and manage sales proceeds from more than 130 platforms from global buyers across 200 markets and 100 currencies.

Inclusive financial services and credit are extended to these merchants through tailored, AI-driven credit technologies and lending solutions that address the unique needs of local markets. Innovation-led technology, together with open collaboration and partnership models, is helping to scale access to financial services and support the development of a more inclusive global economy.

Source: Ant International.

Digital twins

Businesses navigating complex supplier networks face key challenges and often access information too late, due to:

- Compartmentalized procurement and planning processes that diminish flexibility
- An overreliance on suppliers, coupled with complex supplier networks
- A lack of transparency and predictive capabilities within their supply chain

A supply chain digital twin allows organizations to combat these challenges by creating a continuously updated model of operations. This model fuses an enterprise's internal data with external signals like shipping volumes or port utilization, allowing AI to forecast, stress-test and optimize decisions end-to-end within a business's supply chain.[8]

BOX 5 | **Value Chain Digital Twin by BCG X**

This platform uses AI, simulations, scenario modelling and digital data platform techniques to create end-to-end visibility across the internal supply chain and third parties. This capability was created for complex project supply chains (e.g. energy, heavy industries and infrastructure) which have an acute need to manage a wide range of suppliers to drive on-time, on-budget execution. It allows businesses to:

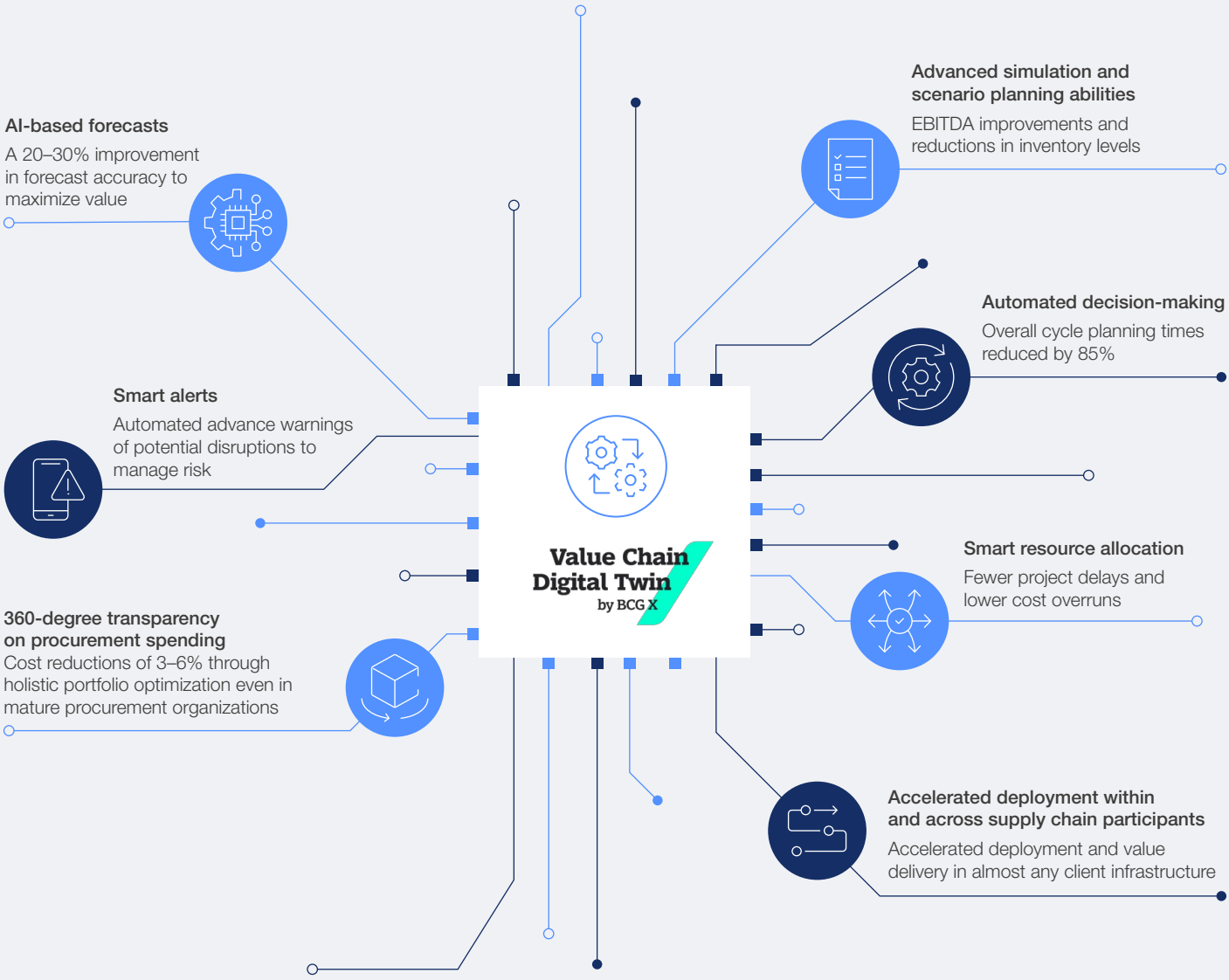
- Enable accurate planning that optimizes profit and stock
- Improve supply management and reduce costs
- Anticipate execution risks and mitigate delays
- Allocate resources effectively to maximize value
- Alleviate supply chain disruptions, generating scenarios that allow for optimized responses to any situation – resulting in a more resilient and flexible supply chain

This solution enables better decision-making, providing users across all levels of the organization with superior insights. Organizations leveraging this technology have reported:

- A 15% reduction in inventory level
- A 3–6% reduction in costs
- A 20–30% improvement in forecast accuracy
- Reductions of 50–80% delays and downtime

Source: Schuster, R. L. Mitjavila and C. Penazzo. (2024). *Using Digital Twins to Manage Complex Supply Chains*. BCG.

FIGURE 3 | **Seven key benefits of Value Chain Digital Twin by BCG X**



Source: Schuster, R. L. Mitjavila and C. Penazzo. (2024). *Using Digital Twins to Manage Complex Supply Chains*. BCG.

Trade compliance

Enterprises also face shifting tariff schedules, fragmented trade agreements and increasing regulatory pressure on carbon emissions and forced labour. As a result of this new reality, trade compliance has evolved into international trade management, which is essential for minimizing the risks of penalties, reputation damage and supply chain disruptions, ultimately becoming a vital tool for enterprises to stay competitive.

Data-driven and AI-augmented tools are being designed to address the increasing complexity of requirements that enterprises must comply with.

BOX 6 **Maersk Trade & Tariff Studio and Emissions Studio – data-driven compliance and decarbonization**

Maersk's digital compliance and sustainability tools use advanced analytics to help companies manage regulatory exposure and measure carbon performance across supply chains.

The **Trade & Tariff Studio** gives businesses a consolidated view of their customs and tariff data at the product level. Its AI-powered pre-screening service identifies compliance risks before goods are shipped, flagging exposure to denied-party and forced-labour lists, high-risk geographies and complex ownership chains. Automated data flows support audit trails and readiness for customs or enforcement inquiries, while tariff-management features highlight duty-saving opportunities and areas of elevated cost or risk, enabling teams to focus resources where they matter most.

The **Emissions Studio** tracks Scope 3 greenhouse gas (GHG) emissions for shipments across all carriers and transport modes, combining public and proprietary data to generate indicative insights on emissions. Built on widely used industry methodologies, it converts shipment records into comparable metrics and clear visuals, highlights emissions hotspots across routes and suppliers, and benchmarks performance against sector averages. Flexible reporting options let teams generate tailored outputs and share findings easily, supporting both disclosure and day-to-day decisions. The product roadmap focuses on turning metrics into action by surfacing the most impactful abatement levers, sequencing interventions across lanes and suppliers, and tracking progress against decarbonization plans.

Source: A.P. Moller – Maersk.

Digital infrastructure

The success of enterprises also depends on the speed and reliability of the networks that move goods, process data and deliver services, which are increasingly being tested by geopolitical shifts. Amid these shifts, logistics companies, port authorities and financial players have developed and implemented technological solutions to enhance coordination, accuracy and speed across their internal processes. In turn, this maintains global trade as predictable and competitive, despite an increasingly complex operating environment.

BOX 7 **DP World – digitalizing the Port of Dar es Salaam, Tanzania**

Strategic ports such as Dar es Salaam are playing an increasingly vital role in connecting emerging markets and regional supply chains as global trade adjusts to new geopolitical dynamics. DP World assumed operations at Tanzania's largest port in April 2024 and launched its Cargoes Community System, creating a unified digital ecosystem linking the port's stakeholders and synchronizing data with the in-house terminal operating system (Zodiac).

In less than two years, this digitalization has resulted in:

- Over 141,000 container terminal transactions and more than 143,000 general cargo transactions processed digitally, avoiding manual visits to port documentation centres
- Over 296,000 vehicle booking system interactions improving gate efficiency
- Over 20,000 self-service requests, facilitating 428 million in revenue collection
- Over 25,000 banking transactions executed, worth 106.9 million.
- Over 147,000 roll-on/roll-off (RORO) gate passes automated, eliminating manual processes and saving time for staff and customers

By replacing fragmented manual processes with seamless digital workflows, the port has increased transparency and reduced friction at a critical gateway for East Africa. As trade routes continue to diversify, Dar es Salaam's transformation demonstrates how local modernization can strengthen regional competitiveness and resilience within the global trading system.

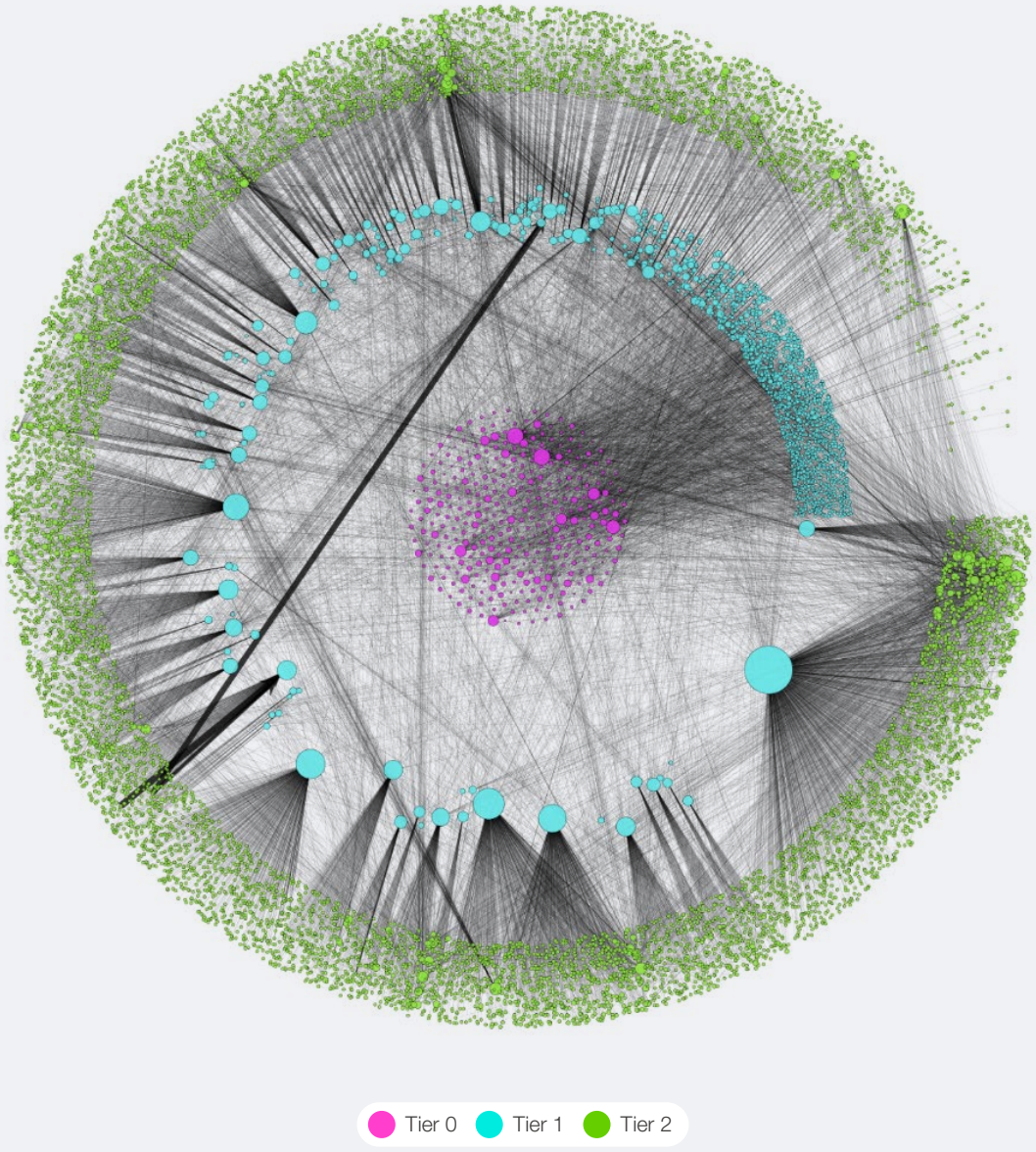
2.3 Multi-layer connections – bridging layers

The fragmented geopolitical landscape means differences in regulation, data governance and market access often slow the movement of goods and information. Two-layer connections help bridge these divides by linking adjacent parts of the system and allowing data, finance and oversight to flow more smoothly between them.

Supply chain visibility

Low visibility beyond direct suppliers in value chains creates uncertainty around supply chain resiliency, and challenges the ability of organizations to formulate and execute strategies for improving resilience. Hidden dependencies in the network can trigger disruptions at business, industry and national levels when there are changes in government policy, natural disasters or failures at key suppliers. Using AI to construct and analyse deep-tier supply chains enables enterprises to better mitigate risk by informing inventory choice, guiding supplier selection and managing exposure through insurance-based risk transfer.

FIGURE 4 **Supply chain complexities**



Note: Illustration of network complexity growth as supplier tiers are added. Dots represent suppliers and are sized according to the volume of goods they supply; lines indicate shipment connections between suppliers.

Source: Altana AI.

Enterprise-enabler level: multi-tier supplier management

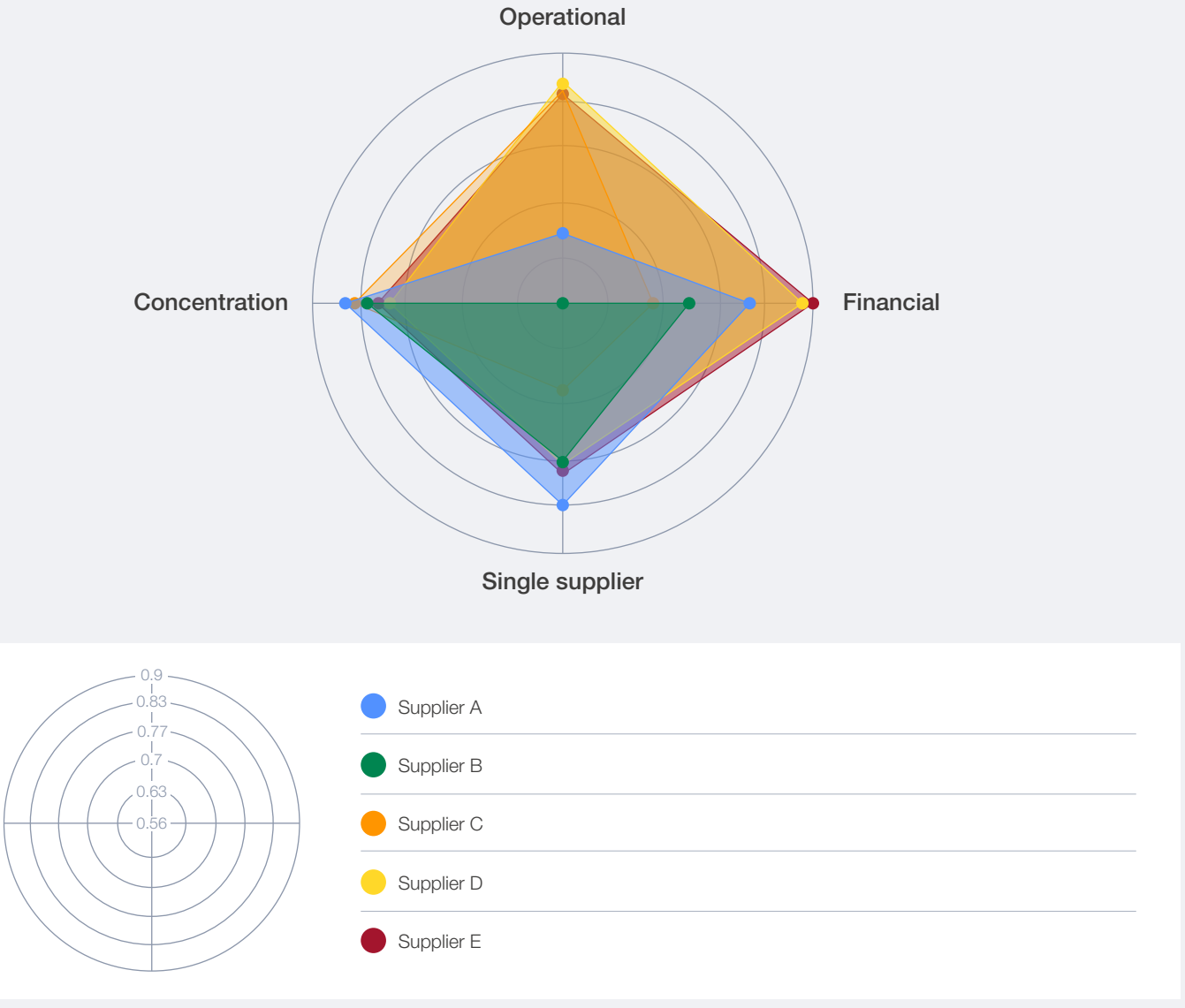
Altana's Global Trade Control Tower gives enterprises a live, comprehensive view of their supply networks beyond their direct suppliers, showing the suppliers of their suppliers and the factories that support them. By combining an enterprise's knowledge of suppliers with Altana's broader network visibility, this AI solution uses global trade and facility data to infer connections higher in the supply chain, highlight sanctioned or high-risk entities and geographies and identify potential bottlenecks. In addition to insights from network structures, enterprises apply scenarios for tariff policies, natural hazards and export restrictions on goods such as critical minerals and rare earth elements.

With deeper supply chain visibility resulting from this solution, procurement, legal and compliance teams within companies can:

- Prioritize the product lines most vulnerable to disruption, compliance breaches or cost shocks, i.e. those linked to high-risk geographies, single-source suppliers or sensitive regulatory regimes
- Recalibrate sourcing through supplier diversification and contingency arrangements
- Document decisions in verifiable audit trails that support regulatory reviews and assurance to respond to evolving regulatory requirements across key markets.

FIGURE 5 **Supplier resilience**

Direct supplier scores



Note: Comparison of five suppliers along four dimensions of resilience. Higher scores indicate higher risk.

Source: Altana AI.

> The UK's Global Supply Chain Intelligence Programme links strategy with operations, helping government agencies anticipate and mitigate systemic risks.

Enterprise-enabler-national governance bridge: product passports for compliance

The same facility- and product-level graph also powers collaboration among importers, suppliers, logistics providers and government. Altana's **Product Passports** extend visibility into operational compliance, allowing importers, suppliers, logistics providers and customs to share a verifiable, auditable record of a product's journey. This creates a single source of truth for sanctions screening, forced labour due diligence and carbon-related measures. Passports align facilitation with compliance by linking product and facility data to trade declarations, allowing logistics providers to include the passport ID in trade documentation. US Customs and Border Protection has selected Altana to build a modern trade infrastructure that enhances enforcement and accelerates border clearance for trusted importers.

As an example, an enterprise discovers a third-tier facility in a sensitive location. Working with its network, it verifies the risk, raises buffers, purchases insurance and, through a Product Passport, coordinates with customs to facilitate compliant importation.

National governance: UK Global Supply Chain Intelligence Programme (GSCIP)

The UK Department for Business and Trade (DBT) leads the UK Government's Global Supply Chain Intelligence Programme (GSCIP). DBT, the Department for Science, Innovation and Technology, the Department of Health and Social Care, the NHS Supply Chain, the Home Office, Ministry of Defence and other UK government organizations use tools, workflows, AI and insights from the Altana-powered GSCIP to develop public policies on a national scale. By joining sovereign UK import and export declarations to the secure deployment of the Altana platform, departments are able to map key industrial supplier dependencies across sectors and simulate disruptions. GSCIP informs trade policy, industrial strategy and economic security planning, while providing the private sector with a clearer understanding of systemic risk. Changes to the supply chain inform these policies and help mitigate potential threats to UK national interests as they develop in real time.

> When ports, carriers, shippers and authorities can see the same key signals in near real time, they can act earlier and collectively to rebook, reroute or resolve bottlenecks.

These AI tools, used by different actors across layers, work in tandem:

- Multi-tier supplier visibility provides the granular evidence governments and enterprises need.
- GSCIP elevates these insights to the national level, where macro analysis guides policy and preparedness.
- Collaboration on a single operating platform reduces friction and time-to-insight on key cross-government policy design and implementation.

AI unlocks a shared, high-fidelity understanding of supply networks, enabling governments and businesses to jointly mitigate vulnerabilities, reduce interruption risk and proactively align facilitation with compliance. Micro feeds macro and macro guides micro, creating a feedback loop that strengthens resilience, improves compliance, and builds trust across the tradetech stack.

Collaboration for collective visibility and coordination

As visibility deepens within firms and scales to national insight, the next frontier is shared visibility across many actors at once. This means moving from company-specific or government-specific maps to data-sharing with clear guardrails, sharing only the necessary information to coordinate while preserving control, privacy and commercial sensitivity. When ports, carriers, shippers and authorities can see the same key signals in near real time, they can act earlier and collectively to rebook, reroute or resolve bottlenecks. They can also measure emissions more accurately and build trust in compliance. This exemplifies the connecting fabric: common data, neutral governance and interoperable tools that turn individual visibility into collective good for resilience, efficiency and lower environmental impact.

BOX 8

The Virtual Watch Tower

The Virtual Watch Tower (VWT) is a shipper-led network that helps actors across the enterprise, enabler and governance layers to see the same situation in real time and coordinate faster when disruption hits, without handing all their data to a single central platform.

How it works:

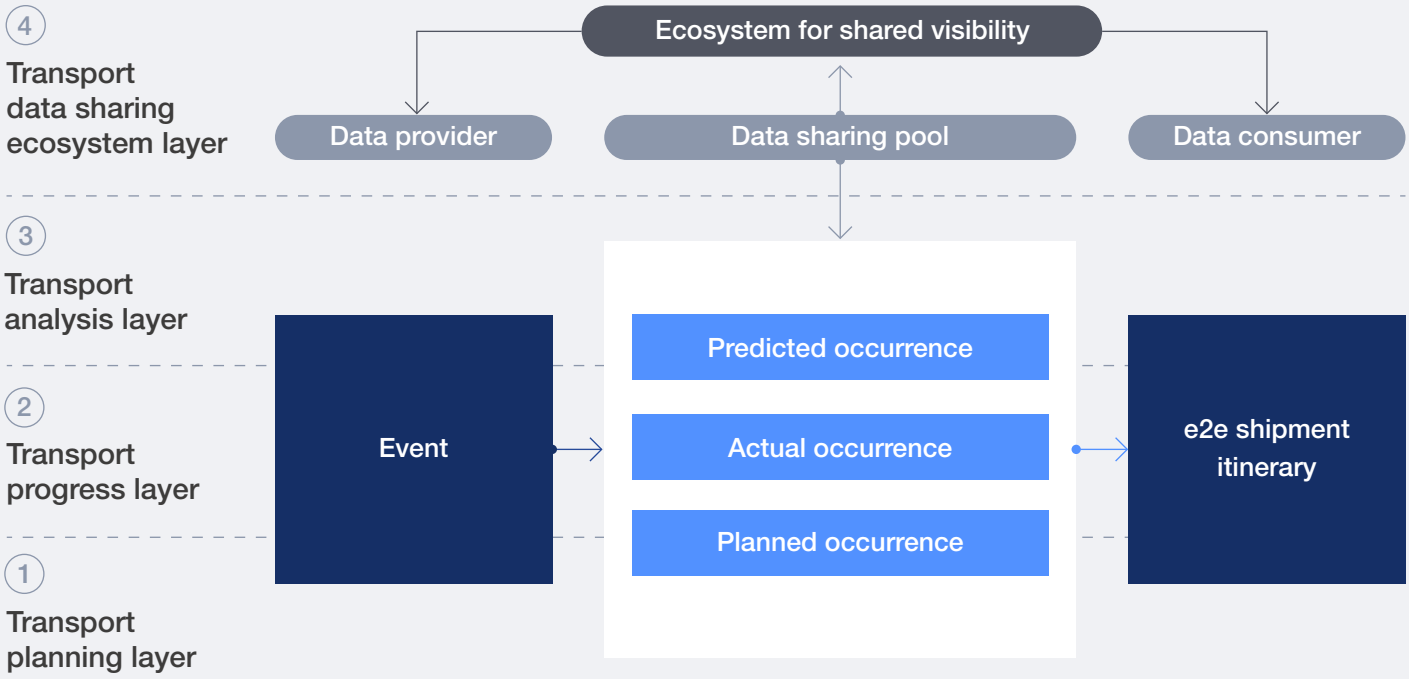
- Share what's needed: VWT's federated architecture (VWTNet) and distributed ledger enable participants to exchange essential shipment data in standardized, traceable and auditable formats while maintaining their own systems and control over information. Built on **TWIN** – an open, public-good infrastructure (see Box 16) – the network's neutral, two-tier governance safeguards data rights and avoids vendor lock-in.
- Augmented by technology: IoT on cargo provides a reliable basis for early warnings and proactive responses. AI-powered apps can transform those signals into alerts and recommended actions at both the individual and collective levels.

What it can do:

- **Disruption management:** The VWT can identify problems such as bad weather, port congestion, or a missed connection earlier and alert everyone involved, ensuring they see the same issue at the same time. Enablers can rebook space on another vessel, reroute via a different port, or reschedule trucks or rail. Acting quickly and together reduces dwell time (i.e. the time containers sit idle) and prevents delays from cascading along the route, resulting in more reliable arrivals, lower costs and reduced emissions.
- **Carbon data sharing:** Sensors on ships, trucks, trains and containers record where a shipment is, when it moved and how it was handled. Sharing a small set of these time-stamped signals in a tamper-evident, traceable manner allows everyone to calculate how much CO_2 each segment of the journey (sea, road, rail or air) uses, using the same facts. Enterprises can then confidently report emissions to customers and regulators, compare routes and carriers, and target the most significant opportunities to cut their footprint.

VWT's strength lies in its ability to bring together shippers, ports, carriers, technology providers and applied researchers to turn minimal shared data into collective action. By preserving data control and focusing on interoperability and neutral governance, VWT shifts responses from fragmented to coordinated and provides a model that can scale across corridors and jurisdictions, essential in a time of geopolitical fragmentation.

FIGURE 6 | **Layered data sharing framework adopted by VWT**



Source: Lind, M., W. Lehmacher, S. Haraldson, E. Hoestra, et al. (2025). *Towards a New Data Sharing Regime: Structuring Supply Chain Data*. The Maritime Executive. https://maritime-executive.com/editorials/towards-a-new-data-sharing-regimestructuring-supply-chain-data.

VWT demonstrates how shared data can align decisions across shippers, ports and carriers. The connective fabric can also be used to turn operational visibility into legal and financial certainty. This requires trusted digital rails where the same shipment facts anchor document exchange, title transfer and finance.

The Global Shipping Business Network (GSBN) is an independent, neutral, not-for-profit technology consortium that connects shipping lines, terminals, banks and other participants across the global trade ecosystem through a permissioned blockchain infrastructure.

This infrastructure allows electronic bills of lading (eBL) – documents that prove ownership of goods in transit – to be exchanged as securely and legally as the traditional paper versions. To date, over 700,000 eBLs have already been issued on GSBN.

BOX 9 **GSBN and trade finance – the Lin-gang milestone**

In September 2025, the first integrated pledge financing powered by three digital trade documents was completed in Shanghai's Lin-gang Special Area. In simple terms, three essential trade documents (the electronic delivery order, eBL and electronic warehouse receipt) are digitally connected through GSBN blockchain infrastructure, allowing goods, ownership rights and financing to be provided in one seamless process. The result was faster processing, lower administrative costs and, crucially, improved access to credit for businesses.

The pilot unlocked RMB 2 million (Chinese Yuan) – equivalent to $280,150 – in financing from the Bank of Jiangsu for a rubber shipment, while reducing handling costs by around 30 per cent, showing how trusted digital infrastructure can translate directly into liquidity and growth. By proving that verified digital documents can underpin financing, it provided a working example of how technology and regulation can combine to unlock the next stage of trade digitalization.

Lin-gang demonstrates that progress is not only moving goods faster but creating new value from digitalization. With AI, stablecoins for payments and a single, reliable digital framework linking title transfer, payment and other business transactions, trusted collaboration can scale across global supply chains, turning data into opportunity and economic growth.

However, while these various innovations presented above are already delivering results, they are not sufficient and must be reinforced by enabling partnerships and frameworks.

3 Beyond the tech

Technology connects trade, but human collaboration makes it resilient.

Technology serves as the central force that weaves the layers of the trade stack together. Single-layer tools such as agentic AI can help bring more enterprises into global markets, while multi-layer technologies build shared visibility among enterprises, enablers and governments.

This demonstrates technology's capacity to enhance efficiency and resilience across the trade ecosystem. However, with technology becoming a primary bargaining chip amid rising geopolitical tensions, it is crucial to understand how to further reinforce and empower this connecting layer.

> **Digital twins, AI, and blockchains can make promises more observable, but they cannot by themselves ensure compliance. Without supporting institutions, dreams of decentralization risk giving way to renewed concentration of power. Ultimately, restoring trust within global trade depends as much on political choices as on technological innovation.**
>
> Krzysztof Pelc, Lester B. Pearson Professor, Department of Politics and International Relations, Oxford University

This chapter focuses on two key truths:

1. Technology must be supported through human capacity, collaboration and an enabling regulatory framework.
2. The connective fabric can be further enhanced through technologies not directly central to the trade stack.

This section explores how various human-led processes and complementary technological innovations can further strengthen the systems linking the various levels of the tradetech stack.

3.1 Inter-governmental collaboration

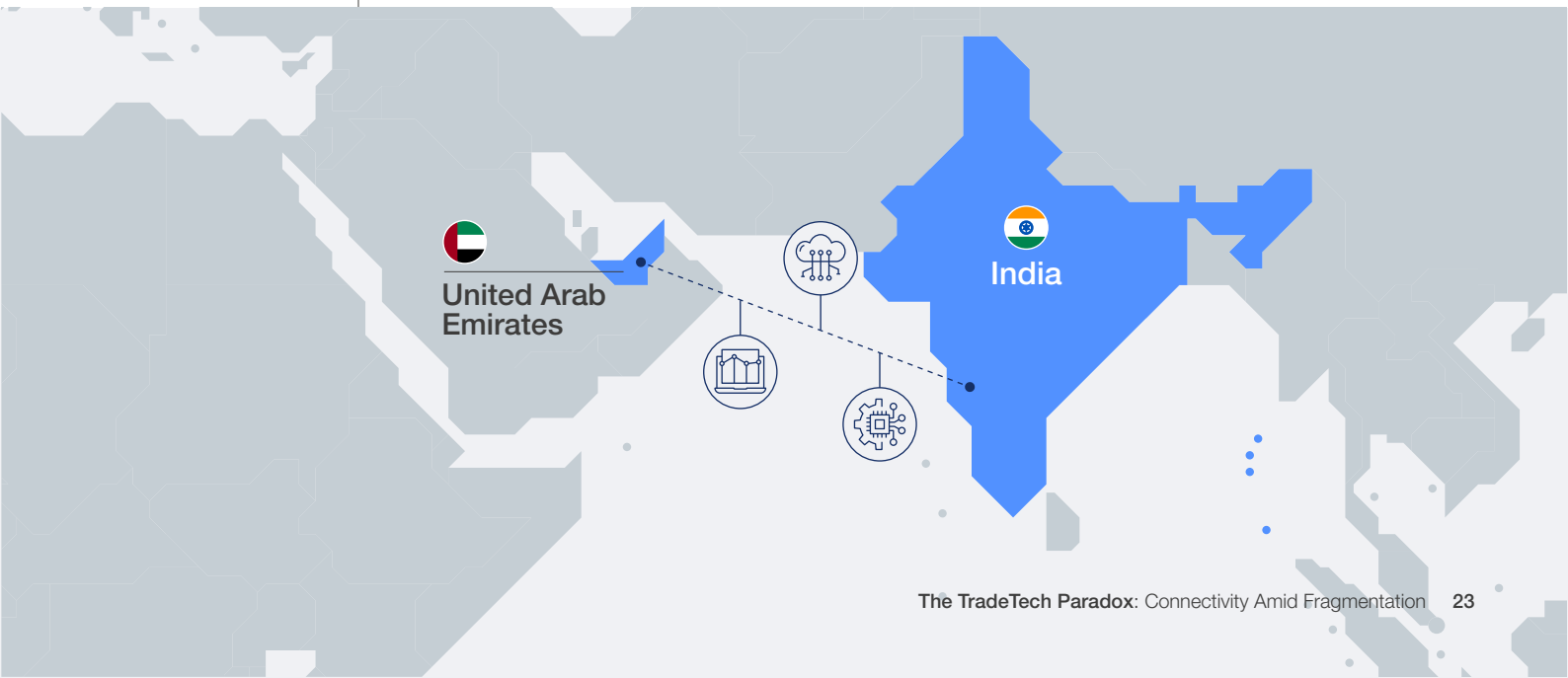
Inter-country collaboration on aligning policies, sharing resources and developing joint initiatives is essential to reinforcing the technological layer of the trade stack. Collaboration ensures that the technology underpinning the trade stack has the proper regulatory environment not just to function in isolation, but to function for all.

Bilateral collaboration

The United Arab Emirates–India digital trade corridor, enabled by DP World in partnership with government stakeholders, demonstrates that collaborative regulatory and economic frameworks are essential to making technological integration effective and resilient.

By digitally linking Dubai Trade with India's digital trade facilitation system through DP World's Cargoes Community System, the digital corridor enables real-time exchange of export and import data across jurisdictions, creating a seamless digital bridge between two of the world's most dynamic trading economies.

FIGURE 7 **United Arab Emirates–India digital trade corridor**



This cross-border interoperability is supported by the United Arab Emirates–India Comprehensive Economic Partnership Agreement (CEPA), a modern free trade agreement that includes provisions for digital trade and regulatory cooperation to reduce friction and enhance bilateral trade and investment between the two countries.

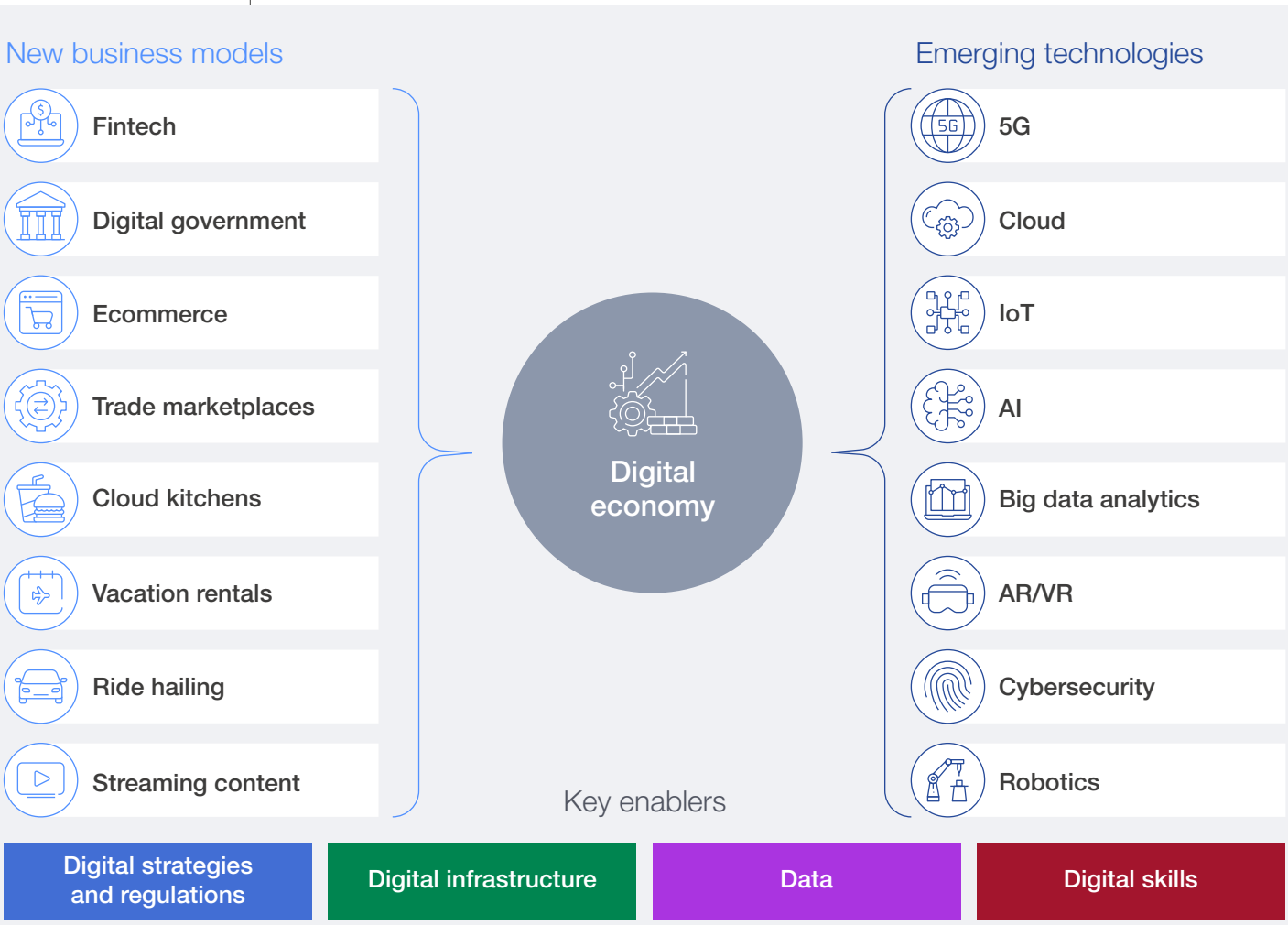
The CEPA enables the United Arab Emirates–India corridor to remain robust and resilient, ensuring that innovations like digital documentation and secure data-sharing protocols operate within a coherent governance framework. The United Arab Emirates–India CEPA was the first CEPA the United Arab Emirates concluded, and as of October 2025, the United Arab Emirates has signed CEPAs with a total of 13 countries.[9]

Regional collaboration

The Association of Southeast Asian Nations (ASEAN) Digital Economy Framework Agreement (DEFA), facilitated in part by the World Economic Forum and the ASEAN-Korea Cooperation Fund, illustrates how regional inter-country collaboration can strengthen the connective fabric.[10]

As the world's first region-wide, binding agreement dedicated exclusively to digital economy governance, DEFA provides a blueprint for how ASEAN's population of almost 680 million can access a digital economic future that is open, secure and inclusive.

FIGURE 8 **Overview of the digital economy**



Source: Nazir, S. (2021). *Accelerating the Digital Economy: Four Key Enablers*. Huawei Enterprise. https://e.huawei.com/mx/blogs/industries/insights/2021/accelerating-digital-economy.

Because DEFA aims to enable the equitable advancement of the digital economy and the technologies that underpin it, a collaborative approach was essential to its design. DEFA was shaped through extensive consultations with governments, enablers, enterprises and academic experts to ensure that the policies underpinning the framework reflected the needs and realities of those most affected by digital transformation. Without such collaboration, the resulting technologies and regulatory mechanisms would risk misalignment with real-world contexts, diminishing their impact and adoption. Additionally, such a coordinated approach allows for the stronger participation of SMEs, which depend on predictable, interoperable rules to participate in international markets.

> **The digital divide may limit the benefits of technology in trade, as small and medium-sized trading firms from developing countries are likely to face resource constraints in adopting such technologies. Hence, it is important to promote complementary policies that provide funding and technical support for such firms in developing countries to adopt these trade-enhancing technologies.**
>
> Usha Nair-Reichert, Associate Professor, Georgia Institute of Technology

Finally, without this regional cooperation, data localization mandates and uneven enforcement of privacy regulations would continue to fragment digital trade systems, resulting in data silos, higher operating costs and reduced innovation capacity.

> **By streamlining clearance procedures, harmonizing data standards such as GS1, and adopting interoperable systems like the Single Trade Window, governments can remove many of the administrative and compliance barriers that often hold smaller traders back.**
>
> Elnaz Irannezhad, Senior Lecturer in Transport Engineering, University of New South Wales

Although still under negotiation, DEFA already demonstrates how human connection and cooperation are prerequisites for building effective policies that guarantee robust technological trade systems for all.

Together, DEFA and the United Arab Emirates–India corridor demonstrate that the connective fabric of the tradetech stack, while enhancing the movement of goods, services and data, must be grounded in trust and inclusive governance.

> **Such agreements, both bilateral and regional, provide a template for what might be possible, and a vehicle on which other countries can tap into. As the world embarks on a bigger share of digital trade in the coming years, we can also think of these as updated free trade agreements for the new digital economy.**
>
> Puay Guan Goh, Associate Professor, National University of Singapore

3.2 Connector countries

As geopolitical rivalries intensify and trade becomes increasingly regionalized, the international system risks fracturing into competing blocs. This fragmentation can result in countries restricting cross-border data flows, undermining the connective fabric of the tradetech stack.

However, connector countries, defined by their neutrality, openness and diplomatic flexibility, maintain balanced relationships across geopolitical divides and harness advanced technology and trade infrastructure to link regions around the world.

Thus, when geopolitical or regulatory fragmentation arises, the neutrality of connector countries provides the stable infrastructure needed to keep digital trade systems interoperable and functioning seamlessly. This guarantee of open and reliable data flows strengthens the resilience of the connective fabric of the tradetech stack.

BOX 10 | **Connector country – United Arab Emirates**

Through its strategic location, diplomatic agility and sustained investment in trade technology, the United Arab Emirates has positioned itself as a bridge between regions, connecting Asia, Africa, Europe, the Americas and the Middle East.

- **Neutral economic diplomacy:** The United Arab Emirates has maintained balanced relationships with major powers across the globe. Its willingness to engage with countries such as Costa Rica, Australia and Serbia through CEPAs demonstrates how a connector state can sustain cross-bloc collaboration, even amid global polarization.
- **Infrastructure for the good of the global public:** By developing world-class ports, logistics systems and digital corridors (e.g. the United Arab Emirates–India trade bridge), the United Arab Emirates ensures that the technology underpinning supply chains remains open, efficient and trustworthy in times of political uncertainty.

Through these efforts, the United Arab Emirates demonstrates how connector diplomacy can strengthen technological innovation, offering the global system continuity when political consensus is absent.

The Future of Investment and Trade Partnership (FITP) exemplifies how connector countries can bring regions together and strengthen the tradetech stack. The FITP is a plurilateral initiative of 14 economies from around the world that are committed to open and rules-based trade and aim to develop solutions in four priority areas, including the adoption and integration of trade technologies.[11] By connecting economies to address tradetech in particular, the FITP is paving the way for collaborative solutions within the national governance layer.

3.3 Cross-layer partnerships

Enterprises and enablers own and operate the majority of global logistics systems, data platforms and payment networks that underpin the global trade system. Therefore, the international and national governance layers must collaborate closely with these layers to fortify the connective fabric.

A flagship example of a cross-layer partnership is the Global Alliance for Trade Facilitation (GATF), which supports low- and middle-income countries in streamlining trade-related processes through technology to transport goods across borders efficiently.

BOX 11 | **The GATF at Bhomra Land Port, Bangladesh**

The GATF worked with Swisscontact, the Bangladesh Land Port Authority (BLPA), and the Bhomra C&F Agents Association to replace paper-based procedures at Bangladesh's key crossing with India (West Bengal) with a digital ePort management system to move goods more efficiently across the border. This project:

1. Introduced an e-payment system to facilitate online payments, eliminating the requirement to pay in person at designated offices
2. Implemented an automated port-billing feature, streamlining bill generation to improve speed and accuracy
3. Enabled traders and C&F agents to track consignments online, eliminating the need for constant physical contact to verify truck movements
4. Created unprecedented levels of trust through facilitating extensive engagement, training and workshops involving BLPA officials, C&F agents and importers/exporters
5. Built a successful template system for roll-out to the country's 22 other land ports

Source: Global Alliance for Trade Facilitation. (n.d.). Bangladesh Impact Flyer. https://www.tradefacilitation.org/wp-content/uploads/2025/01/Alliance-Impact-in-Bangladesh-1.pdf.

Other initiatives, like the TradeTech Regulatory Sandbox, focus instead on balancing technological innovation with enabling regulatory frameworks to ensure that new solutions are tested for compliance and safety while supporting the efficient adoption of tech in trade.

BOX 12 **The TradeTech Regulatory Sandbox**

This pioneering initiative connected United Arab Emirates regulators, including the Ministry of Foreign Trade, Abu Dhabi Department of Economic Development (ADDED), Financial Services Regulatory Authority (FSRA), Dubai Financial Services Authority (DFSA), Central Bank of the United Arab Emirates and United Arab Emirates Regulations Lab, with eight global start-ups to test how their innovations such as digital documentation, digital identity, stablecoins and tokenized trade finance would fare in different simulated real-world trade scenarios.

Participating firms worked alongside regulators and subject-matter experts to test solutions using synthetic data and simulated flows of trade transactions. By allowing start-ups and regulators to experiment together in a safe, structured environment, the sandbox created opportunities for enterprises and government actors to truly understand how technology and regulation interact, resulting in policy recommendations and more applicable innovations.

Source: World Economic Forum. (2024). *Advancing Digital Trade: Insights from the UAE TradeTech Regulatory Sandbox*. https://www.weforum.org/publications/advancing-digital-trade-insights-from-the-uae-tradetech-regulatory-sandbox/.

Another model of cross-layer partnership focuses instead on augmenting special economic zones (SEZs) by pairing enabler know-how and innovation with public land and clear regulatory frameworks, ultimately turning SEZs into high-performance hubs for trade.

BOX 13 **Suez Canal Economic Zone (SCZone) logistics infrastructure**

Under its Economic Zones arm, Agility works with the SCZone Authority, integrating logistics, warehousing, customs and trade platform services.

Agility invests in infrastructure, operates facilities and deploys integrated digital platforms (e.g. SCZone Trade and One Stop Shop) to streamline investor onboarding, enable electronic payments, support compliance management and reduce friction across regulatory and operational interfaces.

These digitalized processes significantly enhance the investor experience while enabling better monitoring and control of SEZ operations through a single, integrated platform. This helps transform SCZone into a leading hub in regional supply chains.

Here, Agility plays multiple roles as an enabler: zone developer, logistics operator, systems integrator and trade interface partner. The public authority contributes land, regulatory oversight and strategic alignment with national trade policy. The Enabler-National Governance partnership facilitates creation of high-performance logistics clusters on public land supported by IT-enabled solutions designed to enhance transparency, reduce delays and improve investor confidence, ensuring continuity of operation and knowledge transfer to the public authority.

Source: Agility.

3.4 Data infrastructure

These facilities are not only commercial assets but also strategic infrastructure that enhances digital resilience, redundancy and interoperability for global trade systems.

Every digital trade solution, whether a blockchain-enabled logistics platform, an AI-driven customs system or an IoT-connected port, relies on the invisible foundation of data infrastructure. Data centres are the silent enablers of the tradetech ecosystem, providing the secure, low-latency environments where trade information is processed, stored and exchanged. Without resilient, distributed and sustainable data infrastructure, the digitalization of trade remains incomplete.

The Middle East is rapidly emerging as one of the world's most dynamic regions for digital infrastructure. The United Arab Emirates is leading large-scale investments in hyperscale and edge data centres to link cloud, energy and connectivity corridors across Africa, Asia and Europe. These facilities are not only commercial assets but also strategic infrastructure that enhances digital resilience, redundancy and interoperability for global trade systems. Examples of the United Arab Emirates pairing national investments with private enablers and enterprises to build data centres include:

- Abu Dhabi Investment Office and Khazna collaborating to build an advanced data centre with an initial capacity of 30 megawatts (MW)
- The "AI Acceleration Partnership" between the United Arab Emirates and the US in May 2025, which includes the launch of a one-gigawatt (GW) AI data centre

The United Arab Emirates' model demonstrates how public-private investment models can build regional digital capacity and expand globally connected hosting infrastructure. Through partnerships with economies around the world and leading technology firms, these facilities serve as neutral gateways, hosting trade-related applications and data exchange platforms that operate seamlessly across jurisdictions.

BOX 14 | **Axiom Space – orbital data centres**

Looking further ahead, orbital data centres could soon complement terrestrial digital infrastructure. By hosting computing power in space, powered by solar energy and connected through laser links, these centres promise lower latency in intercontinental trade transactions and resilience in times of terrestrial disruption.

While still in development, orbital data centres reflect how space will increasingly host not only the infrastructure of observation, but also data processing and decision-making.

Source: Axiom Space.

As Rajeeshwaran Moorthy, Appointed Advisor for the United Nations Office for Outer Space Affairs notes, "Orbital data centres won't just accelerate global data flows, they will allow emerging nations to connect to the digital trade grid on equal footing, creating a more inclusive and resilient future economy."

3.5 Human capacity

Human capacity, including the skills, adaptability and leadership required to manage complex systems, is an essential part of ensuring a robust and resilient digital infrastructure within the trade stack. Innovations are limited if engineers, technicians and frontline workers lack the technical skills necessary to build, operate and maintain these systems.

Thus, without strategic investment in human skills, the connecting fabric will remain underpowered.

> **Finding the human resources capable of implementing and maintaining these technologies so that organizations can benefit from this has been a frustrating task.**
>
> Rod Franklin, Emeritus Professor of Logistics Practice, Kühne Logistics University (KLU)

The human capacity gap becomes especially apparent in times of crisis. Humanitarian logistics accounts for roughly 75% of total relief spending, underscoring the central role of supply chains and human capacity in achieving real-world impact.

Yet, amid widespread cuts to the humanitarian sector, digital transformation is essential for organizations to do more with less. As Maria Besiou, Professor of Humanitarian Logistics, and Mojtaba Salem, Assistant Professor of Humanitarian Operations and Management Practice at Kühne Logistics University (KLU) explain, "The imperative is clear: secure funding for digital platforms, build organization-wide digital literacy, and forge partnerships with the private sector for building tailored solutions."

Beyond digital platforms, technology can play a role by strengthening human capacity. However, it is not enough: as Mojtaba Salem and Maria Besiou explain, organizations must also "secure funding for digital platforms, build organization-wide digital literacy, and forge partnerships with the private sector for building tailored solutions."

In this context, technology can also play a vital role. As Mojtaba Salem and Maria Besiou again emphasize, "technology and AI can personalize learning, reduce costs and deliver high-quality training to remote and crisis-affected areas, thereby democratizing expertise."

Therefore, the lesson is clear: there is not only a need for increased human capacity to grow the connective fabric of the trade stack, but also for technology that can help strengthen human capacity.

3.6 Ethics

Addressing ethical implications is a competitive advantage for the resilience of technology in the long run.

In the absence of ethical design, technological progress risks deepening inequality and eroding global confidence: algorithmic decision-making that neglects inclusion and fairness can reinforce existing trade imbalances, resulting in a more fragmented trade ecosystem where flows are concentrated into "trade islands", leaving smaller economies and vulnerable communities behind – ultimately reducing trade growth.[12]

As Manuela Travaglianti, Project Lead of the Ethics Toolkit at the McCoy Family Center for Ethics in Society of Stanford University, notes, "prioritizing efficiency over ethical sourcing undermines community well-being and exposes trade partners to reputational or geopolitical risks. It also limits transparency in decision-making, reducing buy-in and collaboration."

Ethical design ultimately determines whether technology strengthens or weakens trust between trade partners, and this highlights a shift: addressing ethical implications is a competitive advantage for the resilience of technology in the long run. With increased trust, technologies become more adoptable and interoperable. The more actors adhere to ethical standards, the easier it becomes to achieve uniform enforcement and interoperability, thus demonstrating the importance of ethics in strengthening the technical layer of the trade stack.

BOX 15 **The Trade Worldwide Information Network**

The Trade Worldwide Information Network (TWIN) exemplifies values-driven trade governance. By providing open-source infrastructure that securely digitizes essential trade documents using blockchain technology, it creates a level playing field for countries around the world globally to digitize their trade practices.

The global cooperation required to create TWIN, particularly the data sharing between the public and private sectors, underscores the importance of effective governance and collaboration in implementing and advancing trade technologies. Crucially, TWIN's open infrastructure also enables the exchange of trade-related services, from digital payments to certification and insurance, signalling how thoughtful technology design can expand trust not only in goods trade but in the fast-growing trade of services.

Source: TWIN.

Building on such trust, governments can unlock new models of collaboration with the private sector, reduce systemic inefficiencies and ensure that trade systems remain both inclusive and resilient, benefiting societies at large. In the context of global supply chains, this trust enables greater transparency, coordination and adaptability across borders, ultimately cultivating technological systems that are not only more efficient but also better equipped to withstand and recover from disruptions.

BOX 16 **Hiroshima AI principles**

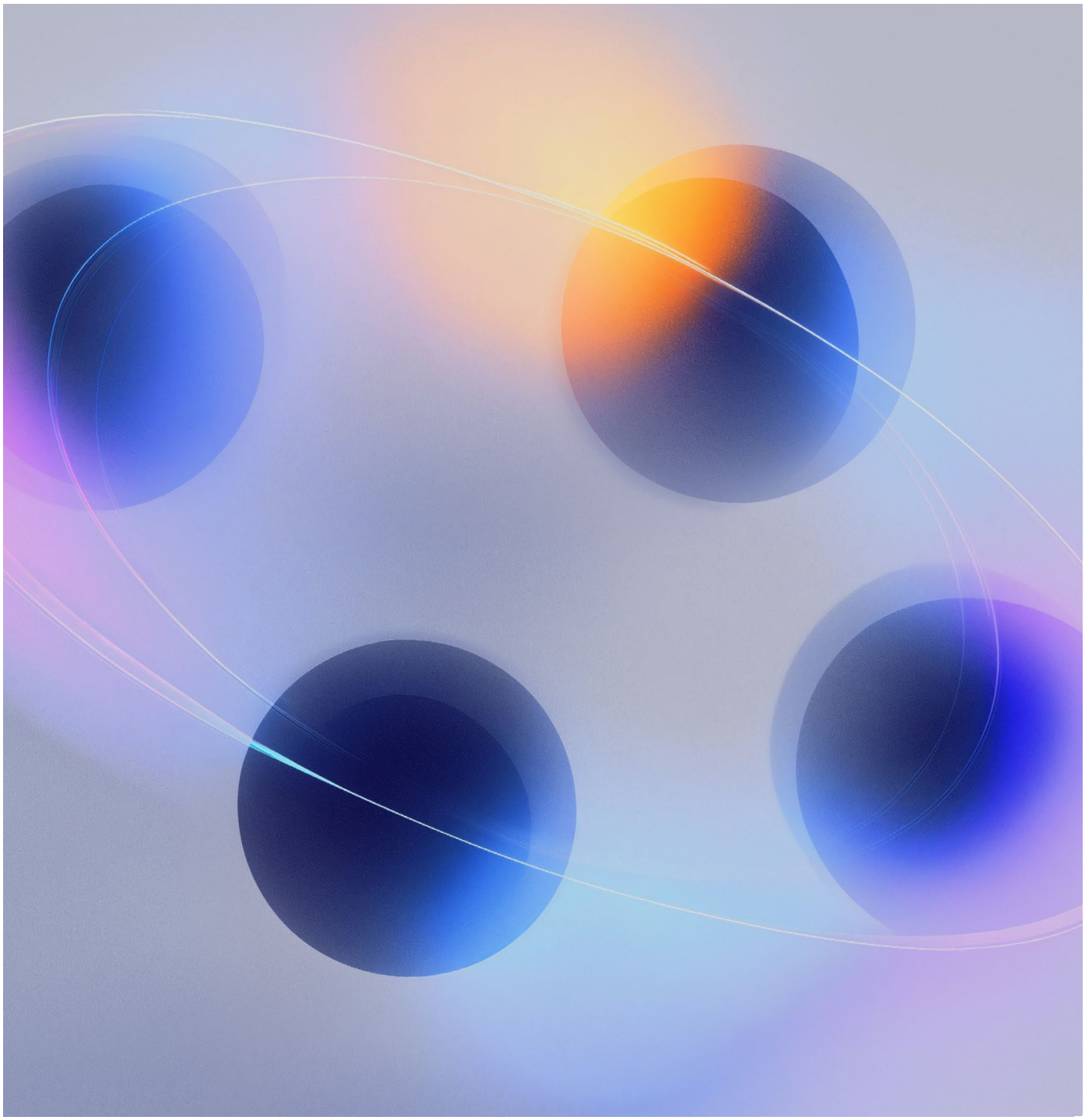
The *Hiroshima Process International Guiding Principles for Organizations Developing Advanced AI Systems*[13] aims to promote safe, secure and trustworthy AI worldwide and provides guidance for organizations developing and using the most advanced AI systems.

In line with these principles, the World Economic Forum's AI Governance Alliance launched the Hiroshima Process International Code of Conduct for Organizations Developing Advanced AI Systems.[14] This code of conduct is supported by the Organisation for Economic Co-operation and Development's (OECD) Hiroshima AI Process Reporting Framework and provides a global, voluntary mechanism that enables organizations to report how they are applying the Hiroshima principles in practice, increasing transparency, accountability and comparability worldwide.

In doing so, these efforts ensure that the technology underpinning global systems, such as international trade, serves all of humanity, enhancing their credibility and, in turn, their strength and resilience.

4 **Strategic foresight stress test:** exploring the resilience of trade technologies in a changing world

How relevant are today's innovations, given the evolving nature of the world?



Background

Peter Drucker said, "Knowledge is different from all other resources. It makes itself constantly obsolete."[15] Similarly, technological innovation, by itself, is not a guarantee of success.

This exercise is a guided reflection designed to help you systemically assess, using strategic foresight, how resilient the technological innovations in this report, as well as your own strategies, remain in the context of different possible futures.

For guidance on the foresight exercise, please click here.

Step 1

Strategic technology choices (10 minutes)

This report has explored different trade technologies. This exercise works with the following three innovation categories:

1. AI for visibility – goods
2. Distributed ledger technologies (DLT) for transparency and trust – data
3. Digital tools for trade finance and payments – money

Imagine you are in a meeting with your team, deciding which technologies you will invest in to achieve your organization's mission. Given your limited budget and resources, which two technologies would you prioritize for your investment and why?

Step 2

Understanding scenario building process (40 minutes)

This step focuses on scenario planning. While multiple methods exist for building future scenarios, the 2X2 matrix approach is highly popular.

Here are the systematic steps for the process of developing your own scenarios:

1. **Define the scope and time horizon:** Clearly establish the area of focus (e.g. the future of international trade) and the planning window (e.g. 10 years).
2. **Identify driving forces:** Brainstorm and list all major factors that will shape the future of your area of focus. The social, technological, economic, environmental and political (STEEP) framework is an excellent tool for comprehensive identification.
3. **Select key driving forces:** From the list, select two forces to help develop your matrix based on the following critical criterion: they must have high impact and high uncertainty. Crucially, the two selected forces must be independent of each other.
4. **Construct the matrix:** Draw a two-by-two matrix using two driving forces you selected as the orthogonal axes. At each end of the axis, add the extreme outcomes (e.g. high/low) of your driving forces. This will create four distinct quadrants. These quadrants must be mutually exclusive and collectively exhaustive.
5. **Develop scenarios:** In 150 words or more, describe worlds in which the conditions within each of the four quadrants are met. Additionally, give each scenario a vivid and compelling name that captures its essence.

Example: Scenario-building application for the future of international trade in 2035

Now, apply the process within the context of this report. The defined scope is the future of international trade in 2035. Out of the diverse factors identified using the STEEP framework, assume that "accessibility to technology" and "openness in global order" have been selected as the two key driving forces due to their high impact and uncertainty.

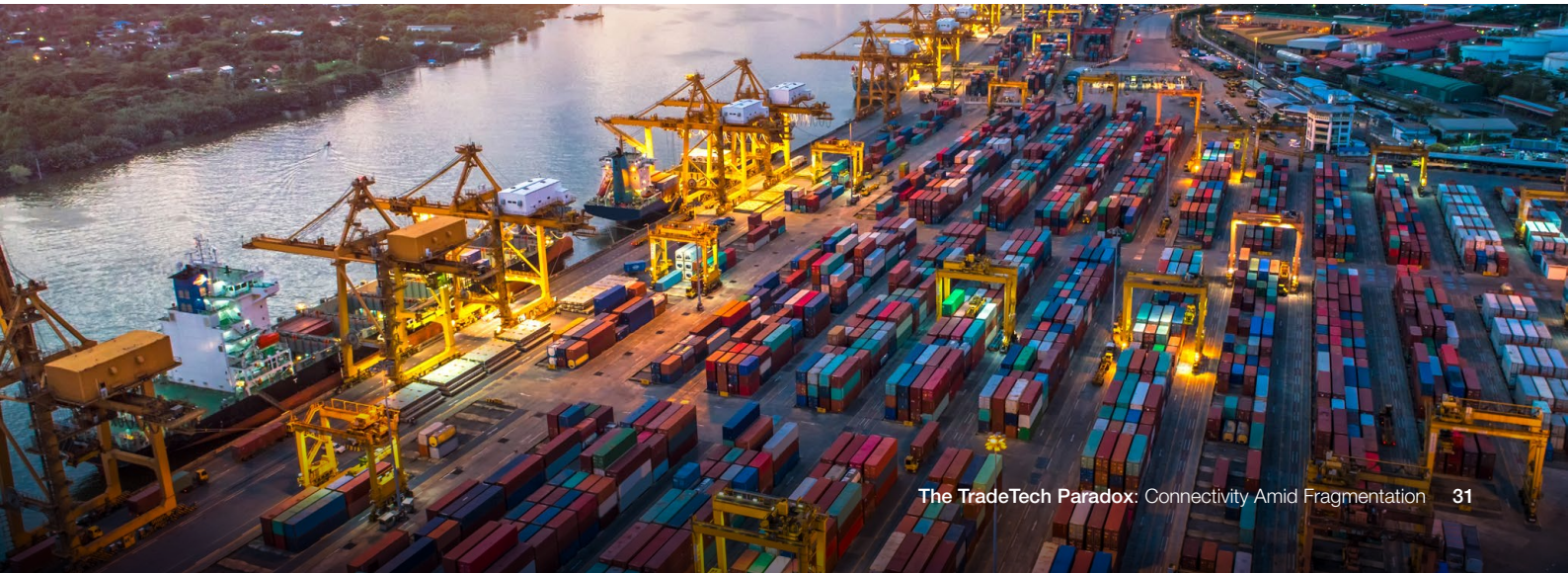
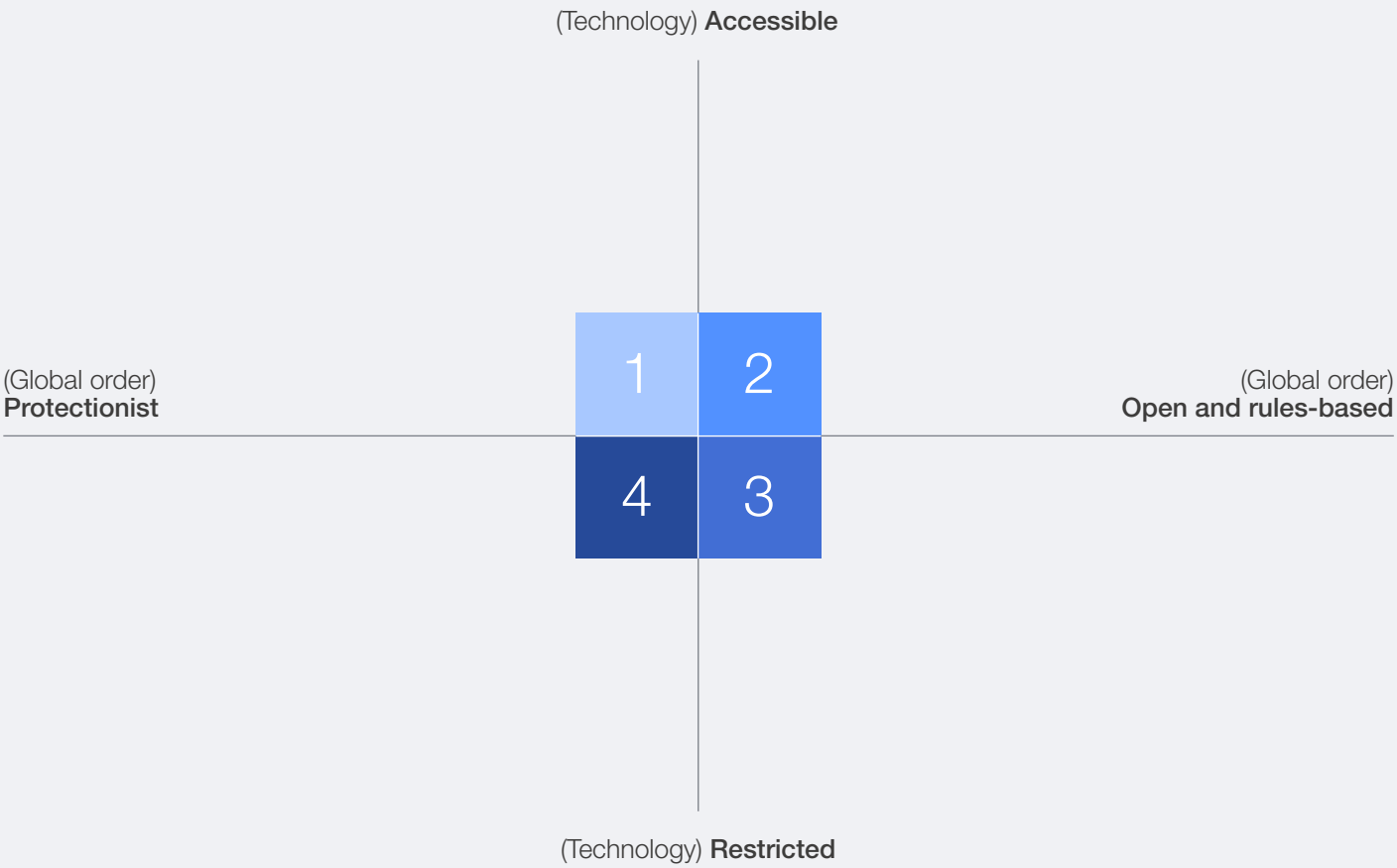


FIGURE 9 | **Scenario matrix**



The following are examples of abbreviated scenarios based on the matrix. They are not predictions but tools to help you test the adaptability of technologies and strategies in the next section of this exercise.

TABLE 6 | **Abbreviated foresight scenarios**

Scenarios	Defining features	Implications for the trade environment
Scenario 1: Fragmented innovation (Accessible tech/ protectionist order)	Technologies spread globally, but regional trade blocs set divergent standards, limiting global interoperability. Widespread tech access fuels strong local innovation ecosystems.	Trade operates through regional, values-based networks. Cross-border flows are selective. Emerging economies use open-source tech. The lack of shared global data hinders collaboration.
Scenario 2: Interoperable prosperity (Accessible tech/open and rules-based order)	Global standards enable interoperability and shared prosperity. Multilateral frameworks govern data flows and AI ethics effectively. Cross-border innovation ecosystems flourish.	Trade is enabled by shared standards and trusted digital verification. Policy aligns with sustainable development goals, allowing SMEs and developing nations to participate in high-value, tech-enabled trade. Technological capacity-building becomes a cornerstone of trade agreements and organizations.
Scenario 3: Tiered world by tech (Restricted tech/open and rules-based order)	Global trade coordination persists, but tech access gaps widen as leading economies dominate intellectual property (IP) and high-tech exports. Inequality significantly increases.	Trade systems are open but structurally unequal. Developing countries rely on outdated imported tech. Smaller economies must strategize to develop trusted intermediaries to access tech value chains.
Scenario 4: Techno-national standoff (Restricted tech/ protectionist order)	Techno-nationalism and digital sovereignty dominate. Nations guard domestic tech advantages. Corporate-state alliances tighten around strategic technologies (e.g. semiconductors).	Security and resilience take precedence. Trade barriers and export controls severely fragment global supply chains. Data localization and national AI frameworks replace multilateral norms, significantly raising tech and compliance costs.

Step 3

Test the resilience of trade technologies (20 minutes)

Use the matrix below to "stress test" each technology innovation. For each future, ask yourself the guiding questions, or questions of your choosing, to decipher if the technology exhibits any of the following qualities.

- **Works well**
- **Requires adaptation**
- **Vulnerable**

TABLE 7 **Foresight stress test**

Technology focus area	Guiding questions	Scenario 1: Fragmented innovation	Scenario 2: Interoperable prosperity	Scenario 3: Tiered world by tech	Scenario 4: Techno-national standoff
AI for supply chain visibility	Would AI systems still deliver accurate and trusted insights across borders for all?				
Trust and credibility technologies (e.g. DLT, digital identities)	Do distributed ledger technologies maintain transparency and trust across diverse regulatory and political environments?				
Digital trade finance platforms	Do digital finance systems remain interoperable and efficient across borders in this scenario?				

Step 4

Reflect and discuss

This final step moves the conversation from the stress test results to concrete strategic action and ongoing monitoring.

1. **Assessing resilience**: Based on the stress test, which technologies demonstrated the highest level of robustness across all four future scenarios?
2. **The strategic pivot**: Compare your original non-scenario technology choices from step 1 with the two technologies identified as most robust here.
3. **Would you change your strategic technology choice now?** If yes, what is the specific change? Why does the scenario analysis force this change?
4. **Contingent risk management**: For any technology that proved non-robust but required to invest, what mitigation strategy would you implement?
5. **Monitoring the future environment**: We cannot predict the future. For each of the four scenarios, identify one specific leading indicator (a "signpost") that would signal that the future scenario is starting to unfold.

Conclusion

Global trade has historically relied on a shared sense of stability built on open markets and multilateral cooperation. Today, that foundation is shifting. As geopolitical fragmentation deepens and economies reorganize, global trade faces a defining inflection point: to connect or to fragment.

Achieving connection requires both a human and technological approach. Within the layers of the trade stack, leaders must identify strategies and technologies that specifically elevate the efficiency of their work. On the other hand, across layers, actors must work together to establish policies that enhance the ability of technology to connect and support the entire trade stack.

Strategies to enhance connection within layers

Enterprises can:

- Manage risk and compliance through AI-powered multi-tier supplier visibility and product-level traceability
- Anticipate and react to disruptions through digital twins and distributed ledger solutions
- Expand access to global markets, particularly for SMEs, through agentic AI and trade finance innovations

Enablers can:

- Further develop tech-focused solutions for enterprises, enablers and national governments
- Digitalize operations and connect them to those of other enablers, creating synergies
- Expand visibility across processes to keep enterprises and national governments in the loop

National governments can:

- Adopt and enact the Model Law on Electronic Transferable Records (MLETR) to legally recognize electronic trade documents
- Facilitate investment in critical physical and digital infrastructure for tradetech
- Connect with other national governments to align digital trade rules and develop tech capacities, including through FIT-P and CEPAs

Alongside investments in tech within each layer, investments in human capability and ethical design are essential for actors within every layer to adopt and improve these solutions properly, strengthening the connecting fabric.

Strategies to enhance connection across layers

Strengthening the entire tradetech stack, however, requires active, focused collaboration across layers, including:

- Co-designing enabling regulations through structured government-enabler-enterprise consultations
- Co-developing shared digital infrastructure to deliver multi-layer interoperability and trust
- Assessing ecosystem gaps by convening all layers to map policy, infrastructure and tech needs
- Sharing best practices in digital payments to reduce friction
- Helping digitize humanitarian logistics by convening enterprises, enablers, governments and non-governmental organizations (NGOs)
- Including enterprises and enablers in regional digital trade negotiations to ensure provisions are appropriate and adoptable
- Empowering cross-layer processes to embed ethics into the development of technology
- Convening all actors in all layers in an annual forum to discuss the way forward for the successful implementation of technology across trade processes

Strengthening processes and jointly building the technological connecting fabric of the trade stack, creates a shared backbone for trade, and takes the world one step closer to advancing connection despite fragmentation.

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