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Recent Technological Advances in ASEAN+3 Financial Market Infrastructure

Financial markets in East and Southeast Asia have become increasingly sophisticated and interlinked over the last two decades. How must they evolve further in the digital age?

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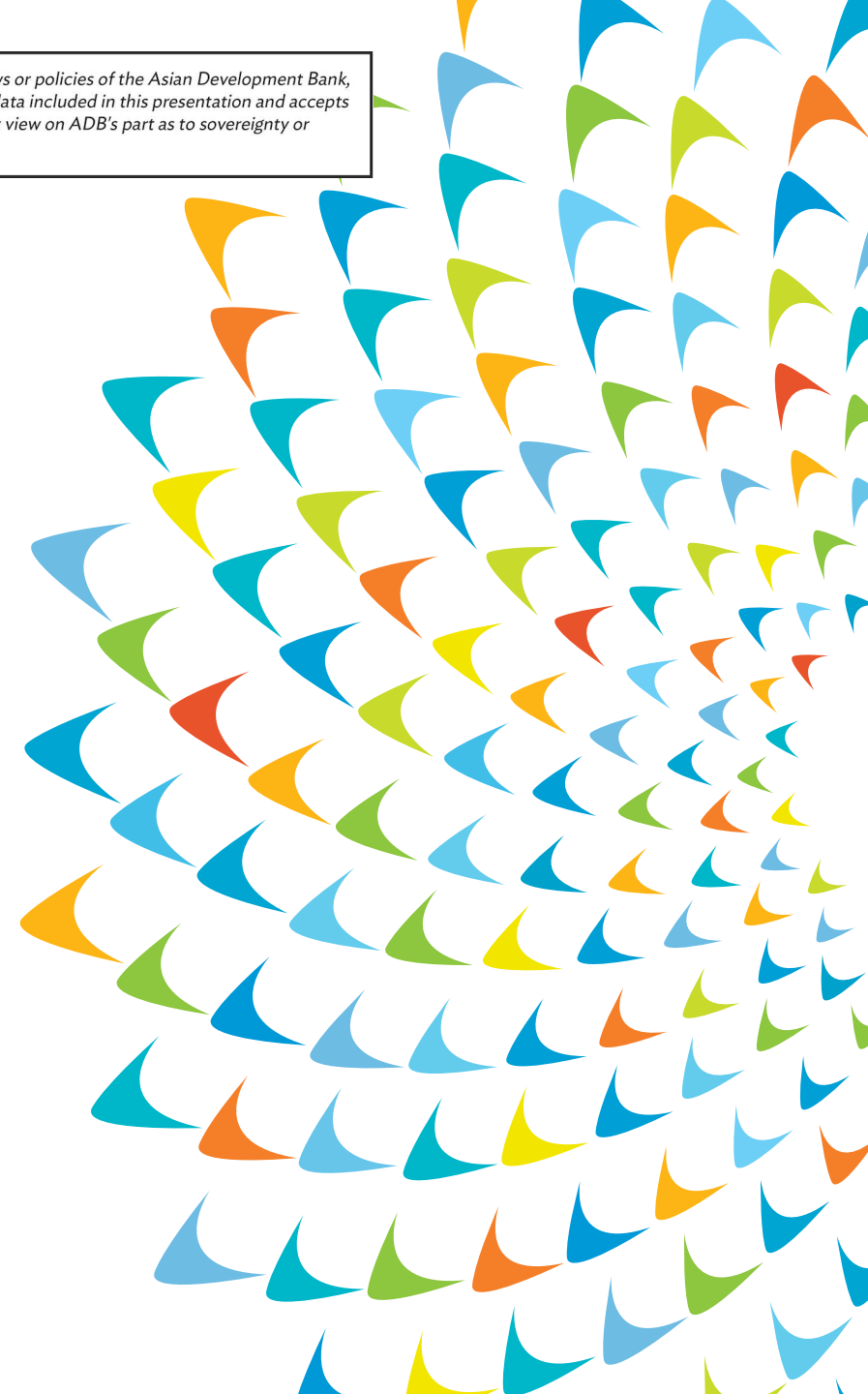**Bénédicte Nolens**
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SESSION 1
Recent Technological Advances in ASEAN+3 Financial Market Infrastructure

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Background Material

https://www.adb.org/sites/default/files/publication/801626/technological-advances-financial-market-infrastructure-asean3.pdf

Agenda

1. **Six Key new techs for FMI**

   - Selection methodology
   - Distributed ledger (blockchain) technology
   - Artificial intelligence (AI)
   - Big data analytics
   - Cloud computing
   - Cybersecurity
   - (Open) application programming interface (API)

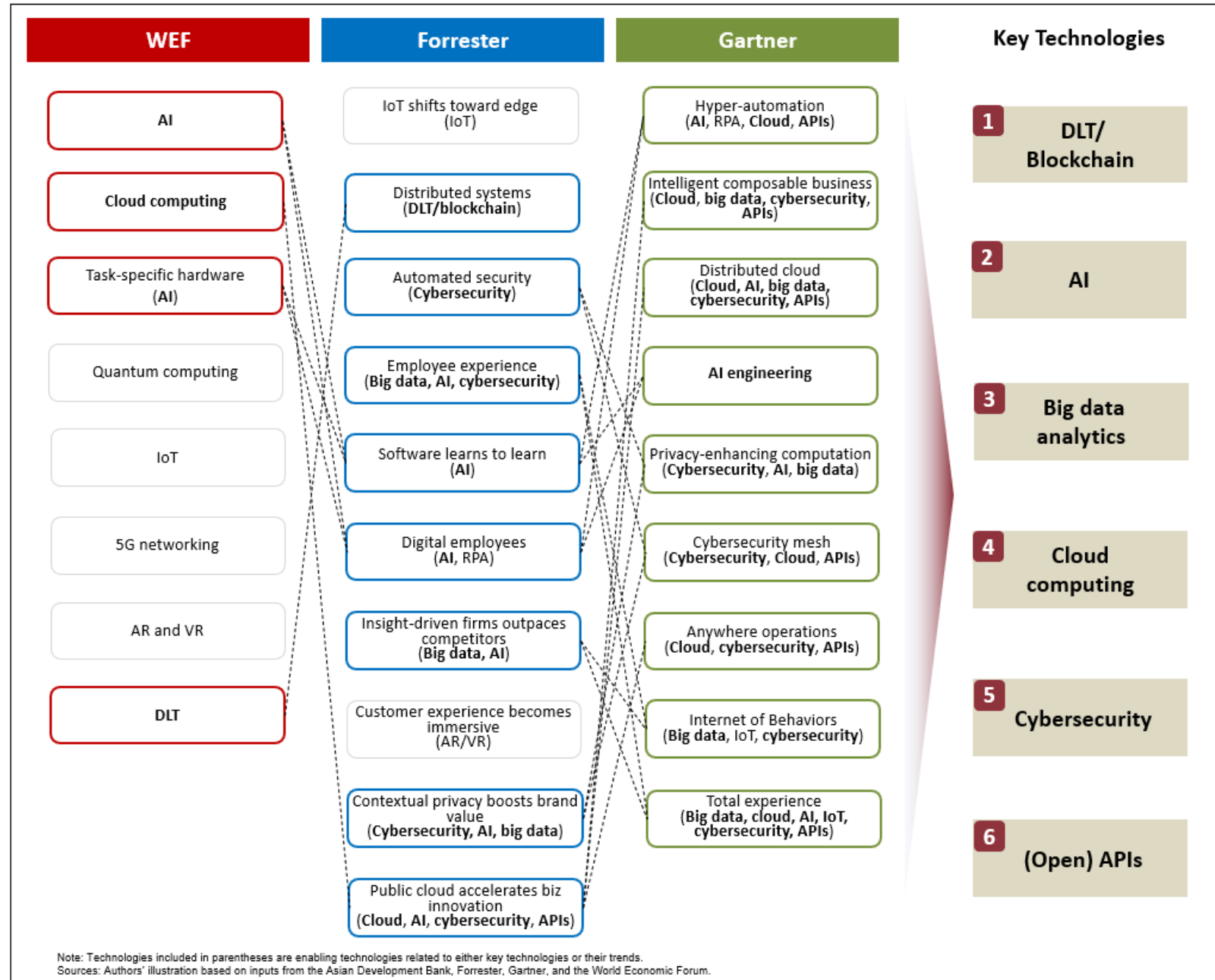2. **New techs in ASEAN+3 FMI**

   - DLT in ASEAN+3 FMI
   - AI in ASEAN+3 FMI
   - Big data analytics in ASEAN+3 FMI
   - Cloud computing in ASEAN+3 FMI
   - Cybersecurity in ASEAN+3 FMI
   - (Open) API in ASEAN+3 FMI

3. **New techs to RSI model under CSIF**

1. Six New Key Techs for FMI

Selection Methodology

WEF	Forrester	Gartner	Key Technologies
AI	IoT shifts toward edge (IoT)	Hyper-automation (AI, RPA, Cloud, APIs)	1 DLT/ Blockchain
Cloud computing	Distributed systems (DLT/blockchain)	Intelligent composable business (Cloud, big data, cybersecurity, APIs)	2 AI
Task-specific hardware (AI)	Automated security (Cybersecurity)	Distributed cloud (Cloud, AI, big data, cybersecurity, APIs)	3 Big data analytics
Quantum computing	Employee experience (Big data, AI, cybersecurity)	AI engineering	
IoT	Software learns to learn (AI)	Privacy-enhancing computation (Cybersecurity, AI, big data)	4 Cloud computing
5G networking	Digital employees (AI, RPA)	Cybersecurity mesh (Cybersecurity, Cloud, APIs)	
AR and VR	Insight-driven firms outpaces competitors (Big data, AI)	Anywhere operations (Cloud, cybersecurity, APIs)	5 Cybersecurity
DLT	Customer experience becomes immersive (AR/VR)	Internet of Behaviors (Big data, IoT, cybersecurity)	
	Contextual privacy boosts brand value (Cybersecurity, AI, big data)	Total experience (Big data, cloud, AI, IoT, cybersecurity, APIs)	6 (Open) APIs
	Public cloud accelerates biz innovation (Cloud, AI, cybersecurity, APIs)		

Note: Technologies included in parentheses are enabling technologies related to either key technologies or their trends.
Sources: Authors' illustration based on inputs from the Asian Development Bank, Forrester, Gartner, and the World Economic Forum.
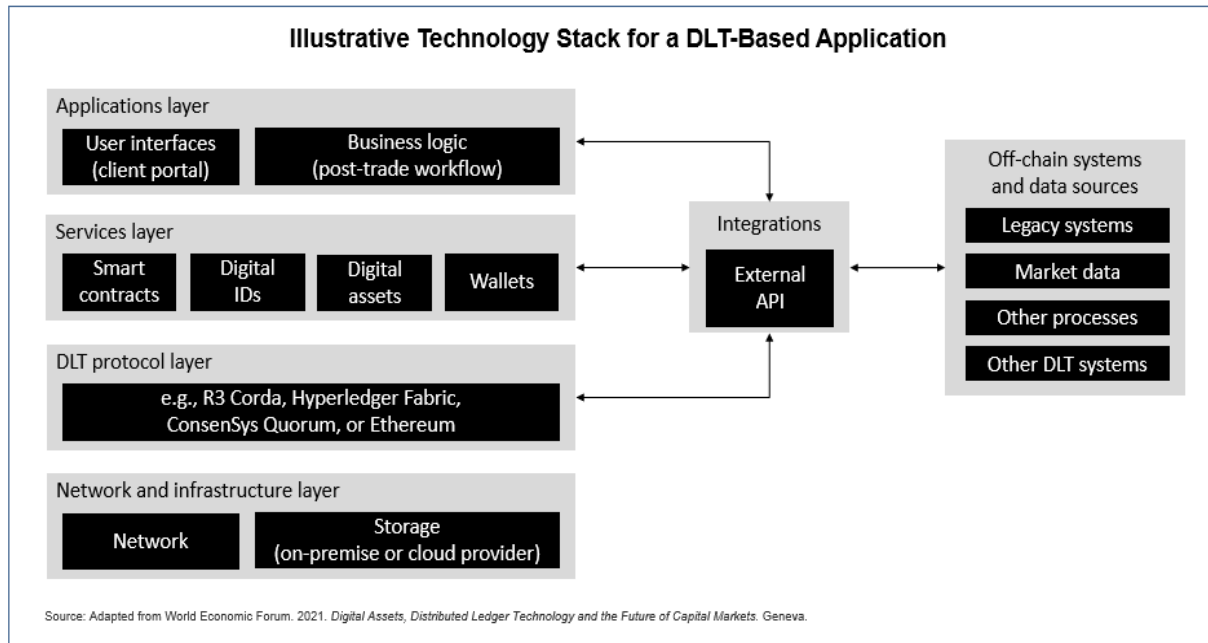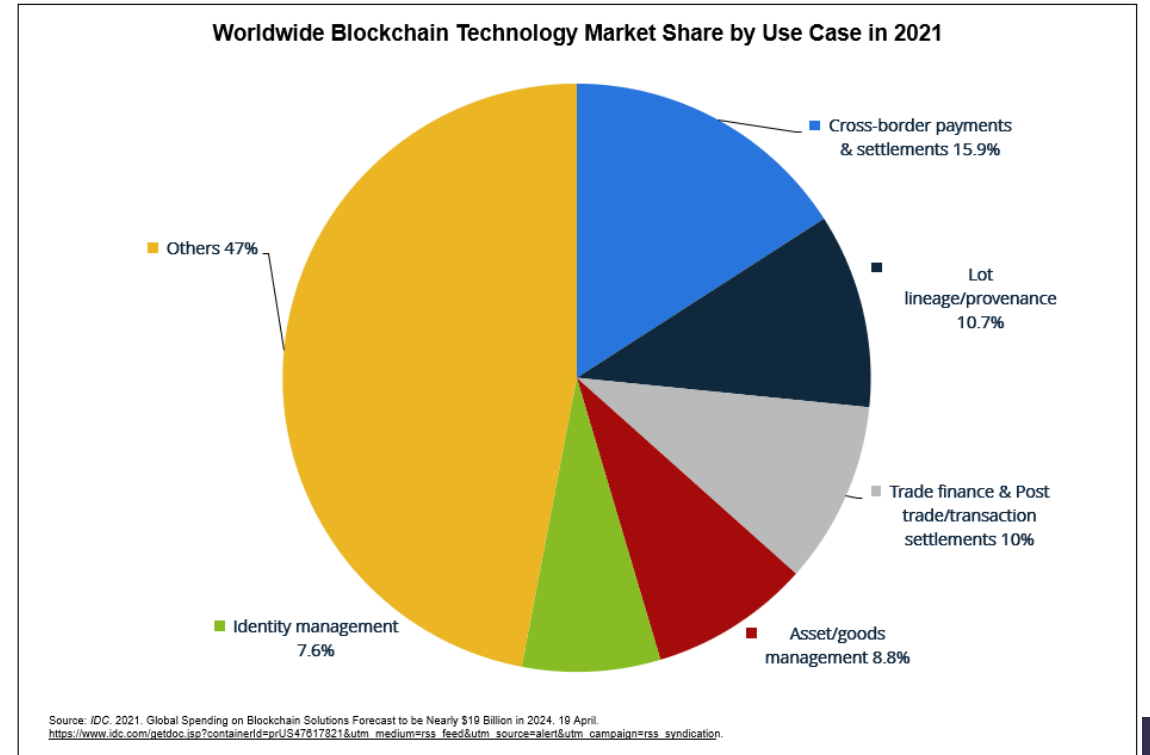
1. Six New Techs for FMI: DLT/Blockchain

Basic concept: shared among participants, not centrally managed, unable to be reversed or changed, and validated by consensus.

Types: public permissionless, public permissioned, permissioned (consortium), and private permissioned (enterprise).
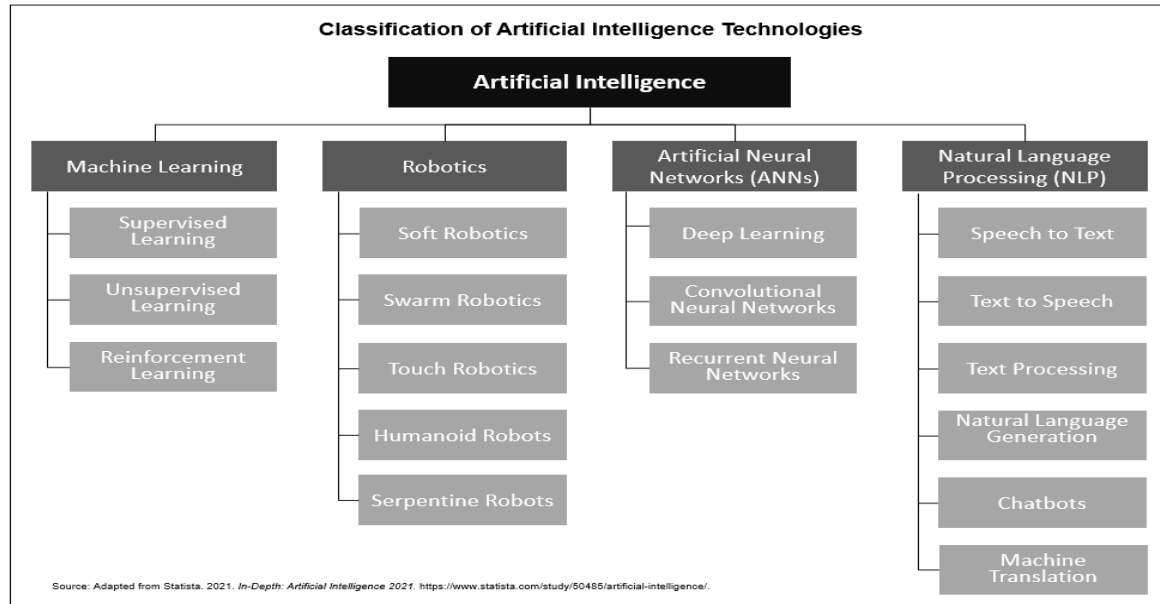
DLT for payment and securities settlement systems: shared source of truth minimizes manual reconciliations and verifications, smart contracts automate processes, and asset tokenization improves asset liquidity.
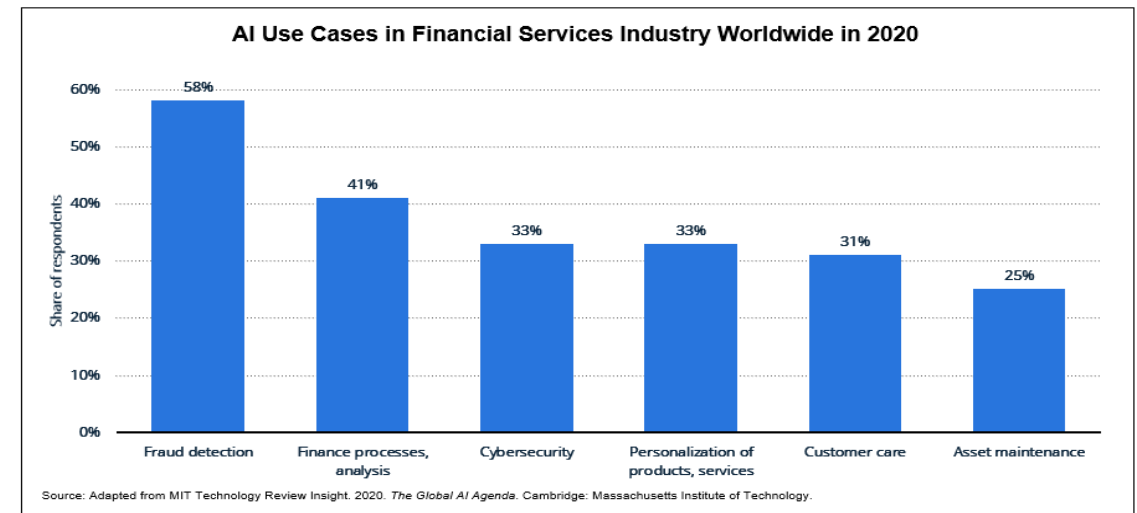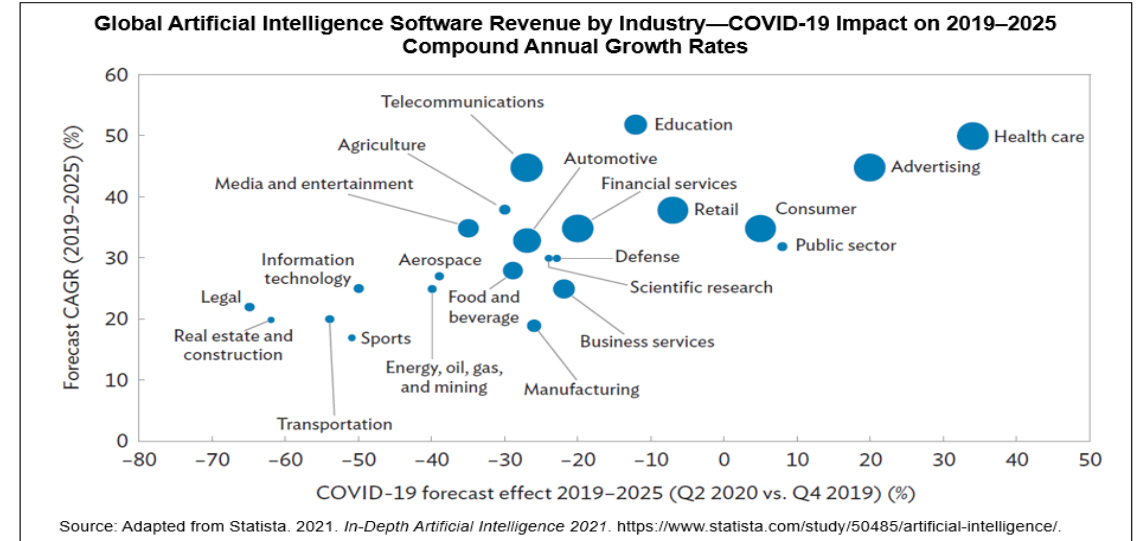

Illustrative Technology Stack for a DLT-Based Application

Applications layer
- User interfaces (client portal)
- Business logic (post-trade workflow)

Services layer
- Smart contracts
- Digital IDs
- Digital assets
- Wallets

DLT protocol layer
- e.g., R3 Corda, Hyperledger Fabric, ConsenSys Quorum, or Ethereum

Network and infrastructure layer
- Network
- Storage (on-premise or cloud provider)

Integrations
- External API

Off-chain systems and data sources
- Legacy systems
- Market data
- Other processes
- Other DLT systems

Source: Adapted from World Economic Forum. 2021. *Digital Assets, Distributed Ledger Technology and the Future of Capital Markets.* Geneva.

Worldwide Blockchain Technology Market Share by Use Case in 2021

- Cross-border payments & settlements 15.9%
- Lot lineage/provenance 10.7%
- Trade finance & Post trade/transaction settlements 10%
- Asset/goods management 8.8%
- Identity management 7.6%
- Others 47%

Source: *IDC*. 2021. Global Spending on Blockchain Solutions Forecast to be Nearly $19 Billion in 2024. 19 April. https://www.idc.com/getdoc.jsp?containerId=prUS47617821&utm_medium=rss_feed&utm_source=alert&utm_campaign=rss_syndication.

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1. Six New Techs for FMI: Artificial Intelligence (AI)

Basic concept: technologies inspired by how humans think and make decisions but operate in a different way than humans.

Classification of Artificial Intelligence Technologies

Source: Adapted from Statista. 2021. *In-Depth: Artificial Intelligence 2021.* https://www.statista.com/study/50485/artificial-intelligence/.

AI evolution and applications: AI-driven process automation has the potential to disrupt every industry and virtually every aspect of human life.

Global Artificial Intelligence Software Revenue by Industry—COVID-19 Impact on 2019–2025 Compound Annual Growth Rates

Source: Adapted from Statista. 2021. *In-Depth Artificial Intelligence 2021.* https://www.statista.com/study/50485/artificial-intelligence/.

AI Use Cases in Financial Services Industry Worldwide in 2020

Source: Adapted from MIT Technology Review Insight. 2020. *The Global AI Agenda.* Cambridge: Massachusetts Institute of Technology.
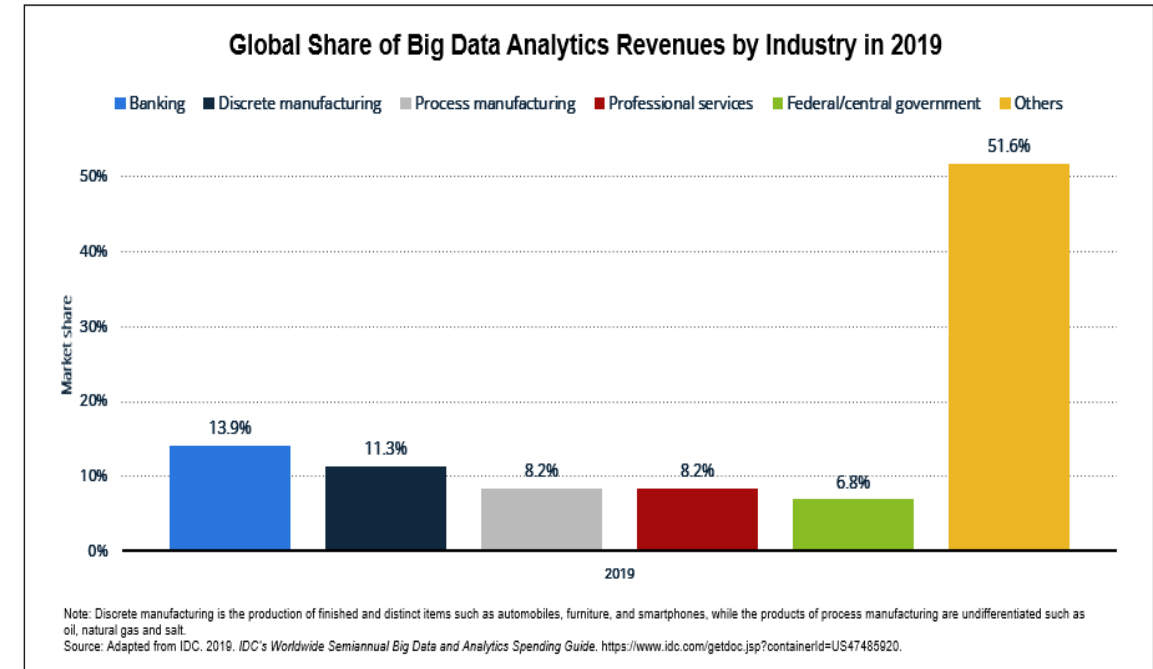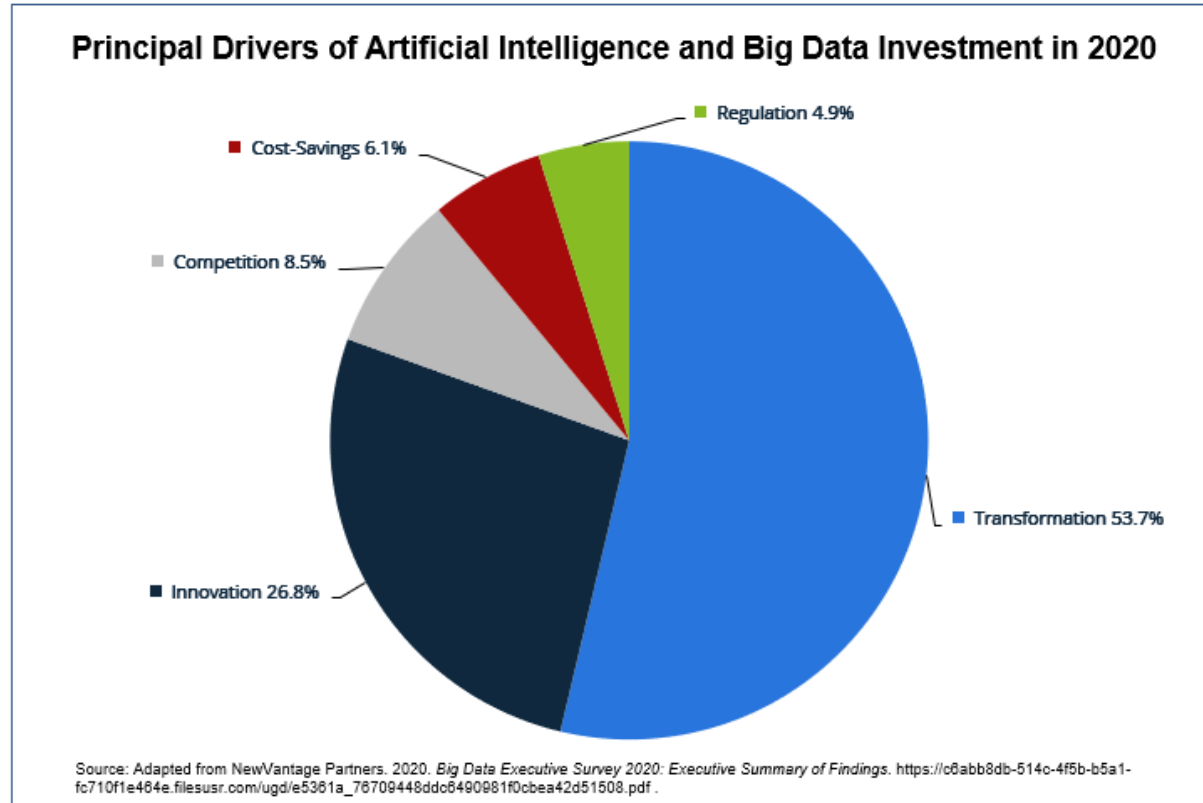
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1. Six New Techs for FMI: Big Data Analytics

Basic concept: the process of identifying trends, and correlations in massive amounts of raw data to aid in making decisions.

Use cases: health care, communications service, finance, and businesses in general (sales and marketing, new products, risk management, cybersecurity, and biz forecasting and management support).
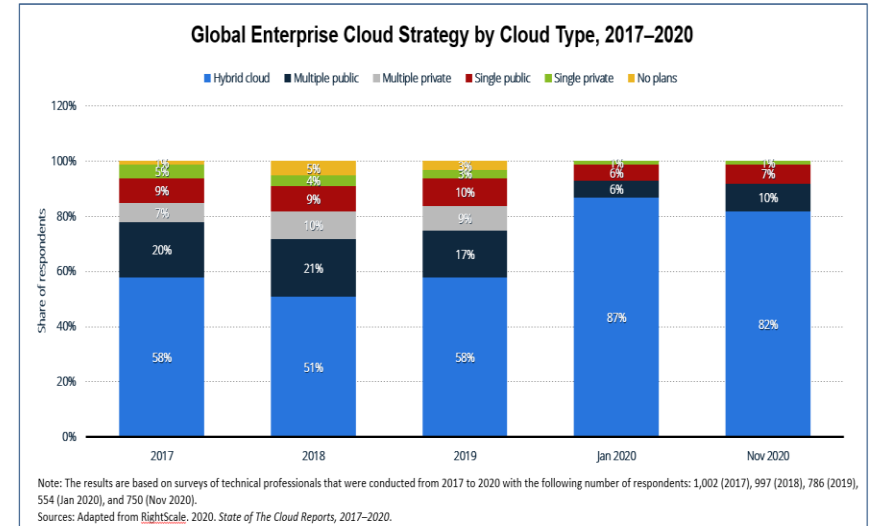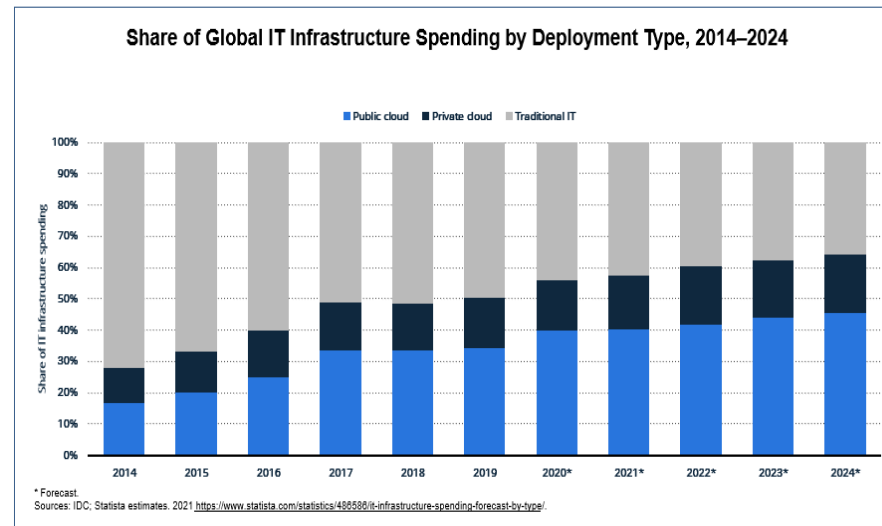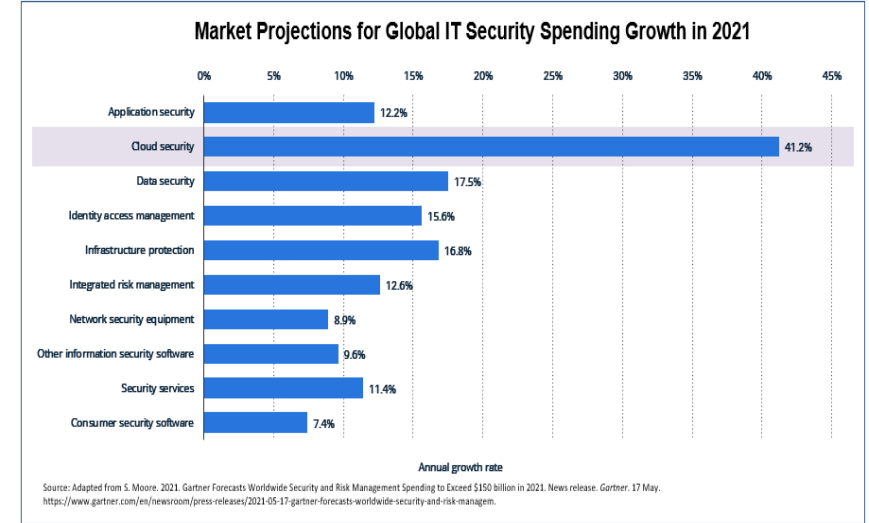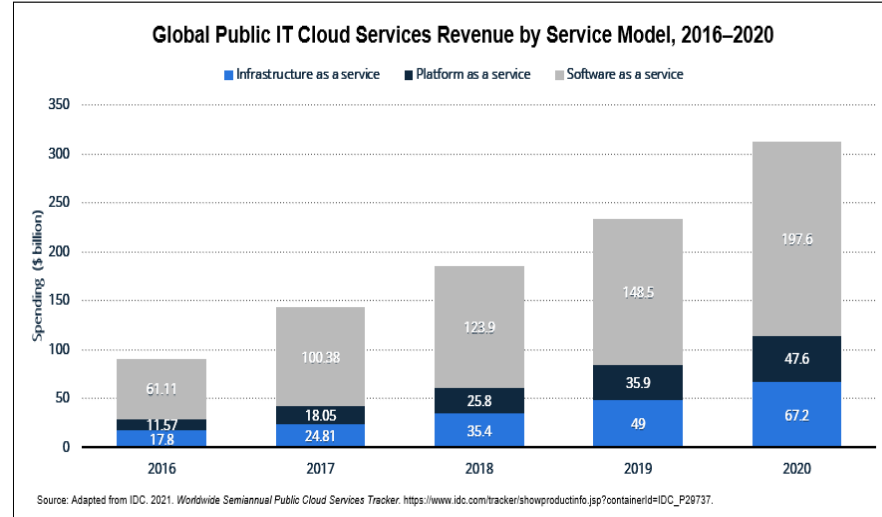

Principal Drivers of Artificial Intelligence and Big Data Investment in 2020

- Regulation 4.9%
- Cost-Savings 6.1%
- Competition 8.5%
- Innovation 26.8%
- Transformation 53.7%

Source: Adapted from NewVantage Partners. 2020. *Big Data Executive Survey 2020: Executive Summary of Findings.* https://c6abb8db-514c-4f5b-b5a1-fc710f1e464e.filesusr.com/ugd/e5361a_76709448ddc6490981f0cbea42d51508.pdf .

Global Share of Big Data Analytics Revenues by Industry in 2019

■ Banking ■ Discrete manufacturing ■ Process manufacturing ■ Professional services ■ Federal/central government ■ Others

- 13.9%
- 11.3%
- 8.2%
- 8.2%
- 6.8%
- 51.6%

Note: Discrete manufacturing is the production of finished and distinct items such as automobiles, furniture, and smartphones, while the products of process manufacturing are undifferentiated such as oil, natural gas and salt.
Source: Adapted from IDC. 2019. *IDC's Worldwide Semiannual Big Data and Analytics Spending Guide.* https://www.idc.com/getdoc.jsp?containerId=US47485920.

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1. Six New Techs for FMI: Cloud Computing

Basic concept: a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of computing resources such as networks, services, storage, and applications.

Service models:
Infrastructure as a Service (IAAS)
Platform as a Service (PAAS)
Software as a Service (SAAS).

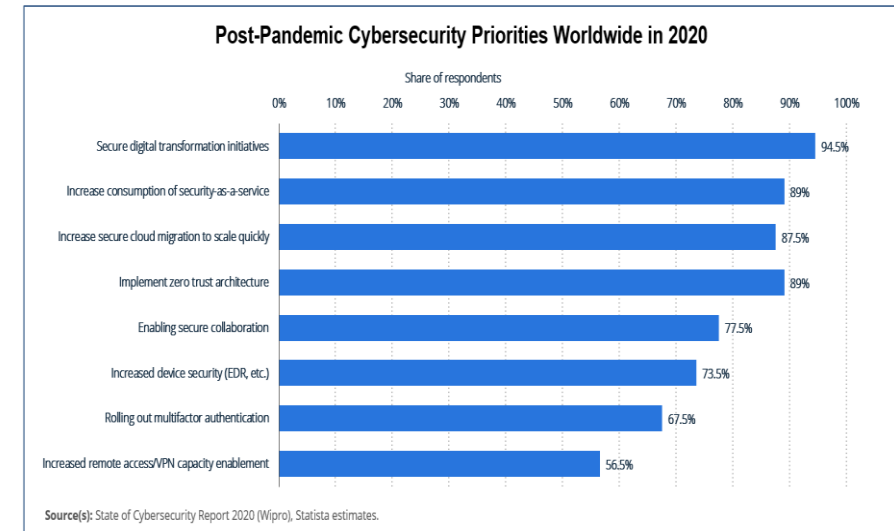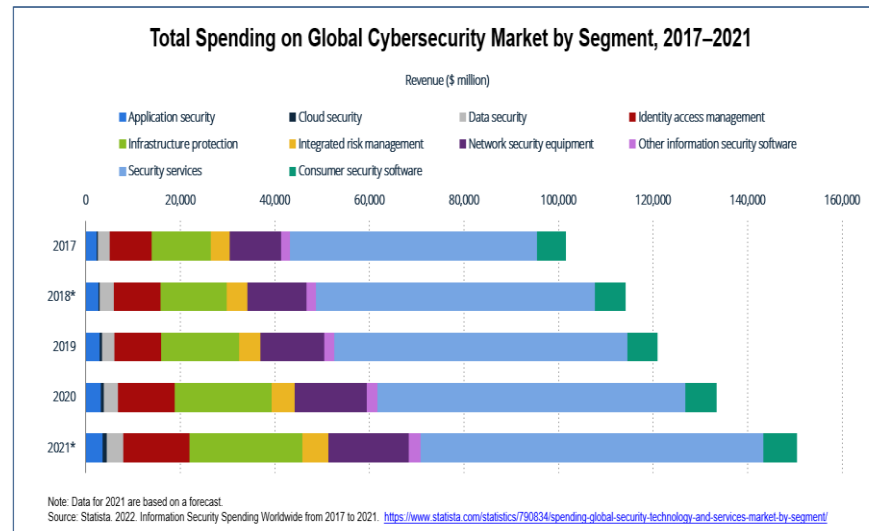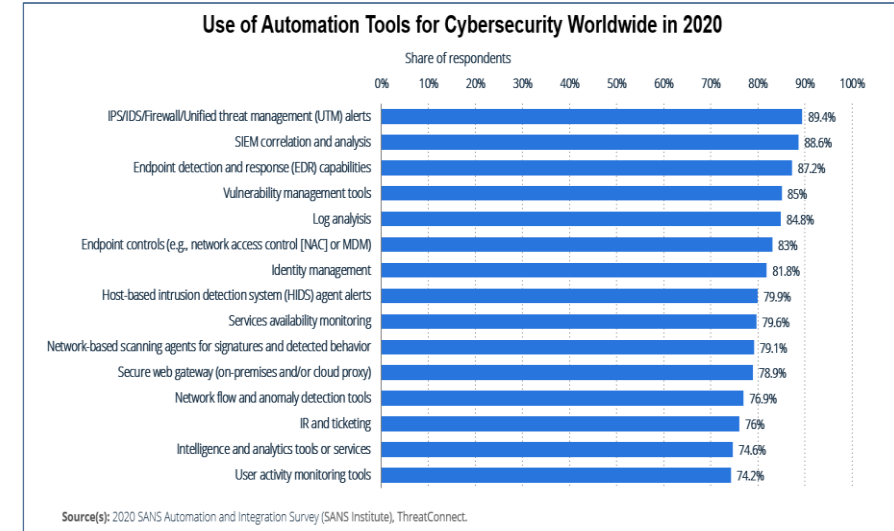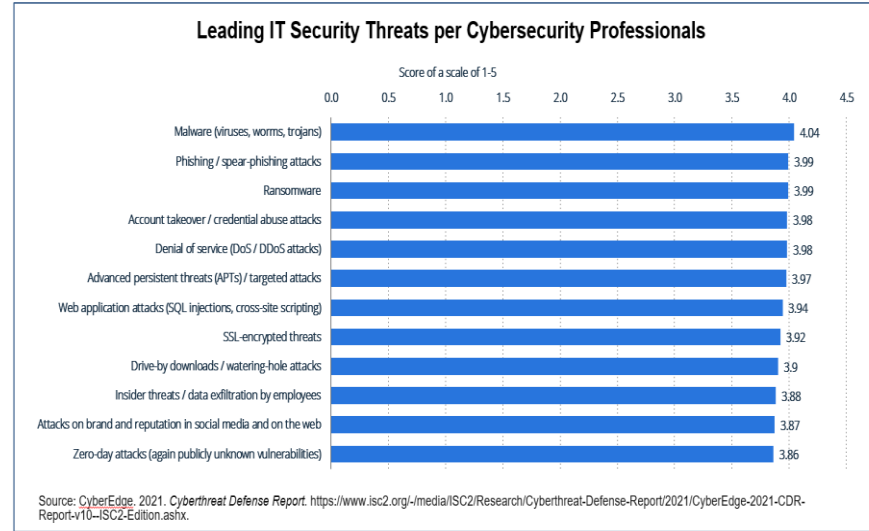**Deployment models**: public, private, community, and hybrid cloud.

Global Public IT Cloud Services Revenue by Service Model, 2016–2020

Source: Adapted from IDC. 2021. *Worldwide Semiannual Public Cloud Services Tracker.* https://www.idc.com/tracker/showproductinfo.jsp?containerId=IDC_P29737.

Market Projections for Global IT Security Spending Growth in 2021

Source: Adapted from S. Moore. 2021. Gartner Forecasts Worldwide Security and Risk Management Spending to Exceed $150 billion in 2021. News release. *Gartner.* 17 May. https://www.gartner.com/en/newsroom/press-releases/2021-05-17-gartner-forecasts-worldwide-security-and-risk-managem.

Share of Global IT Infrastructure Spending by Deployment Type, 2014–2024

* Forecast.
Sources: IDC; Statista estimates. 2021 https://www.statista.com/statistics/486586/it-infrastructure-spending-forecast-by-type/.

Global Enterprise Cloud Strategy by Cloud Type, 2017–2020

Note: The results are based on surveys of technical professionals that were conducted from 2017 to 2020 with the following number of respondents: 1,002 (2017), 997 (2018), 786 (2019), 554 (Jan 2020), and 750 (Nov 2020).
Sources: Adapted from RightScale. 2020. *State of The Cloud Reports, 2017–2020.*

Basic concept: the discipline of defending key systems and sensitive data against digital intrusions.

Threats: malware, social engineering, APTs, (D)DoS attacks, man-in-the-middle attacks, SSL and TLS encrypted threats, zero-day attacks, insider threats, etc.

Segment: network, application, data, cloud, operation, infra and database, BCP, end-user education.

Practices and techs: IAM, behavioral monitoring, MDM, endpoint detection and response, FIM, IDS / IPS, unified threat management, SIEM, sandboxing.

Leading IT Security Threats per Cybersecurity Professionals

Score of a scale of 1-5

Threat	Score
Malware (viruses, worms, trojans)	4.04
Phishing / spear-phishing attacks	3.99
Ransomware	3.99
Account takeover / credential abuse attacks	3.98
Denial of service (DoS / DDoS attacks)	3.98
Advanced persistent threats (APTs) / targeted attacks	3.97
Web application attacks (SQL injections, cross-site scripting)	3.94
SSL-encrypted threats	3.92
Drive-by downloads / watering-hole attacks	3.9
Insider threats / data exfiltration by employees	3.88
Attacks on brand and reputation in social media and on the web	3.87
Zero-day attacks (again publicly unknown vulnerabilities)	3.86

Source: CyberEdge. 2021. *Cyberthreat Defense Report.* https://www.isc2.org/-/media/ISC2/Research/Cyberthreat-Defense-Report/2021/CyberEdge-2021-CDR-Report-v10--ISC2-Edition.ashx.

Use of Automation Tools for Cybersecurity Worldwide in 2020

Share of respondents

Tool	Share
IPS/IDS/Firewall/Unified threat management (UTM) alerts	89.4%
SIEM correlation and analysis	88.6%
Endpoint detection and response (EDR) capabilities	87.2%
Vulnerability management tools	85%
Log analysis	84.8%
Endpoint controls (e.g., network access control [NAC] or MDM)	83%
Identity management	81.8%
Host-based intrusion detection system (HIDS) agent alerts	79.9%
Services availability monitoring	79.6%
Network-based scanning agents for signatures and detected behavior	79.1%
Secure web gateway (on-premises and/or cloud proxy)	78.9%
Network flow and anomaly detection tools	76.9%
IR and ticketing	76%
Intelligence and analytics tools or services	74.6%
User activity monitoring tools	74.2%

Source(s): 2020 SANS Automation and Integration Survey (SANS Institute), ThreatConnect.

Total Spending on Global Cybersecurity Market by Segment, 2017–2021

Revenue ($ million)

Legend: Application security, Cloud security, Data security, Identity access management, Infrastructure protection, Integrated risk management, Network security equipment, Other information security software, Security services, Consumer security software

Years: 2017, 2018*, 2019, 2020, 2021*

Note: Data for 2021 are based on a forecast.
Source: Statista. 2022. Information Security Spending Worldwide from 2017 to 2021. https://www.statista.com/statistics/790834/spending-global-security-technology-and-services-market-by-segment/

Post-Pandemic Cybersecurity Priorities Worldwide in 2020

Share of respondents

Priority	Share
Secure digital transformation initiatives	94.5%
Increase consumption of security-as-a-service	89%
Increase secure cloud migration to scale quickly	87.5%
Implement zero trust architecture	89%
Enabling secure collaboration	77.5%
Increased device security (EDR, etc.)	73.5%
Rolling out multifactor authentication	67.5%
Increased remote access/VPN capacity enablement	56.5%

Source(s): State of Cybersecurity Report 2020 (Wipro), Statista estimates.

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1. Six New Techs for FMI: (Open) API

Basic concept: a collection of instructions that define how one application communicates and interacts with another. It can be tailored to a specific pair of systems or can be a shared standard that enables interoperability across multiple systems.

Types: public or open APIs, private or internal APIs, partner APIs, and composite APIs.

Architectures and protocols: needed to standardize data exchange between applications and seamlessly communicate with each other.

The most common types of API protocols include i) representational state transfer (REST), ii) remote procedural call (RPC), and iii) simple object access protocol (SOAP).

API-powered digital transformation: APIs facilitate businesses' symbioses by enabling developers to quickly access and integrate digital resources stored in disparate infrastructures.

Notable application cases include i) increased SAAS use and hybrid cloud adoption, ii) microservice architectures and DevOps, iii) Service systems in finance sector such as open banking, open finance, or embedded finance (Banking as a Service, BAAS), and iv) AI-powered API security.

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2. New Techs in ASEAN+3 FMI: Overview (1)

- Based on a 2021 CSIF member (12 CSDs and 13 central banks in ASEAN+3) survey

- 20 out of 25 members (80%, 8 CSDs and 12 central banks) responded to the survey

FMIs in ASEAN+3 Engaging with New Technologies by Number

No. of tech(s) applied among the six selected new techs

■ CBs ■ CSDs ■ Total

Note: 20 out of 25 CSIF member institutions responded to the survey.
Source: ABMI 2021 CSIF member survey.

FMIs in ASEAN+3 Engaging with New Technologies by Technology

■ CBs ■ CSDs ■ Total

Source: ABMI 2021 CSIF member survey.
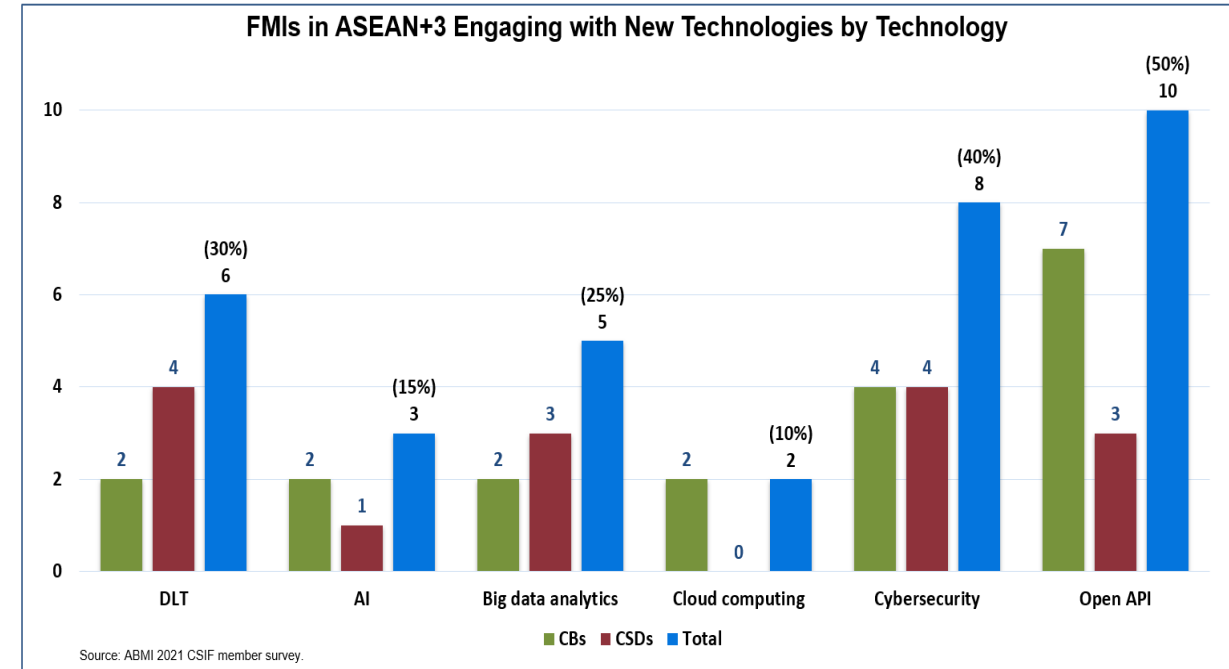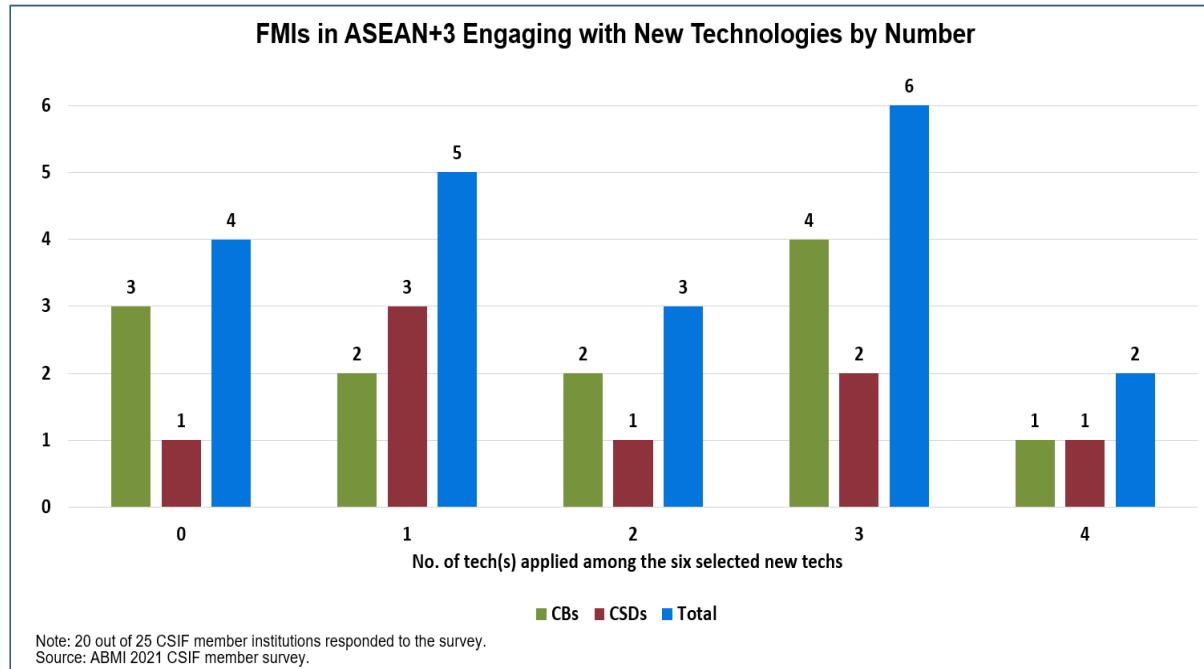
2. New Techs in ASEAN+3 FMI: Overview (2)

FMI Systems with New Technologies by Technology
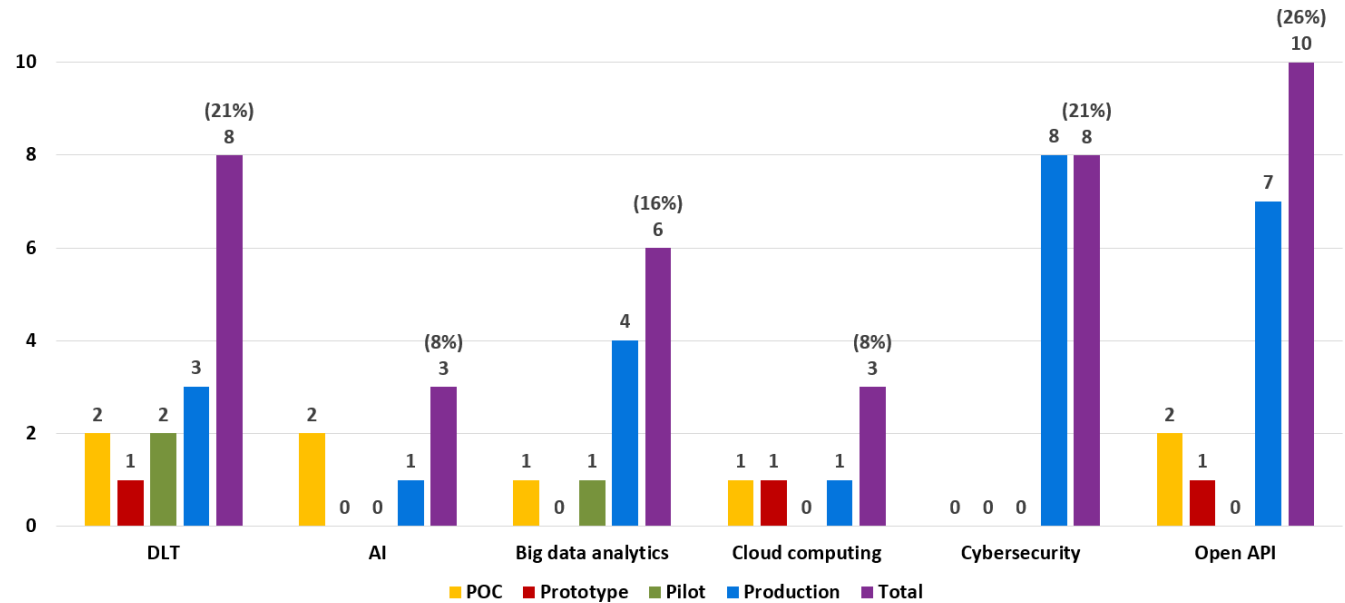
Source: ABMI 2021 CSIF member survey.

FMI Systems with New Technologies by Application Level

Source: ABMI 2021 CSIF member survey.

New Technology Application Cases of CSIF Members by Technology by Application Level

BI = Bank Indonesia, BNM = Bank Negara Malaysia, BOK = Bank of Korea, BOT = Bank of Thailand, BSP = Bangko Sentral ng Pilipinas, BTr = Bureau of Treasury, HKMA = Hong Kong Monetary Authority, KSEI = PT Kustodian Sentral Efek Indonesia, MAS = Monetary Authority of Singapore, KSD = Korea Securities Depository, SBV = State Bank of Vietnam, SET = Stock Exchange of Thailand, SGX = Singapore Exchange, SHCH = Shanghai Clearing House, TSD = Thailand Securities Depository, and VSD = Vietnam Securities Depository.

Legend: ● central bank; and ● central securities depository (CSD).

Source: ABMI 2021 CSIF member survey.

	Institution	System	App. Level	Period	Description
CB	HKMA	eTradeConnect	Pilot	• Started in 2017 • A pilot system launched in Oct 2018	• A blockchain-based trade finance platform developed by a consortium of 12 major banks in Hong Kong, China with the facilitation of HKMA. • The system aims to digitize paper-based documents automate the trade finance process to reduce errors and risks of fraud.
		CBDC projects	Prototype	• 2017 • 2019 • Started in 2021	• Project LionRock (HKMA) • Project Inthanon-LionRock (HKMA and BOT) • mCBDC project (HKMA, BOT, DCI of PBOC, CBUAE, and BIS IH)
		Commercial Data Interchange (CDI)	POC	• POC phase 1: 2020 • POC phase 2: 2021 • Production to be launched in 2023	• CDI is a consent-based financial infrastructure enabling more secure and efficient data flow between banks and commercial firms, particularly SMEs, to solve long-standing pain points in SME financing. • CDI allows SMEs to use their own trade-related and other commercial data to facilitate trade finance application process (POC phase 1) and alternative credit scoring conducted by banks (POC phase 2).
	NBC	Bakong payment system (Project Bakong)	Production	• Started in 2016 • Launched in Oct 2020	• A blockchain-based national retail payment system • Prefunded for settlement (a synthetic CBDC) • Built on Hyperledger Iroha, an open source blockchain framework implementation under Hyperledger Projects • Total of 1.7M transactions from July 2019 to June 2021 (USD0.42 billion + KHR443.8 billion)

	Institution	System	App. Level	Period	Description
CSD	BTr	Bonds.PH (Mobile application)	Pilot	• A pilot system launched in Jul 2020	• A DLT-based retail primary offering facility of government bonds, which allows investors to place subscriptions in retail bonds during the primary offering • Partnering with UnionBank, a government securities eligible dealer, and Philippine Digital Asset Exchange
	KSD	Crowdfunding platform	POC	• Q1–Q3 2021	• DLT-based security token offering a platform for crowdfunding[a, b] • POC successfully completed at the end of September 2021
	TSD (SET)	Scripless govt. bond issuance system ("DLT Scripless Bond Project")	Production	• POC: Q1–Q3 2018 • Production: Started in Q4 2018 and launched in Jun 2020	• A DLT-based retail scripless government savings bond issuance system • Built with Hyperledger Fabric, another open source blockchain framework under Hyperledger Projects • As of May 2021, seven government bonds had been issued through the system.
	SGX	"Marketnode" Issuer platform	Production	• Pilot: Completed in Aug 2020 • Production: launched in Jan 2021	• A DLT-based fixed-income digital asset issuance platform • Focusing on automation of end-to-end issuance, deposit, and post-trade asset servicing with smart contracts • Developed via a joint venture between SGX and Temasek

2. New Techs in ASEAN+3 FMI: AI

	Institution	System	App. Level	Period	Description
CB	BSP	Blockchain Analyzer for Virtual Asset Service Providers	POC	• 2022–	• AI-enabled solutions, which apply data analytics to uncover insights on various transactional behaviors such as activities related to money laundering, terrorist financing, fraud, and other financial crimes using blockchain data from virtual asset service providers and other cryptocurrency domains
	SBV	Data analytics platform for IBPS and websites	POC	• Jul–Oct 2020 • Testing for production: Ongoing since Jul 2021	• Cloud based, AI-powered data analytics platform for SBV IPBS's cybersecurity and DevOps, as well as SBV's websites • POC of AI and big data analytics
CSD	TSD (SET)	Registrar Advisory Bot	Production	• 2020– launched in Feb 2021	• Chatbot registrar services for listed companies appointed TSD as registrar

2. New Techs in ASEAN+3 FMI: Big Data Analytics

	Institution	System	App. Level	Period	Description
CB	BNM	Data analytics platform	Production	• 2021	• Use of data analytics on RENTAS (national RTGS) data to expand supervisory surveillance and obtain better data permutation to facilitate policy-making • Open-source based tools such as Grafana and Kibana for data visualization on technology resilience and languages such as R or Python
	SBV	Data analytics platform for IBPS and websites	POC	• Jul–Oct 2020 • Started testing for production in Jul 2021	• Cloud based, AI-powered data analytics platform for SBV IBPS's cybersecurity and DevOps, as well as SBV's websites • POC of AI and big data analytics
CSD	KSEI	Surveillance system	Production	• 2019	• Leveraging big data analytics to support internal surveillance process
		Big data-based management support system	Production	• 2021	• Started to utilize big data to support management decision-making via swift data provision and analysis
	SHCH	Data Statistics and Analysis Platform	Pilot		• Piloting to realize the unified data management and analysis • Planning to apply AI technology to tackle various business issues
	VSD	SIEM for IT operation management	Production	• Launched in Feb 2018	• To collect and analyze security logs automatically • Application case of both big data analytics to a cybersecurity technology solution

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2. New Techs in ASEAN+3 FMI: Cloud Computing

	Institution	System	App. Level	Period	Description
CB	BSP	Advanced Supervisory Technology Engine for Risk-Based Compliance (ASTERisC)	POC	• Started in 2022	• The system shall support BSP's end-to-end process on cybersecurity supervision and oversight from cyber-profiling, cyber incident reporting, cybersecurity control self-assessments as well as correlating with results of on-site supervision and inspection
	SBV	Electronic Government	Production		• Introduced public cloud services for e-Government applications
		Public Cloud	Prototype	• Scheduled to be completed by 2024	• To introduce cloud services for SBV's public services • Initially considered using private cloud but switched to public cloud • Currently testing and evaluating a public cloud provided by MIC for rollout under the SBV Web portal project 2024

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2. New Techs in ASEAN+3 FMI: Cybersecurity

	Institution	System	App. Level	Period	Description
CB	BNM	CSD and RTGS systems	Production	• SIEM: Launched in 2018 • PAM: Launched in 2018 • APT: Launched in 2018 • SOC: Extended to 24/7 in 2020 • Other initiatives have been deployed since 2018 continuously	• Adopted new technologies such as anti-APT, privileged access management and set up of 24/7 security operations center • Advancements in the cybersecurity domain are in line with recommendations from primary cybersecurity frameworks • Implementation details of techs cannot be shared due to sensitivity.
	BOK	BOK-Wire+ (RTGS)	Production	• SIEM developed: Sep–Dec 2018 • SIEM launched: Jan 2019 • SIEM upgraded: Jul–Sep 2020	• Implemented SIEM to analyze the big data collected from firewall, IPS, antivirus S/W logs to tackle cyberattack and abnormal activities on a real-time basis • Additionally adopted anti-APT solution to protect IT systems from the cyberattacks effectively
	MAS	MEPS+ (RTGS)	Production		• Adopted technology tools, following the guideline of Principles of Financial Market Infrastructures • Implementation details of techs cannot be shared due to sensitivity
	NBC	Bakong payment system ("Project Bakong")	Production	• Project Bakong launched in Oct 2020	• Follows the National Institute of Standards and Technology cybersecurity framework

	Institution	System	App. Level	Period	Description
CSD	BTr	National Registry of Scripless Securities (NRoSS)	Production	• NRoSS launched in Aug 2018	• Cybersecurity solutions applied as an important financial market infrastructure
	SHCH	All market systems	Production		• Cybersecurity solutions applied as an important financial market infrastructure
	TSD (SET)	CSD and Registrar systems	Production	• ISO 20000 and ISO 27001 certified: 2019 • ISO 27701 certified: 2020	• Complies international standards for IT security such as ISO 20000 (IT Service Management), ISO 27001 (Information Security Management) and ISO 27701 (Privacy Information Management)
	VSD	IT operation management	Production	• SIEM launched in Feb 2018	• Implemented SIEM to collect and analyze security logs automatically • Application case of both big data analytics to a cybersecurity technology solution

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Institution	System	App. Level	Period	Description
				• Open APIs are used to serve the public by allowing faster, more efficient, and secure access to data including information such as foreign currency exchange and money services reports. • BNM will explore future application of open API for RENTAS (national RTGS), in accordance with business requirements and needs.
BOK	Economic Statistic System	Production	• Developed since Apr 2013 • Launched in Dec 2013	• A system to disclose economic statistics data that the BOK generated and collected. • Implemented in 2013 to fulfill the Open Government Data Policy and facilitate effective use of the statistics for users utilizing open API.
BOT	BAHTNET API	Production	• Launched in Nov 2020	• Implemented to track the status of BAHTNET (BOT's RTGS system) transactions, enabling BAHTNET participants to notify their customers of fund deposit in a timely manner. • BOT will extend the use of open APIs to enable straight-through-processing in the BAHTNET system.
BSP	Real-time analytics dashboard and report engine [Run by BSP] Open finance platforms [Run by BSFIs]	POC	• Scheduled to be completed by Q4 2022	• To promote open finance among BSP-supervised financial institutions (BSFIs) and third-party providers, the BSP issued in June 2021 the Open Finance Framework, which covers technology, products, services, information, and policies for open finance. • Uses open APIs for banks (BSFIs) to exchange customer and product information and transactions, and for BSP to have real-time analytics and reporting

| Institution		System	App. Level	Period	Description
MAS		API payment gateway [Run by DFWG]	Production	• Launched in Nov 2020	• Developed by the Direct FAST Working Group (DFWG) as an alternative connectivity model for the participating financial institutions to FAST (Singapore's real-time retail payment system) and PayNow (an addressing service allowing participants of FAST to use their identifiers such as mobile numbers to make FAST transfers).
NBC		Bakong payment system ("Project Bakong")	Production	• Project Bakong launched in Oct 2020	• Uses open APIs to connect all payment service institutions (PSIs) with Bakong • Introduced public mobile application to eliminate the need for banks and PSIs to develop their own while allowing those with an existing mobile application to integrate via open API easily
CSD	SHCH	Open Platform for Data Interface	Prototype		
	TSD (SET)	CSD systems	Production	• Developed since 2012 • Launched in 2014	• Uses a FIX API to exchange data with TSD participants
	VSD	Corporate action information auto collection system	POC	• Under development since Feb 2021	• VSD participants automatically collects and processes corporate action information on the VSD website • Uses Restful Web API

3. New Techs to RSI Model under CSIF

- All six technologies can also be deployed to the CSD-RTGS linkages model, an RSI model in ASEAN+3.

- In the short term, DLT combined with open APIs, cloud computing, latest cybersecurity techs.

- In the long term, AI and big data analytics can also be implemented as needed.

- As a first step in exploring new technologies for the RSI model, the CSIF Secretariat at ADB is engaged in an experimental POC project redesigning the current CSD-RTGS linkages model using DLT.

Thank you.

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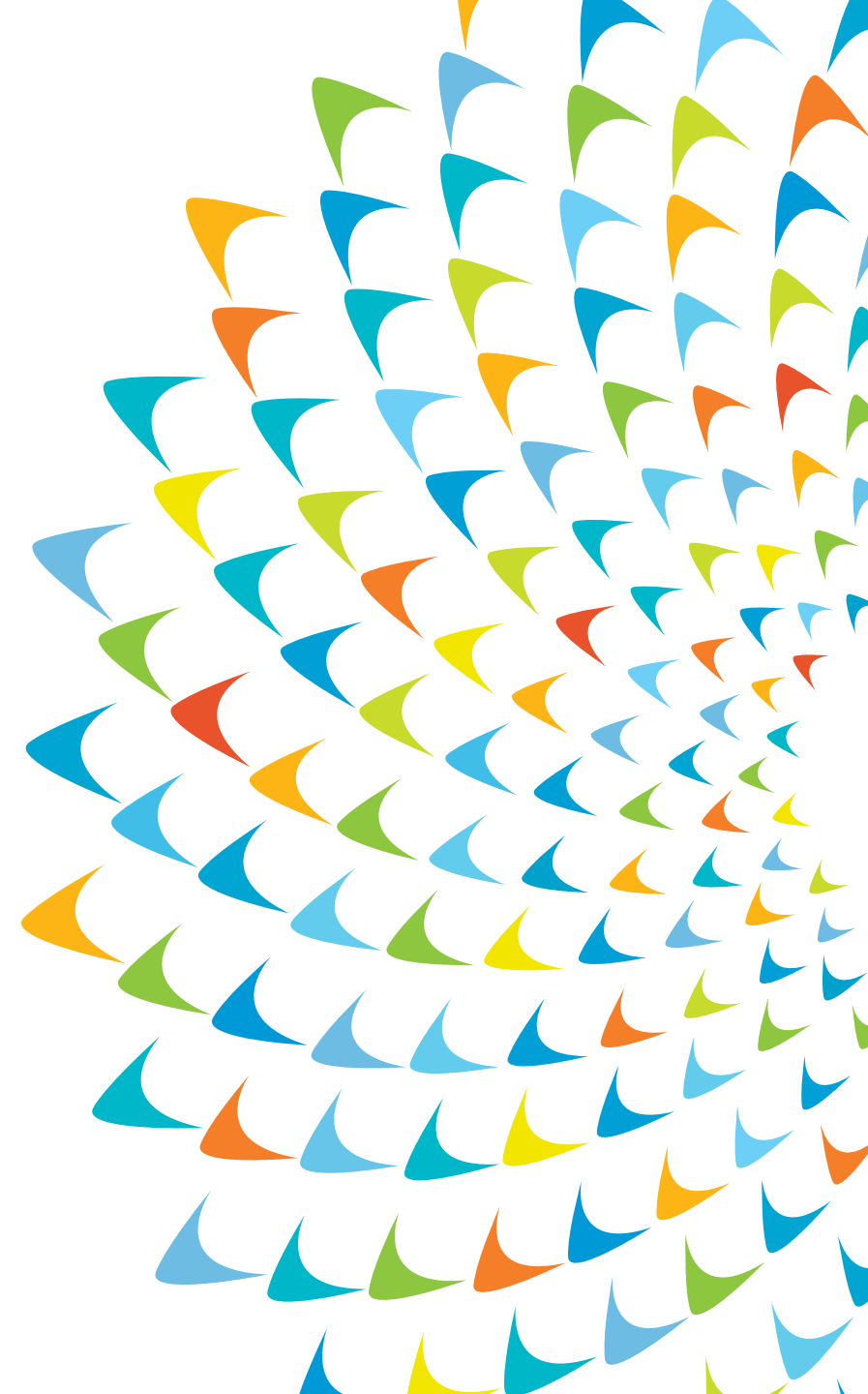
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