Hype Cycle for Digital Government Technology, 2021

> Government CIOs can help accelerate transformation by understanding what new and existing technologies can help meet their objectives. Use this Hype Cycle to pinpoint the technologies or platforms that best contribute to the organization's objectives and advance digital maturity.

Strategic Planning Assumption

By 2023, over 60% of governments will have tripled citizen digital services, but less than 25% will be integrated across organizational silos.

Analysis

What You Need to Know

The pandemic challenged governments to shift priorities, while supply chains and revenue streams dwindled. CIOs were forced to pivot and accelerate digital efforts to address immediate challenges, such as transition to remote work and reliance on contactless services. Governments needed to provide resilient mission-critical services, while managing uncertainty. Technology provided the foundation for the continuation and sustainability of:

- Government service delivery from dispersed locations

- Tracking human interactions and spread of COVID-19 infections

- Distance learning for students and employee training

- Exponential increases in demand for some services

Government CIOs will continue to face these challenges, depending on their countries' situations. Other CIOs must reconsider how to enable existing and revised mission outcomes through swift digital government execution. This Hype Cycle helps CIOs gauge relative risk and timing for investment in digital government technologies and platforms that progress digital maturity and accelerate digital innovation.

The Hype Cycle

Gartner analyzed government business and technology trends to identify technologies that enable key initiatives today and present compelling new use cases tomorrow. CIOs must balance high demand for digital services today with the perpetual austerity magnified by the pandemic. Consequently, technologies on the 2021 Hype Cycle are cross-functional and foundational to enable digital government at scale horizontally, across geographies and government tiers. Most technologies serve as platforms that can be composed and recombined into discrete services and solutions.

Citizen service improvements remain a primary focus of many digital government strategies. Citizen-focused technologies range from engagement technologies like citizen engagement hubs and voice-of-the-citizen applications to service delivery, including:

- Chatbots

- Citizen identity wallets

- Citizen twins

- Consent and preference management

- Decentralized identity

- Document-centric identity proofing

- Multiexperience development platform (MXDP)

The disruption also focused on supporting the government workforce through automation and decision support through better use of government data, resulting in inclusion of technologies like data exchange, data fabrics and digital twins in government. We highlight intelligent support technologies for the workforce with the inclusion of:

- Computer vision

- Human-centered artificial intelligence (AI)

- Intelligent applications

- Knowledge graphs

- Natural language processing

The pandemic highlighted the importance of trust in government, as government agencies explore technologies like authenticated provenance and blockchain.

Finally, a focus on solution design to meet the agility demands of government organizations resulted in the inclusion of technologies such as:

- Digital government technology platforms (DGTPs) or government platforms

- Event stream processing

- Full life cycle API management

- Hybrid cloud computing

- Machine-readable legislation

- Microservices

- Packaged business components

The technologies' maturity and adoption impact the technologies' precise placement on the Hype Cycle. CIOs should review these technologies in the context of the organization's:

- Mission objectives and risk profile

- Context

- Culture

- Digital maturity

- Leadership engagement

- Funding profiles

Then, CIOs and mission leaders can formulate a business-priority-driven roadmap for future technology investments that delivers on the government's agenda.

Figure 1: Hype Cycle for Digital Government Technology, 2021

Hype Cycle for Digital Government Technology, 2021
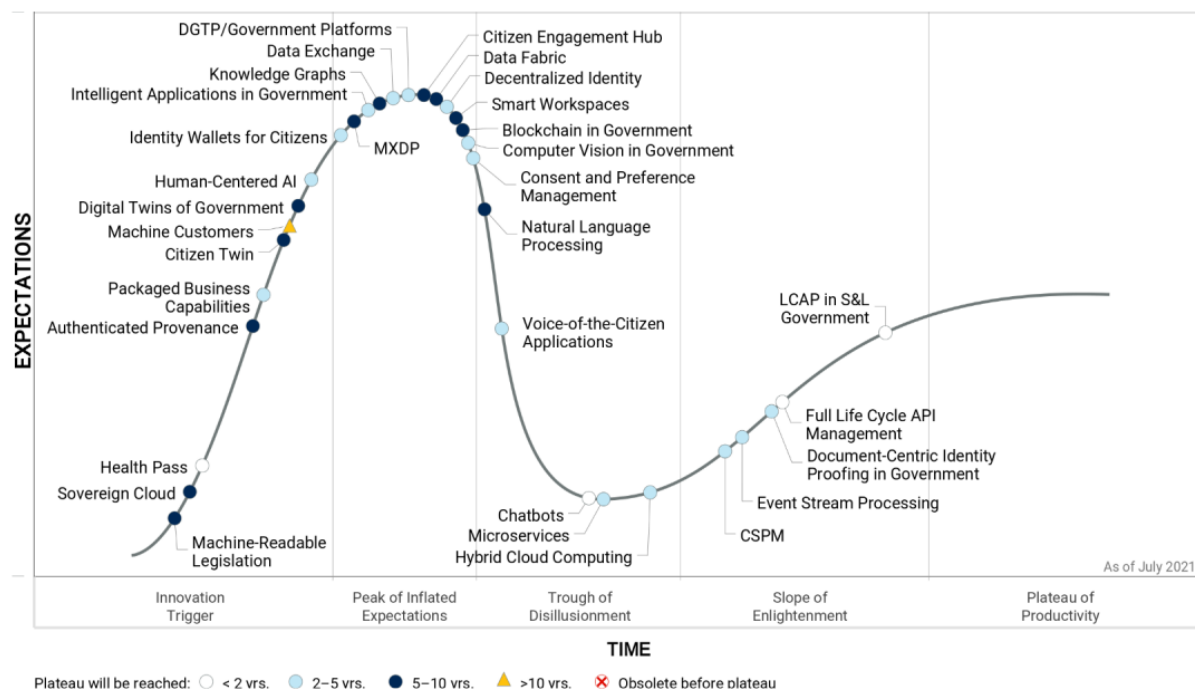
Source: Gartner

The Priority Matrix

The Priority Matrix illustrates the technologies mapped to the time frame by which they are expected to mature into mainstream adoption and deliver benefits, and the level and depth of benefits that can be expected from them. For those technologies in the upper-left section of the Priority Matrix, transformational or high benefits can accrue immediately. Those with similarly significant benefits, but in a less mature state, present strategic opportunities, but should be approached somewhat more cautiously. Technologies with longer times to mainstream adoption should be anticipated to have changing market dynamics and changing dominant players over that horizon.

For example, rapid investments in technologies that accrue immediate benefits, such as chatbots and low-code applications, should be viewed as quick wins. Conversely, solutions such as digital twins of government involve complexity that will extend time to value. Technologies such as citizen twins and machine customers offer high potential but are immature, with fewer use cases in government today. As with the Hype Cycle, the placement of these technologies within the Priority Matrix will vary slightly by geography, vertical and tier of government, particularly with respect to their potential benefit assessments.

Table 1: Priority Matrix for Digital Government Technology, 2021

(Enlarged table in Appendix)

Benefit	Years to Mainstream Adoption			
↓	Less Than 2 Years ↓	2 - 5 Years ↓	5 - 10 Years ↓	More Than 10 Years ↓
Transformational	Health Pass	Data Exchange Decentralized Identity DGTP/Government Platforms Event Stream Processing Human-Centered AI Intelligent Applications in Government	Data Fabric Machine-Readable Legislation Natural Language Processing Smart Workspaces Sovereign Cloud	
High	Chatbots Full Life Cycle API Management LCAP in S&L Government	Computer Vision in Government CSPM Hybrid Cloud Computing Identity Wallets for Citizens Microservices Packaged Business Capabilities Voice-of-the-Citizen Applications	Authenticated Provenance Blockchain in Government Citizen Engagement Hub Citizen Twin Digital Twins of Government Knowledge Graphs MXDP	Machine Customers
Moderate		Consent and Preference Management Document-Centric Identity Proofing in Government		
Low				

Source: Gartner (July 2021)

Machine-Readable Legislation

Analysis By: Bill Finnerty

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

Machine-readable legislation (MRL) is developed by creating the text for legislation or policy simultaneously with the computer code that will be used to implement them. Through concurrent development, technical challenges to the implementation of policy are reduced; however, systems must be built in a modular approach that allows for the implementation of this business logic. MRL enables governments to implement a more consistent and equitable application of the law.

Why This Is Important

MRL ensures policy is designed and implemented as intended, reflected in subsequent administrative rules and automatically carried out by various systems. Implementing laws as computer programs is often difficult, as laws are not necessarily written with binary logic in mind. However, the policy is the technology and technology is the policy and the two are inseparable in a digital society. Society will benefit as systems across industries are implemented in a more consistent manner.

Business Impact

Implementing MRL will be a cross-disciplinary activity, requiring the necessary skills in policy and IT shops, technology implementation and ecosystem engagement to ensure the developed "business logic" is created and used to improve the regulatory process and promote economic benefits. MRL will be a fundamental technical element in creating a composable government to support a digital society by making the writing of laws more data-driven and their implementation more consistent.

Drivers

As an emerging innovation, the drivers for MRL are more aspirational than concrete. However, there are a number of existing challenges that governments face in the transition to digital government that can be addressed through the implementation of MRL.

- **The gap between legislative intent and implementation.** By implementing MRL, the room for interpretation of legislative or executive intent is eliminated from the process, instead making the law that is passed the same as that which is implemented.

- **Limitations in existing legislative processes to respond quickly to needed change.** The ability for governments to iterate, expediently, laws to maximize societal outcomes is difficult in existing legislative processes. MRL, when coupled with other emerging technologies, such as machine learning and digital twins of government, can enable iteration of a large number of scenarios impacting multiple public programs. This approach enables a broader use of data-driven policy and decision making.

- **The need to reduce the cost of developing new laws or updating existing ones.** Implementing MRL and exposing the approved "business logic" as APIs to the partner community, governments will be able to reduce the costs of implementing policy changes and auditing systems. Removing the economic burden related to implementing changes in policy and law can make updating laws more palatable for the broader ecosystem.

- **The needs of a digital society require an updated approach to making laws.** Ultimately, as Estonia's X-tee platform revolutionized government and demonstrated what is possible for digital government, a country that is able to effectively establish MRL will reduce friction in their economy and create a competitive advantage. Countries that accomplish this will be in the position to best meet the needs and evolving expectations of a digital society.

Obstacles

- MRL will require a shift in how policies and laws are developed and implemented; this is beyond the span of control for most CIOs. For those in the position to influence the adoption of MRL, obstacles will need to be dealt with at the executive and legislative levels.

- MRL will change the existing dynamics and power structures related to the development of laws and policy, which may cause those currently in leadership positions to resist its adoption.

- The lack of digital skills in policy teams can generate resistance to the concept of MRL.

- Governments will need to invest in testing capabilities to allow for testing of frequent system updates.

- The private sector may have concerns that MRL will eliminate competitive advantage in their market.

- Society may have concerns related to consolidation of power in what can be perceived as a digital black box.

User Recommendations

- Engage political leadership in establishing a roadmap to adopt MRL. Begin by enacting a law requiring digital-ready legislation, then determine the skills and technology gaps that need to be addressed to implement MRL, and finally educate lawmakers, activists, lobbyists and the public on benefits and risks related to implementing MRL.

- Work with legislative and executive policymakers to adopt a plan for embedding digital capabilities in policy development shops.

- Engage with private-sector partners early in the process of developing machine-readable laws to ensure they understand the shift, are able to provide input and are prepared to make the necessary changes to their solutions to leverage the new capability.

- Refactor existing systems to leverage the business logic of an MRL as an API.

- Gain input from the public on the opportunities and concerns they have with MRL by working with government leaders on a constituent engagement plan.

Sovereign Cloud

Analysis By: Rene Buest, Tiny Haynes, Neville Cannon, Gregor Petri

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Sovereign cloud is the provision of cloud services within a single geography meeting data residency and legislative requirements. Sovereign cloud helps ensure that data remains free from external jurisdiction control and provides protection from foreign legislatively enforced access. Countries engage a sovereign cloud to achieve digital and data sovereignty to provide rules and legal requirements to apply data protection controls, residency requirements, protectionism and intelligence gathering.

Why This Is Important

The importance of digital sovereignty has risen in step with growing discord within global economics, protecting intellectual property, expanding privacy legislation and the desire to be more self-sufficient due to the dominance of a small number of large Chinese and American technology and service providers. The public sector recognizes the value of the digital economy and seeks to develop infrastructure and ecosystems capable of delivering a digital citizen experience while maintaining autonomy.

Business Impact

Legislative mandates can and are being applied to limit the ability to use multinational vendors' services. This clearly impacts current investments and potential sales growth. National vendors may view the changing legislative landscape as a catalyst for further investment and growth. As a result, end users could find themselves in a regulated/fragmented market without access to the software and services that they need to support their ongoing digital business initiatives and drive innovations.

Drivers

- Digitization initiatives need secure and reliable access to data sources and the ability to contextualize and aggregate data from a large number of internal and external data sources. Platform businesses like Alibaba Group, Alphabet, Amazon or Tencent are beneficiaries of this.

- Platform businesses are heavily dominated by U.S. and Chinese companies due in part to their individual market sizes and the common language and currency. Other countries, especially in Europe, lag behind and have already lost national or regional control in core technology areas, such as e-commerce, microprocessors, 5G infrastructure and smartphones, which are necessary to build and run platform businesses. The same applies to the foundational technologies to drive digital transformation and build digital business models or a platform business.

- The market for digital and cloud technology and services is dominated by the U.S. and Asian technology and service providers. As a result, European companies mainly have to access non-European services and technology to build and run digital business models. Hence, data is being stored within non-European cloud and digital service providers, which creates political uneasiness.

- As digital services become increasingly important and system-relevant, companies and regional trade bodies worry about retaining control over their data to stay compliant with local regulations.

- Some more regulated industries and governments are particularly concerned by the U.S. and Chinese legal frameworks that might allow government access under specific circumstances to customers' data.

- In addition, dependence on non-local providers of cloud infrastructure and platform services also comes with economic concerns, such as providers not paying appropriate taxes on transactions conducted within a country or region.

Obstacles

- The range of services and capabilities of hyperscale cloud providers far exceeds pure virtualized infrastructure. Considerable technical obstacles exist if sovereign clouds are expected to deliver the maturity and level of scalability and functionality of hyperscale competitors.

- Too few skilled engineers exist to replicate the design capabilities across multiple countries, simultaneously. With lower levels of skills being available, security and operational maturity will be compromised, potentially leading to greater security and failure risks.

- To date, no non-U.S. or Chinese provider shows the capabilities to compete against one of the hyperscale providers. The market dynamics make it almost impossible for a national vendor to become a strong competitor. Local vendors typically invest significantly less than global players in new infrastructure and find themselves essentially playing catch-up.

- Due to lack of competition, companies will choose to build on technology platforms owned by providers from outside their country.

User Recommendations

- Subject proposals for sovereign cloud to the same level of risk assessment that current cloud computing providers are subjected to. Do not assume that the sovereign cloud conveys any additional security measures in itself.

- Make explicit decisions about your organization's digital sovereignty and track the cloud climate change. Base your plans on the assumption that changes in global cloud climate will potentially disrupt your business.

- Explore evaluating local cloud services for workflows that can be provided locally and leverage third-party solutions to protect data and ensure it is compliant with local requirements.

Gartner Recommended Reading

Market Trends: Europe Aims to Achieve Digital Sovereignty With GAIA-X

Tech Providers 2025: Strategic Responses to Disruption From Geopolitics and World Events

Tech Providers 2025: Strategic Impacts to the Competitive Landscape

Health Pass

Analysis By: Ben Kaner, Sharon Hakkennes, Donna Medeiros

Benefit Rating: Transformational

Market Penetration: 20% to 50% of target audience

Maturity: Emerging

Definition:

A health pass provides a digital means to verify an individual's health status against set criteria defined by the verifying enterprise. These solutions access trusted sources to verify credentials, the output from which is an indicator of adherence to the criteria. Capabilities vary between solutions and include verification of vaccination status, laboratory test results, temperature and self-reported health declarations.

Why This Is Important

Governments and enterprises need to reopen offices, venues and travel locally and internationally without creating a resultant surge of COVID-19 disease. This requires an ability to control the risks of doing so. As the virus continues to evolve, this is likely to be required for some time. In addition, the ability to easily present and act on health information in a health pass will improve the ability to respond to individual and societal health challenges as the situation continues to evolve.

Business Impact

By exploiting a health pass, governments and enterprises should be able to reopen more efficiently while still complying with controls intended to reduce the risks from COVID-19 to their citizens and staff. They are also more likely to be able to control a subsequent surge. Over time, public health could be improved by exploiting the infrastructure to address other health and disease threats as they continue to emerge.

Drivers

- A widespread need for a health pass is driven by COVID-19 — a prime example of a contagious virus that is sufficiently infectious and virulent to spread worldwide and cause the near-collapse of multiple health systems and economies.

- Multiple vaccines against COVID-19 have been created and distributed across multiple countries. Until enough people worldwide are successfully vaccinated, there remain significant risks — and this takes time. As the virus continues to evolve, populations are likely to require revaccination before the first vaccination cycle is complete.

- To prevent new major outbreaks, governments need to exploit multiple tools — including detection (testing); breaking the infection chains (isolation); treatment (e.g., antivirals, antibodies); and of course, prevention (social distancing, vaccination).

- While health passes and the narrower capability of digital vaccine certificates cannot fully resolve this problem, they have the potential to enable economies to operate more normally, and reopen earlier than would otherwise be the case. As the impacts have been so high on many industries and human activities, this is critical to economies, government revenue, public health and civic behavior (e.g., outbreaks of unrest), and provides multiple drivers. Drivers include businesses needing to contain the risks both of health and of financial liability associated with customers, visitors and staff coming into contact with each other — and do so with as low a cost as possible. Government facilities need to support and deal with citizens without discrimination. Also, citizens wish to reestablish their ability to engage socially and economically as much as possible.

Obstacles

- International/cross-jurisdiction standards and acceptance, particularly variable privacy and security requirements, are challenging technically and politically.

- Availability of vaccination registries — some countries have the infrastructure in place, others do not.

- Differing interpretations about what is needed and at what level (WHO vs. EU Digital Green vs. Chinese International Travel Certificate).

- Who will be liable/responsible at point of entry?

- Cost of implementation and infrastructure availability, particularly for low- and middle-income countries.

- Cost and resource to operate the system, e.g., additional queue-handling capacity.

- Significant political and ethical concerns about creation of a mechanism of social exclusion.

- Reluctance from citizens to have to share health information for any purpose.

User Recommendations

- Ensure adaptability to varying standards and evolving needs by separating identity, event recording and verification into different capabilities.

- Allow for broad usage by considering how people with externally provided information can be enabled to operate within your jurisdiction, either by enabling local verification of other health passes or by allowing a registration into your health pass ecosystem.

- Ensure that the system can be used even under stress by ensuring there is a viable option for offline checking of the pass.

- Minimize privacy and security challenges by designing around minimal transfer of information.

Sample Vendors

Clear; Covid-19 Credentials Initiative; Good Health Pass Collaborative; IBM; International Air Transport Association; International Chamber of Commerce; Lumedic; The Commons Project

Gartner Recommended Reading

Demystifying the Relationship Between a Digital Vaccine Certificate and Health Pass

Data Ethics of Tracking Employee Vaccination Status

Now Is the Time to Make Digital Identity Work for Citizens and Governments

Authenticated Provenance

Analysis By: Avivah Litan, Svetlana Sicular, Rick Howard

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Definition:

Authenticated provenance represents the authentication of assets that can be recorded and tracked on the blockchain. The provenance of these assets can later be digitally verified by blockchain network participants. There are many methods used to authenticate the provenance of assets, depending on their nature and whether they are digital or physical goods.

Why This Is Important

At their worst, counterfeit goods, fake content, and erroneous data are national and health security threats. At their best, they are costly problems for organizations. Blockchain provenance and asset tracking applications are used to address these issues, but they don't address the problem of authenticating goods, data and content initially recorded on the blockchain. The question remains — how do you know that the things you are tracking on the blockchain are real to begin with?

Business Impact

Gartner believes that provenance authentication solutions will be in more demand in the coming years, as users adopt blockchain for provenance applications. These users will become increasingly aware of the need to digitally "certify" the first mile — the onboarding of the goods, content or data being tracked on the blockchain in the first place. Over the past year provenance authentication at scale has accelerated due to the necessity of trusted vaccine distribution.

Drivers

- Today, authenticated provenance largely relies on manual audits or human trust. That is certainly not scalable. For example, human fact checkers cannot keep up with the volume of fake content and do not have the technological resources to do so.

- Environmental, social and governance (ESG) goals embraced by asset management firms are forcing companies to produce verifiable data and information on the state of their organizations with regard to ESG indicators.

- Regulators and other government authorities do not have sufficient visibility into supply chains or complex multiparty ecosystems, and therefore cannot validate assertions about the state of goods or services that they are auditing and overseeing.

- Consumers and businesses are placing trust in various labels and certificates, such as "organic" or "non-GMO," but they have no way of verifying the veracity of these assertions. Evidence has shown that these labels and assertions are often incorrect.

- Artificial intelligence (AI) is being successfully used to contextualize and synthesize data that can then be used to authenticate provenance of events and information (for example, detecting a leaking oil pipe). If necessary, findings can then be verified by human auditors.

- The Internet of Things (IoT) is being successfully used to track and record the state of "things" on IoT networks. This capability can be used to validate information used in business processes that rely on externalities.

- Blockchain is successfully providing a single system of record across multiple entities, based on immutable data and audit trails.

Obstacles

- The cost of immature technology is still high; ROI is still unproven.

- There is a need for new multiparty business agreements; and a need for entire ecosystems to participate.

- There is a lack of standards for data and processes in most domains.

- There is a lack of domain-specific tools for assessing "truth."

- Custom integrations are needed for analytics, AI, IoT and blockchain technologies.

- Many multiparty processes are complex and unproven.

- There is very little awareness of trust issues and the methods to address them.

User Recommendations

- Understand how blockchain, combined with other advanced technologies (most notably AI and IoT) can be used to support authenticated provenance.

- Understand project constraints — for example, new complex business processes, a lack of mature domain-specific tooling, the need for custom integrations, skill scarcity and the lack of experienced vendors.

- Where possible, capitalize on blockchain infrastructure that is already in place.

- Add authenticated provenance blockchain use cases, provided that they are relevant to your business and you can demonstrate ROI through improved efficiencies and new revenue streams.

- Public blockchains like Ethereum or Solana can also be utilized in many instances.

- Address customer demand for greater trust. These technologies give customers confidence in your brand and the provenance of your products.

- Aim to replicate what has worked in supply chain and other sector case studies.

- Start small with well-scoped use cases that need these technologies.

Sample Vendors

Circulor; Copperwire; Jitsuin; SettleMint

Gartner Recommended Reading

[Truth and Transparency in Supply Chain: 3 Case Studies on How Blockchain, AI and IoT Are Shedding Light](#)

[How to Detect Fakes in a Zero-Trust World Using Artificial Intelligence and Blockchain](#)

[Assessing the Optimal Blockchain Technology for Your Use Case](#)

[Garbage In, Garbage Forever: Top 5 Blockchain Security Threats](#)

Packaged Business Capabilities

Analysis By: Yefim Natis

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Packaged business capabilities (PBCs) are encapsulated software components that represent a well-defined business capability, recognizable as such by a business user and packaged for programmatic access. The definition does not specify the size, functional scope or internal architecture of the implementation, but PBCs are only as useful as they are modular, discoverable, autonomous and ready for composition (integration).

Why This Is Important

As the pandemic disruption forced organizations to seek increased business adaptability, many turned to the model of the composable business. PBCs are a foundational element of the composable application architecture. They act as the building blocks for composition and recomposition of application experiences. When combined with the democratized application composition tools, PBCs empower fast, safe and efficient application and business innovation by the business-IT fusion development teams.

Business Impact

- Adoption of PBCs improves the ability of organizations to involve business professionals in design of application experiences and to make changes to applications by way of recomposition instead of new coding.

- Composable applications, using PBC architecture, equip organizations to innovate faster, safer and smarter, which in turn delivers business resilience, efficiency and adaptability.

Drivers

- Increasing pace of business change, demanding faster, safer and more efficient application innovation.

- Increasing participation of business professionals in software engineering, requiring more business-oriented expression in software modeling, replacing or augmenting the traditional programmatic orientation.

- Increasing democratization of platform technologies, bringing more business professionals to application design work.

- Increasing orientation of vendor applications (SaaS) to API-first and API-only ("headless") design, leading organizations toward composition and integration instead of the basic customizations of vendor applications.

- Increasing sophistication of agile development practices and product-style application delivery demands more advanced modularity, autonomy, orchestration and discovery for application capabilities.

Obstacles

- Lack of clarity in understanding the fundamentals of composable application architecture, which leads to false starts or "composability-washing" initiatives that do not deliver the expected results.

- Lack of democratized composition tools, which leaves too much of the attempted composition initiatives with technology professionals, limiting the direct business professional participation. This in turn generates designs that are less reflective of the nuance of the required business change and compromise the delivery pace and quality of the outcomes.

- Lack of experience operating fusion teams, which reduces their effectiveness and compromises both technology and business aspects of the products.

- Cultural resistance to change, fear of the shifting business priorities and common familiarity bias — all form obstacles to rapid adoption of architecture of composability and the PBCs.

User Recommendations

- Prioritize expertise in API management, event brokering, integration, business-IT collaboration and democratized tooling to achieve preparedness for composable business applications experience.

- Reject any new monolithic solutions proposed by vendors or in-house developers, and plan to renovate or replace the old ones to enable their participation in composition.

- Accelerate product-style delivery of application capabilities, using agile and DevOps techniques over traditional methods.

- Prioritize democratized tools in support of development, integration (composition) and governance of composed application experiences.

- Give preference to vendor offerings that deliver API-first and API-only (headless) application services.

- Transform the IT organization to the role of a partner and strategic guide to business units, trusted to deliver efficient, safe and fast services to help advance organizations' business objectives.

Gartner Recommended Reading

Innovation Insight for Composable Modularity of Packaged Business Capabilities

Strategic Architecture Roadmap for Composable Enterprise Applications (Presentation)

Use Gartner's Reference Model to Deliver Intelligent Composable Business Applications

Kick-Start Your Composable Business Journey With 2 Key Strategies

How to Design Enterprise Applications That Are Composable by Default

Citizen Twin

Analysis By: Alfonso Velosa

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

A digital twin of a citizen is a digital representation of an individual. National, state and local governments use citizen twins to support citizen services such as health or safety management. The citizen twin core elements are the model, data, a unique one-to-one association, and ability to monitor it. It integrates data into the twin from siloed sources such as health records, credit scores, phone location logs, criminal records, customer 360 records and infrastructure such as cameras.

Why This Is Important

Governments are developing digital twins of citizens to monitor the environment citizens live in and address health, safety, travel and social media impacts on society. The spectrum of complexity of the models and tools can help governments make better decisions for monitoring and supporting patients, prisoners, passengers or the elderly. Some governments, such as China's, are building a scoring methodology. Aggregated citizen twins can help map broad patterns and drive resource allocation.

Business Impact

- Governments will use digital twins to better orchestrate citizen services and other digital services, and even manage crises, such as pandemic protection.

- Aggregate data can help citizens access and expedite government services

- Citizens or governments can drive citizen-twin-based crowdsourcing sentiment analysis to assess government services in near to real time.

- Integrate government services to other systems including the Chinese social credit systems and shopper tracking solutions.

Drivers

- Proliferation of both structured and close-to-structured data on creating digital citizen journey maps.

- Increased integration of government, financial and commercial systems and interest in creating citizen 360 models.

- Citizen interest in systems that help drive their health and safety, such as vaccination passports or solutions to monitor elderly patients using IoT-enabled trackers.

- An increased desire for personalized services from government and other organizations.

- The need to implement proactive services, such as healthcare, mental health, fraud detection, and so forth, with a particular driver for government services for COVID-19 pandemic responses.

- Investment by a broad range of law enforcement, justice and corrections authorities, for example for smart camera monitoring systems that track to a specific police officer, or inmate tracking solutions under home arrest.

- The flexibility of digital twin models from simple to complex models, and the ability to integrate data from siloed services enable governments agencies to build out citizen services both in aggregate as well as servicing individuals.

- The need for both real-time services customized to citizens, for example for emergency medical services, and longer term, more complex solutions that serve elderly patients or inmates.

Obstacles

- Strong concern for privacy and the merits of government access to citizen data is leading to grassroots citizen pushback or government regulations such as the EU Privacy Directive or California Consumer Privacy Act (CCPA) to limit access to citizen data.

- Cost and scope slither without clear benefits to citizens or government agencies, as government bureaucracies increase the types and quantity of data collection.

- Government curation of aggregated citizen data creating a security risk for government data and a potential privacy and safety risk for the individual citizen.

- Conflicting government agencies' objectives, political infighting on data rights, and incompatible regulation on the use of citizen data, and on how to respect rights to privacy.

- Incompatible systems across different government, financial, commercial and healthcare silos driving exorbitant costs for integration, analytics and visualization.

- Lack of skills in the government agencies to drive the use of the citizen twin.

User Recommendations

- Build robust privacy and digital ethics policies that clarify what data is collected, who has access to it, how it is protected, and what citizen remediation actions exist or comply with existing remediation processes.

- Establish clear benefits to citizens such as certifying all passengers on an airplane or train are healthy or vaccinated, simplifying medical triage to get a citizen to medical care, or aligning toll payments to a citizen's car for use of a toll road or during city congestion fees.

- Test IoT sensor and analytics capability to ensure accuracy and validity for the physical part of a citizen digital twin.

- Invest in integration skills to connect into a heterogeneous set of applications and data sources.

- Build data exchanges to protect data, while enhancing the granularity of citizen data support personalized and contextualized citizens services through the government ecosystem.

Sample Vendors

Alibaba Cloud; Apple; Google; Tencent; Vantiq

Gartner Recommended Reading

Getting Started With a Digital Twin of Government

Top 10 Plausible Directions Resulting from COVID-19

Top Trends in Government for 2021: Hyperconnected Public Services

Top Trends in Government for 2021: Data Sharing as a Program

Top Trends in Government for 2021: Multichannel Citizen Engagement

Machine Customers

Analysis By: Don Scheibenreif, Mark Raskino

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Definition:

A machine customer is a nonhuman economic actor that obtains goods or services in exchange for payment. Examples include virtual personal assistants, smart appliances, connected cars and IoT-enabled factory equipment. These machine customers act on behalf of a human customer or organization.

Why This Is Important

Today there are more internet-connected machines with the potential to act as customers than humans on the planet. We expect the number of machines and pervasive artificial intelligence (AI), like virtual personal assistants, with this capability to rise steadily over time. They are increasingly gaining the capacity to buy, sell and request service. Machine customers will advance beyond the role of simple informers to advisors and, ultimately, decision makers.

Business Impact

Over time, trillions of dollars will be in the control of nonhuman customers. This will result in new opportunities for revenue, efficiencies and managing customer relationships. Digital-savvy business leaders seeking new growth horizons will need to reimagine both their operating models and business models to take advantage of this ultimate emerging market, whose numbers will dwarf the number of human customers on (and one day perhaps off) the planet.

Drivers

- According to Gartner research, both CEOs and CIOs agree on the potential of this emerging trend. Seventy six percent of CIOs and 61% of CEOs we surveyed in 2019 believe demand from machine customers will become significant in their industry by 2030. On average, these leaders believe at least 21% of their revenue will come from machine customers by 2030.

- Today, most machines simply inform or make simple recommendations. We do see some examples of machines as more complex customers emerging, such as smart grid technologies. HP Inc. embraced this future when it created Instant Ink — a service that already enables connected printers to automatically order their own ink when supplies run low. Some Tesla cars already order their own spare parts, and Walmart has patented grocery auto reordering based on home Internet of Things (IoT) sensing.

- In B2B, U.S.-based industrial supply company Fastenal uses smart vending machines that proactively place orders when stocks run low. Thinking forward, an autonomous vehicle could determine what parking garage to take its human passengers to based on criteria such as distance from destination, price, online review score, parking space dimensions, valet options, etc. In this case, it is the parking garage marketing to the car, not the humans.

- The rise of machine customers begs some important questions. These include: (1) How do you market to, sell, service and obtain feedback from a machine customer?; (2) What will get a machine customer to buy from you when its decisions are based on algorithms, not emotion?; (3) What does "customer experience" even mean for a machine customer?

- Machine customers have the potential to generate new revenue opportunities, increase productivity and efficiency, improve health/well-being and enhance security of physical assets and people. They will also result in new sources of competition, fraud, legal and taxation challenges, and operational challenges.

Obstacles

- **Trust** — Can the human customer trust the technology to accurately predict and execute? Conversely, can the machine customer trust the organization that offers the service? The complexity involved in developing a machine customer that can learn the depth and breadth of knowledge and preference trade-offs required to act on behalf of a human customer in a variety of situations is staggering.

- **Fear** — Some humans may initially be uneasy about delegating purchasing functions to machines. And, organizations will have to consider what ethical standards, legal issues and risk mitigation are needed to operate in a world of machines as customers.

- **Technology that works** — Other barriers include: complex AI technologies, privacy, security and risk, regulatory compliance issues and data sharing.

All this will mean that machine customers across industries will not reach the Plateau of Productivity for at least five to 10 years.

User Recommendations

- Create scenarios to explore the market opportunities. Initiate collaboration with your chief digital officer, chief data officer, chief strategy officer, sales leaders, chief customer officers and others to explore the business potential of machines as your customers.

- Identify specific use cases where your products and services can be extended to machine customers; and pilot those ideas to understand the technologies, processes and skills required.

- Build your organization's capabilities around digital commerce and AI over the next five years. First in machine learning, then extending to other facets involved in machine customers processing information, making informed decisions, and performing purchase transactions. Or, join other platforms that already have those capabilities if you don't have the resources to build them yourself.

- Follow examples from organizations like Tesla, Google, Amazon and HP to look for evidence of capabilities and business model impact.

Sample Vendors

Amazon; Google; HP; John Deere; Tesla

Gartner Recommended Reading

[Machine Customers: The Next Massive Emerging Market](#)

[How Customer Experience Changes When Your Customer Is a Thing](#)

[Why Machine Customers May Be Better Than Human Customers](#)

[Meet Your Machine Customers: 10 Machines That Will Drive Business Growth in the 2020s](#)

[IoT-Based Thing Commerce Requires a Differentiated Customer Experience](#)

[The Future of Customer Self-Service: The Digital Future Will Stall Without Customer-Led Automation](#)

Digital Twins of Government

Analysis By: Bill Finnerty, Milly Xiang

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

A digital twin of government is a virtual representation of government and partner assets, people and operations to provide real-time analysis, operations automation and scenario-based planning. Key features include a single point of visualization and access to supporting data, APIs for issuing commands to things and processes, and the ability to execute scenario planning and urban modeling. A mature digital twin of government is a system of systems, requiring strong integration capabilities.

Why This Is Important

Having a single view of the multiple, interdependent systems that impact the operations of a jurisdiction has long been a struggle for governments. Digital twins of government address this challenge, providing a single interface to the operations of a jurisdiction, and are starting to be used by governments around the globe. Many digital twins of government often start as GIS models; a fully realized future state will:

- Include command-and-control capabilities

- Drive scenario planning at scale

Business Impact

- In the short term, governments need to identify a focused business use case for piloting a digital twin of government.

- In the midterm, governments will leverage digital twins for command and control of operations, frequently enabling greater automation.

- Over time, digital twins will be used to model and test scenarios related to policy, legislation, and infrastructure rollout and changes.

Drivers

- There are three drivers to the increased adoption of digital twins of government. The first driver is advances in vendor solutions, including both advances in technology and the number of vendors providing solutions. The second driver is progress on government programs intended to establish national standards and adoption of digital twins. The third driver is the growing application of digital twins to real-world problems, providing a research base on which to justify future investments.

- In addition to a larger number of vendors entering the market for digital twins of the built-world, many providers are expanding their capabilities. These vendors are increasingly including easier, low-code integration to IoT datasets; integration with indoor GIS, BIM and computer-aided drafting solutions; and inclusion or extension to AI and ML capabilities.

- Progress on governmental standards in Australia, China, the U.K. and other countries is establishing national working groups and standards for digital twins of the built world, including those used for government. These programs are further advancing the interoperability of digital twins of government, an essential component of their future use across jurisdictions.

- The number continues to grow of prominent digital twins of government being developed, used to solve problems and integrated with other capabilities, such as data marketplaces. They provide examples and inspiration for other governments to consider developing a twin. They include Virtual Singapore, New South Wales government's Spatial Digital Twin, Shanghai's digital twin, the Dutch government's digital twin of The Hague, Helsinki's Kalasatama Digital Twin and Boston's digital twin of the city.

Obstacles

A number of challenges to digital twins of government may impede their implementation and growth:

- Foundationally, they are integrated systems that will span the silos of government, and silos are an ongoing challenge for governments. This requires both coordination on data standards and integration capabilities.

- In many jurisdictions, expectations of digital twins of government are high. However, sustaining interest, budget and business unit participation in developing a digital twin of government will require focus over multiple administrations.

- CIOs planning for digital twins of government will need to address fundamental questions of any emerging technology — privacy, ethics and business value. This will ensure that the question asked is not, "Can we do this?" but, "Should we do this?"

- The skills to develop digital twins are limited in most markets. Thus, governments will need to compete with other entities for the available talent.

User Recommendations

CIOs leading the development of a digital twin of government:

- Engage elected officials and program leaders in defining the vision in business terms to maximize understanding and buy-in.

- Use future planning exercises (that is, scenario planning) to develop use cases that can demonstrate the "art of the possible" and prioritize investments.

- Establish a guiding principle to protect citizen data by implementing privacy controls and end-to-end encryption.

- Make a digital manifestation of a single aspect, particularly in early states. The digital twins of government need not be a complete clone of the jurisdiction. For instance, transportation-related digital twins have been created for rail stations in China and for city mobility in Colombia.

- Access relevant solutions that could support your vision, based on their ability to integrate with existing systems, use of nonproprietary data standards, ability to scale using cloud services and vendor technology roadmaps.

Sample Vendors

Cityzenith; Esri; Estudios GIS; Eutech Cybernetic; IBM; Idrica; OSIsoft; Worldsensing

Gartner Recommended Reading

What to Expect When You're Expecting Digital Twins

Governments Are Developing a Unique Kind of Digital Twin

Getting Started With a Digital Twin of Government

Use 4 Building Blocks for Successful Digital Twin Design

Human-Centered AI

Analysis By: Svetlana Sicular

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

Human-centered AI (HCAI) is a common AI design principle calling for AI to benefit people and society. It assumes a partnership model of people and AI working together to enhance cognitive performance, including learning, decision making and new experiences. HCAI is sometimes referred to as "augmented intelligence," "centaur intelligence" or "human in the loop," but in a wider sense, even a fully automated system must have human benefits as a goal.

Why This Is Important

HCAI, when AI serves human and societal goals, continues to emerge as a design approach to deliver the most value from AI. An early idea that AI is simply a neutral technology is passing. Organizations see that HCAI allows them to manage the AI risks, to be ethical and more efficient with automation, while complementing AI with a human touch and with common sense. Many AI vendors have also shifted their positions to the more impactful and responsible HCAI approach.

Business Impact

HCAI compensates for human limitations and expands the possibilities for AI in the following key scenarios:

- Certain job tasks are done by AI, and the rest are done by people.

- People complete the job started with AI when AI reaches the limits of its capabilities or resources.

- Assistive AI develops and expands people's skills and talents.

- Innovation when neither AI nor people can accomplish the task without each other.

- Fully automated or autonomous systems where humans have an override capacity.

Drivers

- AI solutions must support human goals and objectives. This includes nonhuman, beneficial to people, ways of optimizing a process or solving a problem in order to arrive at new and different results, taking advantage of machine learning working differently from human learning.

- People are the ones who adopt AI (they can sabotage it too). It is human nature to use what we like, understand and trust. AI can remove many avoidable limitations, biases and blind spots. However, there are many intrinsically human irrationalities that we admire and want to preserve as a society. People do not want to be treated as robots. These people are your employees and your customers, and they are the key to AI adoption.

- More organizations are turning to the HCAI approach where they lead an ongoing discussion about what's right and wrong to do with AI before and during the progress of AI projects.

- HCAI is an intentional approach that questions and validates AI optimization goals. AI systems that solely focus on optimizing for a single business metric, like making customers click on the next news item or video, lead to dangerous societal outcomes and damage reputation in the eyes of customers, partners and employees.

- AI is probabilistic: It means that AI's mistakes are unavoidable. AI-related opportunities promise to do what only people could do in the past — diagnose diseases, play games and maintain cogent conversations. Some results could be (egregiously) incorrect, although most of them are amazingly accurate. AI mistakes without a human in the loop lead to unintended consequences.

- People's flexibility compensates for automation's limitations. Properly orchestrated autonomy makes AI impactful, for example, when AI substitutes a human in harsh working conditions. But unattended automation may lead to a misappropriation of investment and often presents insurmountable complexity.

Obstacles

- Many data science and AI teams include exclusively technical reviews for AI projects, while the resulting human impact might invalidate the entire project.

- AI systems often make decisions and take actions, but miss a feedback loop or include it as an afterthought. This doesn't mean that a human must validate every single decision, but there must always be a review and override possibility for decisions. For example, autonomous vehicle design is centered on human safety and always includes a possibility of giving control to a human driver.

- It is hard to define what AI solution is socially beneficial and human-centered. Not everything that is socially beneficial is human-centered — for instance, a social credit system.

- Anthropomorphizing AI does not mean it is human-centered. For example, virtual assistants might not give users enough understanding and control over AI-enabled answers, thus impairing AI adoption.

User Recommendations

- Establish HCAI as a key principle and a design approach. Always determine who will benefit from an AI solution. Implement AI to focus human attention where it is most needed in order to accelerate organizational competencies that fulfill your vision for digital transformation.

- Create an AI oversight board that reviews your AI plans from the HCAI position as part of its charter. Make AI goals explicit and a decision process about AI planning and validation transparent. Ensure all people can voice their concerns.

- Ensure human safety — for example, for AI moderation in social media.

- Include user experience design to facilitate HCAI. This design could be abstract (software, services, digital) or in the physical space (physical robots).

- Maximize the effects of AI-augmented roles via ongoing education, experience labs, AI-enabled just-in-time training and other methods, so the company, ecosystem and the entire society can take on more exceptional and forward-looking work.

Gartner Recommended Reading

A Human-Centric Approach to Data and Analytics: Introducing the Homo Analyticus

AI Ethics: Use 5 Common Guidelines as Your Starting Point

The Chief Data Scientist Role Is Key to Evolving Advanced Analytics and AI

AI Development Must Embrace Empathy or Face a Human Uprising

Take a Human-Centric Approach to Empower the Workforce With AI

Identity Wallets for Citizens

Analysis By: Arthur Mickoleit

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Adolescent

Definition:

Identity wallets are digital products (typically mobile apps) that enable an individual citizen to store, manage and selectively disclose identity-related data from different sources and for different purposes. Advanced identity wallets are interoperable platform components that enable services for the individual holding the credentials, as well as for issuers and verifiers as part of decentralized identity schemes.

Why This Is Important

For citizens, a digital identity wallet promises greater control over their identity data (e.g., purpose, form, amount and time any of it is shared). For service providers, identity wallets enable new service models that depend on consented sharing of identity data. Citizen-oriented use cases involve government as verifier of identity data when providing a service, or as issuer of identity data stored in a wallet. But governments might also act as regulators or providers of identity wallets.

Business Impact

Identity wallets can help citizens manage personal data from any source, public/private (e.g., ID card, driving license data, professional qualifications, COVID-19 vaccination). Use cases can span sectors (e.g., police checks, online transactions, contactless check-ins). But there is significant confusion and variation with citizen "identity wallets" today, ranging from walled-garden mobile ID apps to open, standards-based wallets that enable decentralized or self-sovereign identity.

Drivers

- **Privacy needs while disclosing identity data.** Identity wallets can enable citizens to grant explicit and selective consent for sharing of identity data with a service provider requesting such data. An example is attesting that a person is over 18 or holds a valid driving license without disclosing date of birth, address or other data typically visible on physical ID documents. Initiatives include several U.S. states (LA Wallet, myColorado), Sweden (Freja eID) and Singapore (Singpass).

- **Surges in identity theft and fraud.** Citizens and administrations mostly rely on outdated methods to identify each other during remote transactions. Enormous magnitudes of fraud related to COVID-19 financial assistance are driving the need for trusted yet convenient and scalable ways to verify and share identity data between different parties in a transaction.

- **New service delivery models.** Public services often depend on diverse ecosystem partners needing to verify identity data (e.g., across sectors or borders). Governments are exploring new use cases and ecosystem partnerships enabled by mobile identity wallets — e.g., using identity data by banks to access government services (verified.me in Canada) or enabling contactless identity verification in travel and tourism use cases (government-sponsored pilots in Germany). The European Commission recommends member states issue digital identity wallets to citizens, starting 2022.

- **Growing traction of decentralized identity.** Interest in identity wallets is growing along with interest in decentralized and self-sovereign identity. Adoption is facilitated by the emergence of global standards like W3C verifiable credentials (VCs) and decentralized identifiers (DIDs). These enable the creation of open, interoperable identity wallet services.

- **COVID-19 vaccination certificates.** Several government and commercial initiatives explore the use of identity wallets to manage COVID-19 vaccination certificates and other health status data, especially for cross-border travel. Some initiatives build on the W3C VC standard, others don't.

Obstacles

- **Lack of mature standards and definitions.** Vendors and governments are labeling proprietary mobile apps that have only limited use and interoperability as identity wallets. These are unlikely to scale for new and unforeseen use cases.

- **Political uncertainties**. (Digital) identity is a controversial topic with high variation of connotations and sensitivities across geographies and societal groups. National digital sovereignty debates add to uncertainty about where governments will try to steer adoption and regulation of digital identity and identity wallets in particular.

- **Adoption by citizens**. Citizens may not accept identity wallets without assurance about control, privacy and security. They may also show little interest unless there are value-adding use cases and a low-friction user experience.

- **Smartphone penetration**. Identity wallets depend on citizens possessing a suitable smartphone, which risks increasing digital divides. This needs to be addressed to avoid disenfranchising citizens.

User Recommendations

- Identify opportunities and implications of citizen-oriented identity wallets by building use cases, pilots and POCs that involve stakeholders across different sectors and that pursue concrete benefits for holders, issuers and verifiers of identity credentials.

- Realize the different roles government can play — e.g., issuer or verifier of identity credentials, developer or regulator of identity wallets. Governments can explore how identity wallets interact with the evolving digital identity ecosystems, especially for decentralized and self-sovereign identity. Governments can also identify ways they can support citizens in making informed choices about their trust in and use of identity wallets.

- Promote open, transparent and scalable identity wallet infrastructures by making compatibility with emerging standards and participation in consortiums for identity wallets part of your digital identity roadmap and by avoiding premature vendor or technology lock-ins.

Sample Vendors

Evernym; Finema; IBM; IDEMIA; InfoCert; Jolocom; Microsoft; SecureKey; Thales; Trinsic

Gartner Recommended Reading

Top Trends in Government for 2021: Citizen Digital Identity

Predicts 2021: Identity and Access Management and Fraud Detection

MXDP

Analysis By: Arun Batchu, Jim Scheibmeir, Van Baker, Adrian Leow

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

A multiexperience development platform (MXDP) offers development teams an opinionated and integrated set of front-end development tools and "backends for frontends" services. Its purpose is to enable distributed and scalable development (both in teams and architecture) of fit-for-purpose apps across digital touchpoints and interaction modalities.

Why This Is Important

A MXDP unifies front-end application development activities across heterogenous types of apps so that the user experience (UX) across these apps is seamless, persistent and enjoyable. MXDPs ensure maximum reuse and accelerate development velocity.

Business Impact

- Delightful application user experiences that seamlessly and persistently span multiple devices and augment human senses (touch, vision, auditory).

- Simplified and composable construction of complex front-ends that speed-up application development and deployment.

- Smoother development experiences resulting in more engaged and loyal software engineers.

- Reduction of the number of development teams and personnel by allowing cross-platform development.

Drivers

- Need for consistent, seamless and distinctive application experiences that span an increasing number of end-user computing devices.

- Need for ambient (no-touch) experiences accelerated by the pandemic.

- Increased sophistication of multiexperience development platform technology.

- Increased demand for digitalization of industries using heavy machinery or operating in hazardous environments.

Obstacles

- Lack of portability of applications across MXDPs and vendor lock-in.

- Immaturity of immersive technologies.

- Inconsistent implementation of browser models across multiple devices and operating systems.

- Platform licensing costs, especially for consumer facing use cases.

- Learning curve for proprietary stack.

- Lack of and retention of trained personnel.

- Preference for open-source software stacks.

User Recommendations

- Guide teams to consider an MXDP as a supplement to open-source software stacks and low-code application platforms (LCAP).

- Drive innovation by having teams demonstrate the power of MXDPs to business and upper management stakeholders.

- Narrow down a consideration set by using Gartner's Critical Capabilities research for MXDPs.

- Use Gartner's Magic Quadrant research to pick a vendor that best matches the strategic vision and expectations of product execution.

- Evaluate licensing costs at scale, before increasing the impact of MXDPs.

- Develop plans for training and recruiting developers for the chosen MXDP.

- Mitigate lock-in risk by encouraging modularizing of applications and replacing them with open source stacks when appropriate.

- Utilize software engineering skills to extend the MXDP offerings with custom and reusable modules that citizen developers can utilize in no or low code development.

Sample Vendors

Appian; Builder.ai; GeneXus; HCL Software; Mendix; Neptune; Neutrinos; OutSystems; Pegasystems; Salesforce; SAP; ServiceNow; XOne

Gartner Recommended Reading

Technology Insight for Multiexperience Development Platforms

Magic Quadrant for Multiexperience Development Platforms

Critical Capabilities for Multiexperience Development Platform

Intelligent Applications in Government

Analysis By: Alia Mendonsa

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Intelligent applications are defined as enterprise applications with embedded or integrated artificial intelligence (AI) technologies, such as intelligent automation, data-driven insights and guided recommendations, to deliver a personalized interface, and improve productivity and decision making.

Why This Is Important

The pandemic catalyzed digital government acceleration, changing the way employees work and citizens interact with government. Legacy modernization gained momentum and funding as agility and fraud vulnerabilities surfaced. Leading enterprise application providers now incorporate AI capability. As new applications are acquired, government CIOs can leverage these capabilities to enable:

- Intuitive user experiences for employees and citizens

- Improved data transparency for better decision making

Business Impact

- Reduce or eliminate manual tasks, allowing workers to focus on value-based activities using intelligent automation and insights — via bots, sensors and machine learning.

- Embed AI in business processes for efficiencies, providing recommended next best actions for greater effectiveness in achieving mission.

- Enhance the user interface with conversation capabilities that interact through text or speech and improve the citizen experience.

Drivers

- Enhance data capture and response: Technologies such as NLP, text analytics, deep neural networks (DNNs) and image recognition can be used for intelligent invoice matching, extracting terms and conditions or clauses from contracts, or analysis of images for photographic recognition.

- Enhance and refine business processes: Machine learning, decision intelligence, knowledge graphs and explainable AI can infuse intelligent actions into an application. Eventually, this can be extended to identify patterns of work, from which process models can be built and executed. When processes or recommendations change due to AI, the business user must understand the reason for the changes, hence the use of explainable AI.

- Improve user experience: Conversational UI platforms are used to develop language-based interfaces that use text or speech to interact with the user. NLP used to create virtual assistants is one AI application. Further examples include facial recognition and other applications for understanding user emotions, context or intent, and predicting user needs.

- Improve decision making with augmented analytics: Create more predictive and prescriptive analytics that can then be presented to users for further evaluation or plugged into a process to drive an autonomous action.

- Legacy modernization increasing adoption: Visibility into supporting citizens' challenges as a part of pandemic response has spurred legacy modernization funding, accelerating adoption — especially where AI points toward fraud prevention, business process improvement in service delivery, and enhanced citizen experience.

Obstacles

- Although intelligent applications will have a widespread transformational effect, the hype around them has not particularly advanced since 2019. The message may have been obscured by the move to the composable enterprise. Application leaders may be considering intelligent components as distinctly separate solutions from the application itself. However, as the technologies have matured, they are increasingly offered native to applications.

- Typical refresh and funding cycles for application modernization in government may delay acquisition.

- A focus on citizen-facing use of AI and mobile applications will take priority over back-office use cases for AI.

- Concerns about bias, data quality and transparency may delay adoption of AI.

- Smart components may require updating from machine learning models, causing deployment challenges.

User Recommendations

- Build business cases for how AI can improve decisions through the use of data and operations by adding ways to capture and efficiently consume information.

- Challenge your packaged software providers to outline in their product roadmaps how they are incorporating AI to add value.

- Prioritize investments in domain-specific intelligent applications that improve citizen engagement, and service and collaboration to demonstrate AI's value and improve stakeholder buy-in.

- Verify vendor bias safeguards and transparency to further explainable AI goals and allay concerns in its use.

- Increase data literacy in preparation for intelligent applications by implementing data governance and data quality practices.

- Incorporate AI components into your composable enterprise thinking to innovate, reduce costs and lay the foundation for ecosystem partnerships. Continuously consider how AI can refresh and rebuild machine learning models, as this can impact implementation and usage.

Sample Vendors

Google Docs; Infor Coleman; Microsoft 365; Oracle Fusion Cloud Applications; Salesforce Einstein; SAP Leonardo; ServiceNow; Sievo; Workday

Gartner Recommended Reading

Top Trends in Government for 2021: Operationalized Analytics

Application Leaders: Master Composable Enterprise Thinking for Your Post-COVID-19 Reset

Drive Better Digital Workplace Employee Collaboration Using AI, Chatbots and Advanced Analytics

How to Apply 'Intelligent' to Your ERP Strategy

Knowledge Graphs

Analysis By: Afraz Jaffri

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Knowledge graphs are data structures, representing knowledge of the real world including entities (people, companies, digital assets, etc.) and their relationships, which adheres to a graph data model — a network of nodes (vertices) and links (edges/arcs). The knowledge within the graph can be explicitly stated or implicitly inferred using rules that are defined in an ontology for classes of entities and relationships. Further knowledge can be derived using graph analytics and machine learning.

Why This Is Important

Knowledge graphs capture information about the world in an intuitive way that is often easier to understand, manipulate and use than other types of data models. Google, Facebook, Amazon and other tech companies use graphs as the backbone of a number of products and services due to their ability to encode and interrelate disparate data at source. They support collaboration and sharing, search and discovery, and the extraction of insights through analysis.

Business Impact

Knowledge graphs can drive business impact in a variety of different settings including:

- Digital workplace (e.g., collaboration, sharing and insight).

- Automation (e.g., ingestion of data from content to RPA).

- Machine learning (e.g., augmenting training data).

- Investigative analysis (e.g., law enforcement, cybersecurity or financial transactions).

- Digital commerce (e.g., product information management and recommendations).

- Data management (e.g., metadata management, data cataloging and data fabric).

Drivers

- Ongoing digitization and globalization initiatives lead to growing levels of complexity and dynamics, creating a need for more adaptive and integral approaches, as offered by knowledge graphs, replacing more static and siloed approaches.

- Increasing awareness of the use of knowledge graphs in consumer products and services such as smart devices and voice assistants, chatbots, search engines, recommendation engines and route planning.

- Improvements in graph DBMS technology that can handle the storage and manipulation of graph data structures at scale. This includes PaaS offerings that take away the complexity of provisioning and optimizing hardware and infrastructure.

- Knowledge graph platform providers are entering the market that provide a suite of tools for creating, managing and using knowledge graphs. Low/no-code tools are developing and expanding the use of knowledge graphs to business and nontechnical users.

- The desire to make better use of unstructured data held in documents, images and videos using standardized metadata that can be related and managed.

- The need to manage the increasing number of data silos where data is often duplicated and usage and consumption cannot be controlled.

- The increasing use of graph algorithms and machine learning to identify influencers, customer segments, suspicious activity and critical bottlenecks in complex networks.

- Service providers are specializing in knowledge graph implementation and building offerings based on the technology.

Obstacles

- Awareness of knowledge graph use cases are increasing but business value is difficult to capture in the early stages of implementation making them low priority initiatives.

- Moving knowledge graph models from prototypes to production requires engineering and system integration expertise. Methods to maintain knowledge graphs as their size increases to ensure reliable performance and handle duplication and data quality remain immature.

- Fragmentation of the graph DBMS market across the types of knowledge graph data models (RDF or property), implementation architectures (native or multimodal) and differences in optimal workloads (operational or analytical) continue to cause confusion and hesitancy among adopters.

- Key to the long-term success of knowledge graphs is enabling data within organizations to be interoperable with external knowledge graphs to enable the ingestion, validation and sharing of ontologies and data relating to entities e.g., geography, people, events, etc.

User Recommendations

- Identify use cases where there is a need for custom-made knowledge graphs through the use of a pilot project that delivers tangible value for the business, but also learning and development for data and analytics staff.

- Take an agile approach to knowledge graph development to decrease time to value. Assess the data that is needed to feed a knowledge graph, both structured and unstructured, creating a minimum viable subset that can be used to capture the information of a business domain.

- Utilize vendor and service provider expertise to validate use cases, educate stakeholders and provide an initial knowledge graph implementation.

- Include knowledge graphs within the scope of data and analytics governance and management. To ward against perpetuating data silos, investigate and establish ways for multiple knowledge graphs to interoperate. This is likely to extend to third party data knowledge graphs.

Sample Vendors

Cambridge Semantics; Diffbot; eccenca; Ontotext; Semantic Web Company; TopQuadrant

Gartner Recommended Reading

How to Build Knowledge Graphs That Enable AI-Driven Enterprise Applications

Top Trends in Data and Analytics for 2021: Graph Relates Everything

Graph Steps Onto the Main Stage of Data and Analytics: A Gartner Trend Insight Report

Working With Graph Data Stores

Financial Data Strategy and Knowledge Graphs

Data Exchange

Analysis By: Bettina Tratz-Ryan

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

Data exchanges in intelligent urban ecosystems have been developed from the data marketplace concept that drives the flow and exchange of data between the smart city stakeholders. The value of data will be determined through the context and significance of developing and executing on valuable data streams for various public and private use cases. The value of data exchanges is measured by the impact and usefulness of data collaboration and its outcome of business cases.

Why This Is Important

In an intelligent urban ecosystem/smart city, data access and its exchange are key by orchestrating data streams from multiple sources and interconnecting them with ecosystem stakeholders. The acceleration of data marketplaces for industry and government sectors on financial bases into data exchanges with various transaction mechanisms is based on cities collaborating with ecosystem partners to find a "system of systems" approach that potentially offers data exchange as a service.

Business Impact

An intelligent urban ecosystem can only work when there is a valuable data exchange between stakeholders, with a clear win-win strategy between citizens, businesses and governments. For example, smart campuses, industry parks and downtown areas develop mobility, service enhancements for concierge or health, and retail and office services by accessing data exchanges. In addition, data exchanges create an innovation thrust for new digital business models by cross-referencing the environment.

Drivers

- By associating big data with people or situations, city managers can provide responsive services that apply predictive and prescriptive capabilities to anticipate unfolding events in real time.

- The exchange of business or industry datasets, together with prioritization on quality of assessments for modeling or real-time decision making, becomes a critical enabler of service quality for the entire urban ecosystem.

- The speed of adoption has been changed to five years, given that many cities are building out data orchestration around data generated by government agencies, citizens, assets and businesses, and operations management data resulting from urban infrastructure and operations.

- With interactions between public and private sectors, cities and smart communities have opportunities to create service and market response agility by identifying market data for digital knowledge sharing and management, including crowdsourcing insights that could support communities to develop civic entrepreneurship.

- Organizations like Google Sidewalk Labs are showing interest in ecosystem data in smart districts to leverage curbside or data-exchange data for new service models. That can lead to data monetization acceleration.

Obstacles

- Data literacy is a critical enabler for data exchanges because it helps to create skills in using data for all business activities, inadvertently turning to trust in the data-exchange mechanism. Without literacy and trust, the ecosystem will be challenged to tap into good data for business development, especially in relation to privacy grounds.

- The value and market price of enriched data are determined by the business opportunity that is represented and on the certifiable quality of the data itself to cities and the wider industrial ecosystem. Its adoption rate will vary based on the ability to convince the data owners of the value of data orchestration and sharing. It also requires the technical interoperability of data layers and analytics systems.

- The ability to contextualize data with data orchestration requires data collection and dissemination based on a city's understanding and skill of industrial data governance, which needs to be applied across the ecosystem.

User Recommendations

- Examine standardization or adaptive governance models to feed open-source application and delivery models as they plan to integrate their application operation systems and platforms. The ability to interface with middleware underlying a proposed ecosystem will be critical.

- Engage with third-party developers or other entities to enable solutions in automotive, environmental development and journey mapping to be built on your platform, if unable to drive scale and usability across all ecosystem partners.

- Engage in discussions with the business and knowledge communities and collaborate with them on digital rights management, data attributes required and privacy issues. In the long term, develop a roadmap for connecting a "system of data marts" that embed open data portals and warehouses in an algorithmic business environment.

- Appraise chatbots and smart machines for creating automatic and machine learning insights.

Sample Vendors

Cloudera; HERE Technologies; Hitachi; IBM; Insait; NTT DATA; NXN; Opendatasoft

Gartner Recommended Reading

Turning Smart Cities Into Intelligent Urban Ecosystems

Establish an Urban Data Exchange for Smart Cities

The Urban Data Exchange Will Be an Engine of Community and Ecosystem Innovation

DGTP/Government Platforms

Analysis By: Bill Finnerty, Alia Mendonsa

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Digital government technology platforms (DGTPs) are a set of cross-cutting, integrated, horizontal capabilities that coordinate government services across multiple domains such as citizen experience, ecosystem, Internet of Things, IT systems and analytics. A DGTP approach enables modernizing legacy systems, and promotes innovation and digital transformation as a catalyst for the development of new platform business models.

Why This Is Important

Government use of digital technology platforms is growing in support of innovation, agility and adoption of platform business models. A DGTP exposes common tools and services through APIs and packaged business capabilities to enable a composable government enterprise. Governments of all levels and tiers are adopting DGTPs as single-function and whole-of-government platforms. Mature DGTPs are being equipped with low-code capabilities to enable use by both professional and citizen developers.

Business Impact

Government agencies can leverage a DGTP to deliver new digital services and fundamentally reinvent existing services in an ecosystem and constituent-centric manner while complying with enterprise privacy and security policies. Through the implementation of a DGTP, governments are able to maximize IT investments by reusing shared digital capabilities to be more streamlined, agile and integrated in using data to develop both internal- and external-facing digital solutions.

Drivers

- By implementing a DGTP, particularly with a low-code solution, government IT shops can leverage reusable components and packaged business capabilities to accelerate the development of digital services and drive innovation.

- Governments continue to struggle with the burdens of legacy systems. A DGTP provides them with a tool to drive continuous modernization to improve services and respond more rapidly to changing regulatory and legislative requirements.

- Enterprise implementation of DGTP capabilities provides the most cost-effective, efficient and user-friendly approach to implementation.

- Constituents do not want to be concerned with the mechanisms of government, whether they be what agency or ministry delivers a service or which tier of government is responsible. By leveraging a DGTP, governments are able to provide these capabilities to all services developed by agencies across their organizations, in other jurisdictions and other tiers of government, in an integrated manner.

- Government IT shops often struggle to meet the demand of program areas to be agile and responsive in delivering new digital services, resulting in a backlog of both updates to existing services and requests for new ones. A DGTP with a low-code solution included in its development environment provides an efficient, cost-effective way for IT and business technologists to efficiently address backlogs of needed updates and new services.

Obstacles

- Government culture and bureaucracy encourage perpetuation of silos, and it takes high-level sponsorship and resolve to change behaviors so that federated organizations can leverage DGTP effectively.

- While many vendor products aspire to Gartner's definition of a DGTP, few of them deliver all the features and platform benefits consistently. This results in the need for integration across a multivendor environment.

- Funding targeted at a single program or initiative can impede use of common components within a DGTP across divisions.

- Vendor roadmaps often do not support a modular approach to technology or licensing. This can limit these solutions' interoperability and effectiveness within a DGTP.

- Immature data governance can be a barrier to data sharing across continuous services that would benefit from the implementation of a DGTP.

User Recommendations

Government CIOs will need to influence strategic planning to prioritize agency needs for moving to a DGTP by working with their program and mission peers to:

- Define cross-agency opportunities and develop a shared vision that will improve citizen satisfaction and achieve mission objectives.

- Implement adaptive governance, and adopt and communicate a shared vision for the use (and reuse) of interoperable platform components.

- Build a compelling case for agencywide investments, and for not-new siloed platforms, based on economy, cost avoidance, operational efficiency, interoperability, agility and risk management.

- Create a developers' portal for the DGTP that includes documentation, training, licensing, transparency of usage and a low-code environment to enable developers and business technologists to create new digital services.

- Establish an enterprise integration layer that includes components that are on-premises, in the cloud or hosted in a hybrid environment.

Sample Vendors

Accenture; CivicPlus; Granicus; Microsoft; Oracle; PayIt; Pegasystems; Salesforce; SAP; Tyler Technologies

Citizen Engagement Hub

Analysis By: Apeksha Kaushik

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

A citizen engagement hub (CEH) is an architectural framework that ties multiple systems together to optimally engage citizens. It enables proactive and reactive communication, as well as personalized, contextual citizen engagement, using humans, artificial agents or sensors, across all interaction channels. It can also reach and connect various departments and agencies to enable, for example, synchronization of service delivery, capture, measure and analyze data for improved citizen experience.

Why This Is Important

CEH is a core component of a DGTP. Supporting citizens "anytime, anywhere," together with increasing citizen expectation, should make remedying shortcomings a priority for CIOs. With each service comes its own dependencies. Operations become costly as it scales, resulting in complex infrastructures whose management becomes burdensome. The proliferation of devices, digital touchpoints and interaction modalities requires leaders to transcend omnichannel and deliver single-view citizen services.

Business Impact

The future state of the CEH will be a combination of technologies, governance, integration and processes. Need is to determine which technologies will address the identified pain points in the citizen journey and what approaches to integration are available for each. This will also provide a single view of government for the citizens. Breaking into the silos, CEH can reduce time spent gathering information already collected by another part of the organization

Drivers

A number of factors are driving the need for a more holistic view of citizens and how to serve them seamlessly across agencies:

- The pandemic has forced governments to respond rapidly to keep citizens and stakeholders informed. This demand has led to the growth in importance of digital channels as a means of reaching citizens as stakeholders. Eighty-two percent of government CIOs report an increase in the use of digital channels to reach citizens in 2020, and expect that increase to be sustained in 2021 (2021 CIO Agenda: Government CIOs Step Up to Action for Digital Acceleration).

- Governments need to be equitable in their service delivery. As digital channels take more and more of the share, they still need to serve those not using digital means. A CEH can help manage that risk.

- As organizations plan to engage citizens with a greater array of digital touchpoints and interaction modalities, multiexperience will become an increasingly important strategy aligned with CEH. The multiple channels, from multiple parts of government must be orchestrated. This can be achieved through the CEH.

- Citizen engagement is not just a digital services problem or objective; it takes longer to develop and spans all channels and all engagements. Forty-seven percent of government CIOs report that engagement has increased throughout 2020, with a further 59% reporting that they expect citizen engagement to further increase in 2021 (2021 CIO Agenda: Government CIOs Step Up to Action for Digital Acceleration).

- For government CIOs, operational and technology silos will remain a norm that they must confront across various tiers and departments of the governments. A focus on the emerging CEH will foster consistent engagement with citizens breaking silos with effective use of data.

Obstacles

- To impact citizen engagement, governments need to ensure that they take a human-centered approach to service design, looking at the end-to-end experience of the citizen, not just spot-fixing problems.

- Agency barriers, politics, data regulation that limits sharing, and concerns about privacy prohibit the full implementation of many cross-agency collaborative efforts.

- The implementation of CX management and a CEH will require a significant amount of change to both business processes and technologies. Leaders should recognize that employees may face "change fatigue" and plan accordingly.

- At present, most components of a CEH are not bundled as a suite. There is a likelihood that the CEH will remain a system of systems and never evolve into a product.

- Vendors tend to focus on what can be mass-produced and easily sold, rather than on products that can transform a business but require complex buying centers and change management. They will need to focus on integration of the needed components.

User Recommendations

Government CIOs responsible for technology optimization and modernization should realize the need for enterprise governance of a CEH, as a product:

- Approach the idea of the CEH as a business strategy linked to a technology framework, rather than as a software product to be bought from the market by setting up CX metrics and aligning outcomes.

- Test the fitness of CRM/CX-oriented applications to meet the needs of engaged citizens.

- Align the business and IT processes for various agencies and functions laying out the guidelines for data usage, analytics and governance addressing concerns regarding citizen privacy and ethics.

- Evolve citizen engagement processes and technologies by examining vendors' roadmaps, need and readiness of their own organization.

- Optimize real-time, cross-process, cross-agency-domain, context-aware decisions by applying continuous intelligence in their CEH, emphasizing on citizen journey maps and "Human-Centred Design (HCD)."

Gartner Recommended Reading

Top Trends in Government for 2021: Multichannel Citizen Engagement

Innovation Insight: Assessing Public Meeting Management Solutions for Government

Data Fabric

Analysis By: Ehtisham Zaidi, Robert Thanaraj, Mark Beyer

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

A data fabric is an emerging data management design for attaining flexible and reusable data integration pipelines, services and semantics. A data fabric supports various operational and analytics use cases delivered across multiple deployment and orchestration platforms. Data fabrics support a combination of different data integration styles and leverage active metadata, knowledge graphs, semantics and ML to automate and enhance data integration design and delivery.

Why This Is Important

A data fabric leverages both traditional and emerging technologies in enterprise architectural design and evolution. It is composable and supports flexibility, scalability and extensibility in an infrastructure used by humans or machines across multiple data and analytics use cases. It abstracts data management infrastructure to disintermediate any incumbent platforms, and enables data integration and delivery regardless of the number of on-premises or CSP-based data assets in use.

Business Impact

Organizations benefit as data fabric:

- Provides insights to data engineers and ultimately automates repeatable tasks in data integration, quality, data delivery, access enablement and more.

- Adds semantic knowledge for context and meaning, and provides enriched data models.

- Evolves into a self-learning model that recognizes similar data content regardless of form and structure, enabling broader connectivity to new assets.

- Monitors data assets on allocated resources for optimization and cost control.

Drivers

- A data fabric enables tracking, auditing, monitoring, reporting and evaluating data use and utilization, and data analysis for content, values, veracity of data assets in a business unit, department or organization. This results in a trusted asset capability.

- Demand for rapid comprehension and adaptation of new data assets has risen sharply and continues to accelerate — regardless of the deployed structure and format. The data fabric provides an operational model that permits use cases, users and developers to identify when data experience varies from the data expectations depicted in system designs.

- A shortage of data management professionals is increasing the demand for accurate and actively utilized metadata to make system design, data availability and data trust decisions.

- Catalogs alone are insufficient in assisting with data self-service. Data fabrics capitalize on machine learning to resolve what has been a primarily human labor effort using metadata to provide recommendations for integration design and delivery.

- Business delivery and management professionals find it difficult to identify adjacent, parallel and complementary data assets to expand their analytical models. Data fabrics have the capability to assist with graph data modeling capabilities (which is useful to preserve the context of the data along with its complex relationships), and allow the business to enrich the models with agreed upon semantics.

- Significant growth in demand and utilization of knowledge graphs of linked data as well as ML algorithms to provide actionable recommendations and insights to developers and consumers of data can be supported in a data fabric.

- Organizations have found that one or two approaches to data acquisition and integration are insufficient. Data fabrics provide capabilities to deliver integrated data through a broad range of combined data delivery styles including bulk/batch (ETL), data virtualization, message queues, use of APIs, microservices and more.

Obstacles

Data fabrics are just past the Peak of Inflated Expectations. The main challenges surrounding broad adoption are:

- Diversity of skills and platforms to build a data fabric present both technical and cultural barriers. It requires a shift from data management based upon analysis, requirements and design to one of discovery, response and recommendation.

- Intentional market hype by providers and services organizations purporting a data fabric delivery is adding to market cynicism.

- Misunderstanding and lack of knowledge in how to reconcile and manage a data fabric and a legacy data and analytics governance program that assumes all data is equal will lead to failure.

- Proprietary metadata restrictions will hamper the data fabric, which is wholly dependent upon acquiring metadata from a wide variety of data management platforms. Without metadata, the fabric requires analytic and machine learning capabilities to infer missing metadata, and while possible, will be error prone.

User Recommendations

Data and analytics leaders looking to modernize their data management with a data fabric should:

- Invest in an augmented data catalog that assists with creating a flexible data model. Enrich the model through semantics and ontologies for the business to understand and contribute to the catalog.

- Invest in data fabrics that can utilize knowledge graph constructs.

- Ensure subject matter expert support by selecting enabling technologies that allow them to enrich knowledge graphs with business semantics.

- Combine different data integration styles into your strategy (bulk/batch, message, virtualization, event, stream, replication and synchronization).

- Evaluate existing tools to determine the availability of three classes of metadata: design/run, administration/deployment and optimization/algorithmic metadata. Rate existing and candidate platforms and favor those that share the most metadata.

- Focus on a similar transparency and availability of metadata between PaaS and SaaS solutions.

Sample Vendors

Cambridge Semantics; Cinchy; CluedIn; Denodo; IBM; Informatica; Semantic Web Company; Stardog; Talend

Gartner Recommended Reading

Top Trends in Data and Analytics for 2021: Data Fabric Is the Foundation

What Is Data Fabric Design?

Top Trends in Data and Analytics for 2021: Data Fabric Is the Foundation

Emerging Technologies: Data Fabric Is the Future of Data Management

Decentralized Identity

Analysis By: David Mahdi, Michael Kelley

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Decentralized identity (DCI) leverages technologies such as blockchain or other distributed ledger technologies (DLTs) to allow an entity to create and control its own digital identity. Thus, it provides an alternative to centralized IAM architectures by establishing trust in identities and resilience within the overall system, with little reliance on centralized arbiters or identity stores.

Why This Is Important

Isolated digital identities will not scale with the needs of digital business. Online and mobile identities continue to be in a fragmented state due to service providers (banks, retailers, social networks, etc.) forcing consumers to create individual identities for each and every service. DCI offers an alternative approach that does not have the security, privacy and usability issues associated with traditional, fragmented, digital identity approaches.

Business Impact

With DCI, users gain control of their identities and data, enabling service providers to interact with users with greater speed and confidence. Currently, providers typically hoard identity information about users. Leveraging DCI, identity and service providers will be able to increase security and access convenience for end users, while reducing exposure to data breaches and potential privacy compliance violations.

Drivers

- **Vendor investments in DCI:** Due to the ubiquity and influence of vendors investing in this space, there is high potential to drive the DCI market forward. Significant investments have been made by IBM and Microsoft. Other major developments in this space include the acquisition of ShoCard by Ping Identity, and funding received by vendors such as 1Kosmos and InfoCert.

- **Investments in BYOI:** Including investments in overall BYOI could also act as a precursor to DCI adoption. E.g., Microsoft enabling "external identities" with Azure Active Directory (Azure AD).

- **Client and overall market interest in DCI:** Interest is increasing due to attractive elements such as the ability to enable new digital business opportunities while maintaining client privacy. For example, using DCI to share verified claims, such as age/income, without the need to expose sensitive personal data.

- **Standards enabling consistency:** Standards are currently emerging, led by entities such as the World Wide Web Consortium (W3C) and Decentralized Identity Foundation (DIF), to create a consistent approach to DCI. These standards will help propel this technology forward.

Obstacles

- Despite a lot of promise and hype, adoption is slow due to lack of progress and inaction by most large ecosystem players, CIAM vendors and various IDPs including governments.

- Standards are still in the development stage.

- Lack of core DLT/blockchain performance, interoperability, scalability and maturity.

- Lack of clear security standards for DLTs, such as crypto-agility, wallet standards/adoption and security.

- Lack of production-level solutions, which prevents some organizations from deploying due to concerns of having to "rip and replace" in the near future when the solutions stabilize.

User Recommendations

- Deliver attainable use cases as POCs, such as a DCI solution focused on business partners (i.e., limited deployments, low in scale). Plan for, but don't rush, long-term, large-scale initiatives such as consortium and/or DCI interoperable global identity.

- Leverage market vendors, such as IBM, Microsoft or Ping Identity, to understand the possibilities and potential of DCI.

- Be cautious of overoptimistic vendor claims. Evaluate the technical security aspects of blockchain platforms under consideration. In particular, examine vendor plans for support of standards, such as W3C and DIF.

Sample Vendors

1Kosmos; Evernym; Finema; IBM; InfoCert; Microsoft; Ping Identity; SecureKey

Gartner Recommended Reading

Guidance for Decentralized Identity and Verifiable Claims

Smart Workspaces

Analysis By: Gavin Tay, Rashmi Kotipalli, Annette Jump

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

A smart workspace exploits the growing digitalization of physical objects enabled by the Internet of Things (IoT) to deliver new ways of working, scheduling resources, coordinating facility services, sharing information and collaborating. The programmability of physical environments enables smart workspaces to work contextually with devices, software applications, enterprise social graphs and artificial intelligence (AI) to improve workforce efficiency and effectiveness.

Why This Is Important

Remote working instituted by COVID-19 has diversified smart workspaces. Home spaces now support employee productivity, safety and cultural perception of the workplace. Employee experience improvement is a priority so that employees make better use of smart workspaces for hybrid work. Traditional office models that were pandemic-struck and underutilized are being phased out. Utilization data of these changes is leading to smart workspaces focused on well-being and safety while reducing cost.

Business Impact

Smart workspaces have been forever reshaped into multilocation workspaces. The digitalization and programmability of these multilocation workplaces is creating new integration opportunities. IT methodologies related to system design are requiring new skills for design teams to understand how people use places and things. Smart workspaces are also having an organizational impact as IT teams now need to work with facilities management teams in ways not previously envisioned.

Drivers

- Digital workplace strategies that focus on facilities modernization, more agile/hybrid work environments and the value of employee experience continue to shape interest in smart workspace technologies. We see synergies between 10 trends: the IoT; AI-related technologies; AR/VR/MR; digital signage and electronic whiteboards; indoor mapping; smart buildings, including trends in integrated workplace management systems (IWMSs); IWMS platforms (as they move into IoT-based services); remote working/collaboration and virtual workspaces; occupancy and motion sensors; wearables; and facial recognition/natural language processing (NLP).

- A smart workspace is a key aspect of a digital workplace initiative, as it includes strategists involved in facilities and real estate as key stakeholders. It applies to physical environments such as: building and campus environments, including in-building open spaces; ome spaces (due to remote working instituted by COVID-19); co-working spaces to support agile/hybrid work; office and desk spaces; conference and huddle rooms; smart meeting rooms; retail and shop floors; and manufacturing assembly lines.

- "Things" participate in a smart workspace. Examples include building interfaces (HVAC), large digital displays, smart badges, workstations, mobile devices and wearables.

- Electronic whiteboards are becoming integrated with traditional collaboration and content software systems to address a hybrid workforce. Meeting artifacts can be better captured and connected to digital workplace graphs, to become more widely searchable.

- Beacons and sensors placed in key locations within a workplace can interact with mobile apps to deliver personalized information to workers, based on proximity. These can be used to improve employee learning, provide relevant information on products or communicate safety procedures based on employee location.

- As workers return to work postpandemic, contactless authentication using facial recognition and QR code scanning has become the norm.

Obstacles

- Smart workspaces are emerging at an uneven pace as organizations prioritize potential solutions independent of one another. For instance, building upgrades may take longer than expected, and some market sectors will lag in terms of smart workspace adoption. Localization needs will also influence smart workspace adoption.

- Adoption rates will vary based on organizations' requirements to support flexible hybrid work models that optimize the physical and interactive aspects of places and things (as well as employees' privacy concerns).

- As workers return to work postpandemic, we should expect organizations to take full advantage of a smart workspace. It requires organizations' expertise to reimagine and redesign strategies to include methods for gaining a better understanding of how people participate in physical spaces or adhere to social distancing. Such insight, which is scarce, can create new capabilities related to seating and room allocation, access management, and wayfaring.

User Recommendations

- Focus digital workplace strategies and digitalized business processes toward smart workspace trends. Seek deployment opportunities that include hybrid offices, co-working spaces and in-building open spaces.

- Expand beyond traditional productivity scenarios, with emerging applications that are more industry- and process-specific. Examples derived from COVID-19 include insurance professionals using a remote digital pen that interacts with back-end processing systems, and patients being remotely monitored via a wearable that interfaces with diagnostic systems to update healthcare professionals.

- Foster close partnerships between IT, and real estate, facilities and HR teams. Identity and access management (IAM), privacy and security teams play a critical role in supporting contact-tracing requirements. Anonymizing data is key to safeguard privacy expectations and promote adoption of new services while delivering employee experience.

Sample Vendors

AgilQuest; Condeco; Estimote; Eutech; Microsoft; Oblong; Planon; PRYSM Group; Spacewell; Trimble

Gartner Recommended Reading

Emerging Technology Analysis: Smart Spaces

Emerging Technologies: Smart Robots Will Augment Human Workers, Not Replace Them

Market Insight: Choose the Right Technology to Dynamically Track People Within a Smart Space

Transform Ghost Offices Into 24/7 Wellness-Monitored Co-working Offices and Capitalize on Tax Relief

Blockchain in Government

Analysis By: Arthur Mickoleit, Rick Howard

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

Blockchain in government refers to the broad and diverse portfolio of public services that could be improved or transformed by multiple entities in an ecosystem having a shared, single version of the truth. Those services are built on cryptographically signed transactional records.

Why This Is Important

Blockchain can reshape government services by providing a transparent, authoritative transaction record and reduced friction across multistakeholder ecosystems. Even though the majority of blockchain technologies are not ready for large-scale government adoption, there are potential near-term impacts in financial market regulation, record keeping, smart contracts, digital identity and credential sharing. Emerging economies, including China and India, are seeing considerable traction.

Business Impact

- Blockchain has begun to impact government by inspiring new governance, business and service delivery models in areas like record keeping and digital identity.

- Government is more cautious in blockchain adoption than industries like financial services, trade, utilities and insurance, with most government blockchain initiatives in exploratory stages. Much ROI, therefore, lies in building internal capacities and capabilities, and gauging potential impacts of wider blockchain adoption in government.

Drivers

Government exploration of blockchain opportunities keeps on growing due to:

Political attention to blockchain

Governments at different tiers are including blockchain in their strategies for competitive edge or digital transformation. Examples include:

- Australia's national blockchain roadmap

- Blockchain in China's new infrastructure plan

- EU blockchain partnership

- Blockchain policy in Tamil Nadu, India

- United Arab Emirates' blockchain strategy

- Cryptocurrency task force in Miami-Dade County, Florida

- Several U.S. states using blockchain to process digital evidence in courts

Growing maturity of blockchain technologies

Future opportunities to scale initiatives toward production stages revolve around:

- Financial market regulation — For example, Brazil's PIER platform for licensing financial institutions or Sweden's e-krona exploration.

- Record keeping — For example, the Verifiable Organizations Network (VON) in Canada or registering land titles in Georgia

- Smart contracts and provenance — For example, the Smart Trade Mark service piloted by the Australian government

- Identity data sharing — For example, Singapore's OpenCerts for education credentials or Verified.Me in Canada

More use cases becoming blockchain-complete

Outside selected areas (decentralized finance and nonfungible tokens), most current initiatives include blockchain as an optional component — making them "blockchain-inspired." Future potential for disruption is expected from blockchain-complete service delivery models.

Traction coming from COVID-19 vaccination certificates

Some national and international initiatives are exploring blockchain-enabled schemes for managing individuals' vaccination information.

Availability of "walled garden" blockchain applications

Private and permissioned blockchains and related technologies offer possibilities for selective sharing between exclusive sets of stakeholders — making the technology more palatable for government authorities.

Obstacles

- **Limited government use cases with proven ROI.** Many proofs of concept and prototypes of blockchain's potential are underway at all government levels (including smart cities). But hype and uncertainty clearly coexist when it comes to evidence of the added value and impacts of government blockchain initiatives.

- **Nascent technology maturity.** Some blockchain technologies are maturing, but many are not yet mature enough for large-scale rollouts in public-sector contexts. Only a few global standards exist (for example, some within ISO/TC 307), but a much larger number are still under development.

- **Lack of agreement among diverse stakeholders.** Blockchain solutions can add value where a single system of record (a single source of truth) is needed across multiple entities, based on immutable data and audit trails. However, that also means building necessary consensus and agreeing on common infrastructures, which takes time, resources and political will.

User Recommendations

Government CIOs must:

- Manage stakeholder expectations regarding potential value and current risks of blockchain by producing and delivering a short, high-level presentation that includes realistic ROI. Use this to become a trusted and strategic ally for managing the expectations and impacts upward (politicians), sideways (peers), downward (teams) and outward (constituents).

- Evaluate and screen blockchain-inspired business proposals by using a decision tree to determine if blockchain is the best solution. Prioritize sustainable blockchain opportunities that align with business priorities, show a proven track record of maturity progress, and add value for the public sector and citizens.

- Identify government-specific opportunities by exploring alternatives to public blockchains, such as private or permissioned blockchains, and by exploring blockchain needs and opportunities with a wide range of nongovernment stakeholders.

Gartner Recommended Reading

Blockchain Trials Show Business Executives Drive Focused Solutions to Production

Assessing the Optimal Blockchain Technology for Your Use Case

Case Study: Digital Transformation of a Legacy Paper-Based Process (U.N. Joint Staff Pension Fund)

Case Study: Using Blockchain to Assure Property

The China Blockchain Service Network: A New Digital Infrastructure to Accelerate and Challenge Digital Commerce Globally

Computer Vision in Government

Analysis By: Dean Lacheca

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Computer vision (CV) is a process that involves capturing, processing and analyzing real-world images and videos to allow machines to extract meaningful, contextual information from the physical world. CV in government is the application of the technology, by all levels of government, to new and existing government image and video source data to expand the data's relevance, accelerate speed to insight and improve decision making.

Why This Is Important

Interest and use cases for CV in government continues to grow. Currently, public safety, law enforcement and local government lead adoption of CV; however, opportunities exist for use in all sectors of government. CV has the potential to unlock the value of underutilized data in government, as well as support the redesign of government service delivery. The privacy implications of CV may be politically significant, requiring close regulatory and ethical attention.

Business Impact

Computer vision will augment the capabilities of the government workforce and its partners. Beyond public safety, law enforcement and smart city use cases, opportunities also include:

- Automating and streamlining regulatory activities

- Accelerating speed to value of some labor-intensive tasks

- Redesigning service delivery and data capture

- Reducing data errors

- Improving citizen experience, and in some cases, the risk to the workforce and citizens

Drivers

- CV offers the potential to accelerate the manual analysis of existing government image and video source data by governments.

- The proliferation of government-controlled cameras and other sensors is generating exponential increases in image data, creating a critical and growing demand for methods to automate analysis and manage and extract value from that data.

- This increased availability of video and image content has opened up new use cases across a range of government sectors, from environment to defense to emergency management and response. Examples include wildfire detection, agriculture inspections and land use mapping.

- Combining CV with new data capture technology such as drones and LiDar allows governments to explore new ways of working. For example, physical inspections, such as infrastructure inspections of bridges, can be made safer, more efficient and cost-effective.

- CV has enabled a number of COVID-19-triggered use cases to support social distancing compliance, PPE compliance, people counting and occupancy and fever screening.

- Pressure on governments to be more proactive and frictionless in service delivery requires innovative approaches to service delivery.

Obstacles

- Price, performance and reliability — high-end systems are expensive to maintain and support, and building business cases with adequate ROI remains challenging.

- Integration with existing systems is problematic due to a lack of open interfaces, off-the-shelf solutions and plug-and-play capabilities.

- Governments concerned about community trust and privacy concerns/regulations can limit the ability to apply CV solutions.

- Scaling solutions is often challenging due to the requirement for a high level of customization and service support.

- Adequate, unbiased training and testing data may be hard or expensive to acquire, especially in areas where available open-source CV datasets are declining.

- Government data source quality may not be high enough to deliver the expected benefits in a cost-effective way.

- Proprietary algorithms and patent pools deter innovation.

- The operationalization of the AI techniques (such as deep learning) that underlie CV is challenging.

User Recommendations

- Start to address quality data source issues by developing a quality source dataset from existing government-controlled feeds.

- Critically assess change management impacts of CV projects on the organization and its people.

- Focus initially on a few small projects, using fail-fast approaches, and scale the most promising systems into production using cross-disciplinary teams.

- Test production systems early in the real-world environment since lighting, color, object disposition and movement can break CV solutions that worked well in the development cycle.

- Build internal CV competencies and processes for exploiting image and video assets. This will enable the organization to make better procurement choices and lay the groundwork for more advanced innovation and product development opportunities.

- Exploit third-party CV tooling and services to accelerate data preparation and reduce costs.

- Evaluate legal, regulatory, commercial and reputational risks associated with CV projects at the outset.

Consent and Preference Management

Analysis By: Andrew Frank

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Consent and preference management platforms consolidate end-user choices regarding how their personal data should be handled. Choices are synchronized across legacy, active and incoming repositories, both on-premises and in the cloud. The intent is to extend visibility and control to website visitors, allowing them to determine and change how much of their data to expose, to whom and for what purpose. This also empowers marketers to respect customers' choices with a minimum of manual overhead.

Why This Is Important

A global wave of legislation and technology changes is rapidly transforming norms and protections for personal data collected digitally. Organizations that fail to keep up with these changes now face substantial material risk. The result is an imperative for organizations to invest in consent and preference management platforms (CPMPs) to comply with new laws, preserve essential capabilities, and demonstrate to customers and stakeholders that they care about privacy.

Business Impact

- Decisive actions of governments and technology platform providers have raised public awareness of privacy issues associated with digital data collection, creating consumer expectations and demands for transparency and control over personal data.

- Meeting these new demands while maintaining suitable capabilities to utilize customer data for business purposes can be technically and operationally challenging. CPMPs address these difficulties.

Drivers

Three kinds of drivers are accelerating the need for consent and preference management:

- **Social norms and expectations —** As consumers' expectations of transparency and control over personal data increase, respecting their choices becomes imperative. But consent flow banners and dialogues can significantly downgrade user experience, driving the need for better design solutions enabled by certain CPM providers.

- **Compliance —** Since the European Union implemented the General Data Protection Regulation in 2018, regions worldwide have been following suit with similar laws. CPMPs address specific requirements, such as enforcing consent options and making data available for data subject rights requests. These complex requirements often affect multiple systems within and across organizations, discouraging do-it-yourself solutions.

- **Technology platform changes** — Third-party cookies, which provide the foundational mechanism for tracking browser activity across websites, have been deprecated by Apple in its Safari browser and are slated for deprecation by Google in Chrome in late 2023. Apple has also introduced new user consent requirements for the use of mobile app identifiers for tracking. These changes are driving organizations to seek alternative customer identifiers, such as email addresses and phone numbers, along with the consent to use them for marketing and personalization.

Obstacles

- **Uncertain requirements and best practices** — Evolving laws and emerging technologies make CPMP projects difficult to scope and subject to cross-functional oversight and expertise. Vendors tend to downplay complexities of managing consent options and satisfying rights requests that impact internal and external datasets.

- **Lack of UX design support** — Forcing too many privacy choices on consumers degrades UX and leads to high opt-out and abandonment rates. Too few limits the ability to tailor experiences. To strike the right balance requires uncommon design skills.

- **Regional variations** — Laws vary by region, challenging organizations' attempts to standardize practices and governance across geographies.

- **Slow adoption by major providers** — Leading providers of cloud-based CX platforms to date rely on third-party integrations, creating friction for organizations that prefer native platform solutions. Accelerating consolidation among specialty providers increases uncertainty for buyers.

User Recommendations

- Establish consent management projects as a No. 1 enterprisewide priority. Plan for a complex array of consent management requirements and assemble sufficient resources from across the organization.

- Develop a consent matrix that defines types of communications granularly, and port existing customer databases into this new model. Justify your CPM solution by assessing requirements against market options and internal costs.

- Implement a formal review process for consent flow designs and work with designers and CX experts to create prototypes and test alternatives. To the extent permissible, treat consent as a contextual and progressive experience. Quantify costs in terms of user abandonment and consent decline rates.

- Avoid "dark pattern" consent dialogues that attempt to influence user choices by using unclear or deceptive language or presentation techniques. Beware of "off label" uses of CPM to extend data processing use cases beyond what users explicitly authorize.

Sample Vendors

BigID; Consentua; Crownpeak; LiveRamp; OneTrust; PossibleNOW; Salesforce; SAP; Tealium; TrustArc

Gartner Recommended Reading

Market Guide for Consent and Preference Management

Survey Analysis: Consent and Preference Management Platform Adoption Remains Low Despite Mounting Privacy Concerns

Survey Analysis: European Marketers Favor Short-Term Flexibility in Tech Deployments Over Long-Term Strategy

Assessing the Impact of Implementing a Customer Data Platform

Sliding into the Trough

Natural Language Processing

Analysis By: Bern Elliot, Erick Brethenoux

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

Natural language processing (NLP) enables an intuitive form of communication between humans and systems; NLP includes computational linguistic techniques aimed at parsing and interpreting (and sometimes generating) human languages. NLP techniques deal with the pragmatics (contextual), semantics (meanings), grammatical (syntax) and lexical (words) aspects of natural languages. The phonetic part is often left to speech-processing technologies that are essentially signal-processing systems.

Why This Is Important

NLP enables the automated processing and leveraging of vast quantities and types of text-based information. These can include documents, literature, email, text messages, invoices, receipts and so forth. With speech-to-text, NLP can also process speech, including livestreams of text and speech. As a result, NLP enables a vast array of applications and automation that previously were not achievable by machine, offering businesses significant levels of process improvement.

Business Impact

Many applications outlined in the Hype Cycle for natural language technology use NLP in some way.

- NLP is an enabler typically useful when built into applications that support business workflows.

- Because so many tasks involving text have had to rely on human labor, the potential for savings and for new business processes is vast.

- Business value reported from some applications using NLP, for instance machine translation, are thousandfold efficiency improvements and operational cost savings.

Drivers

- Basic transcription and translation services.

- Language-generation applications that produce natural language descriptions of tabular data, making it easier for many to understand.

- Keyword tagging in documents, making it easier to determine relevant sections or to extract other information such as intent and entities.

- Content moderation services that analyze user-generated content (text or images), to flag potentially offensive content or to identify fake news in social media.

- Sentiment analysis to identify the affective states and subjective information in statements — for instance from negative to neutral, to positive.

- Search improvements through better understanding of the intent of a search query as well as through summaries of the retrieved content.

- Text analytics to quickly process large numbers of organizations' documents and determine their compliance or legal validity.

- Advancement in insight engine text capabilities combined with more advanced NLP functionality.

- The introduction of new machine learning techniques, including transformer-based approaches such as BERT and GPT-2 and GPT-3. This has enabled new use cases and improvements to existing use cases.

Obstacles

- Human language is complex, dynamic and deeply influenced by cultural and other idiosyncratic conditions.

- Despite the progress made in NLP methods, there are many subtleties and nuances to properly processing the complex and enormous variety found in human languages.

- Recent NLP methods leverage deep neural networks. While the progress of neural and neural-symbolic processing is significant, many of these are experimental and fragile.

- Despite advances in new techniques, the hyped expectations surrounding NLP may result in unrealistic expectations, leading to disappointment in the actual results.

- New use cases of emerging NLP opportunities are poorly understood and face issues with meeting expectations or defining a clear business value to companies.

User Recommendations

- Select the strongest and most immediate use cases for NLP. Examples include customer service (impacting cost, service levels, customer satisfaction and upselling) and employee support (including augmenting them as they perform their tasks). Another example is automation of paper- and document-based tasks (such as contract analysis, compliance enforcement, document generation, translation and transcription).

- Demonstrate success in initial projects by starting with modest goals. As experience is obtained, projects should iterate, and scope can increase. As enterprises enhance their NLP implementations, new skills should be explored that are better able to leverage the new NLP methods.

- Verify the effectiveness of their solutions before making significant commitments, because the quality of NLP solutions will vary.

Sample Vendors

Clarabridge; IBM; Microsoft; NLTK; Rasa

Gartner Recommended Reading

Infographic: Artificial Intelligence Use-Case Prism for Customer Service

Cool Vendors in Conversational and Natural Language Technologies

2021 Strategic Roadmap for Enterprise AI: Natural Language Architecture

Craft a Chatbot Initiative Based on Your Business Requirements and Solution Complexity

Toolkit: Document the Mission of Your AI COE and Start to Staff It

Voice-of-the-Citizen Applications

Analysis By: Apeksha Kaushik

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Voice of the citizen (VoC) applications combine multiple, traditionally siloed technologies associated with the capture and analysis of direct, indirect and inferred customer feedback. Technologies involving citizen surveying, social media monitoring, speech and citizen journey analytics are integrated to provide a holistic view of the citizen's "voice." The resultant insights can be acted on automatically or disseminated to relevant government organizations to enhance citizen experience.

Why This Is Important

The pandemic has accelerated the adoption of digital services; however, many were MVPs. Making improvements to them and ensuring the longevity of the investments require more intentful listening of the constituent. Competing with digital services across all sectors requires that the government actively listen to constituents feedback on their service through use of data and emerging technologies like sentiment analysis.

Business Impact

VoC data sources can improve government understanding of citizens and drive continuous improvement. Integrated data, enables governments to:

- Uncover subtler insights.

- Drive accuracy in decision making process and system efficiency.

This holistic approach ensures that employees receive timely insights and instills confidence in actions taken at policymaking, implementation and strategic levels, improving:

- Digital optimization

- Transformation

- Citizen experience and engagement strategies

Drivers

Better government services are accelerating the adoption and maturity of VoC, including:

- Uncertainty caused by changes to the digital strategy and operations as a result of COVID-19, fueling the need for improved understanding of citizen needs

- Citizen expectation of digital service delivery increased by consumer experiences that leverage these solutions; governments must be more responsive to changing needs, requiring a robust VoC application

- Growing proliferation of online misinformation lead governments to develop citizen engagement frameworks and include social media guidelines, while leveraging VoC solutions to disperse information to more citizens via numerous channels to combat this

- Strong focus on KPIs and ROI for digital transformation investments by policymakers, executives and citizens

- Alignment with complementary employee experience (EX) initiatives currently fashionable with HCM leaders as a driver of convergence between customer and employee experience initiatives

- Technology progress allowing two types of actions: top-down policy improvements and, increasingly, real-time interaction improvements

Obstacles

Due to low digital government maturity and an emerging vendor landscape:

- Vendor expertise often lacks diverse feedback techniques as a holistic VoC solution for government organizations depending on myriad subsectors and tiers of the government.

- Few long-term viable solutions are available in the market, which makes procurement difficult.

- There is low acceptance by some government agencies, as individual departments may be reluctant to relinquish their tools and standardize on one central application.

- Multiple VoC data sources in silos inhibit identifying the true results. Analytics in isolation inherently limit the opportunity to fully understand citizens and can lead to redundancies.

- Few organizations have aligned the various sources to create an integrated VoC solution and are failing to realize the potential positive impact that feedback can have on improving the CX.

- An uncertainty of acceptance exists with certain citizens concerned about privacy, data sharing and usage.

User Recommendations

VoC should be in remit of a central citizen experience function or with a dedicated team. CIOs should:

- Conduct an internal audit to assess current citizen feedback capabilities and reduce duplication.

- Prioritize future initiatives that collect VoC data by balancing insightfulness with the quantity of feedback available. Strive to obtain a single, holistic view of VoC.

- Determine the most appropriate data architecture and analytical techniques to extract key citizen insights and aggregate those across government organizations and tiers.

- Distribute relevant insights/actions across the organization (front line and management) in a timely manner using workflow and operational integration.

- Build a proof of concept for impacts on service delivery, and use of HCD for assessment of citizen perceptions and concerns regarding 360-degree citizen views such as privacy and ethics.

- Leverage VoC in core business processes, with long-term viability toward real-time usage. Set a low threshold as a trigger.

Gartner Recommended Reading

2021 CIO Agenda: Government CIOs Step Up to Action for Digital Acceleration

Top Trends in Government for 2021: Multichannel Citizen Engagement

Innovation Insight: Assessing Public Meeting Management Solutions for Government

Toolkit: 2020 Strategic Roadmap for Digital Government CX Programs

Chatbots

Analysis By: Magnus Revang

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Early mainstream

Definition:

Chatbots are domain-specific or task-specific conversational interfaces that use an app, messaging platform, social network or chat solution for conversations. Chatbots range in use-case sophistication from simple, decision-tree-based, to implementations built on feature-rich platforms. They are always narrow in scope. A chatbot can be text-based or voice-based, or a combination of both.

Why This Is Important

Chatbots represent the No. 1 use of artificial intelligence (AI) in enterprises. Primary use cases are in customer service, human resources, IT help desk, self-service, scheduling, enterprise software front ends, employee productivity and advisory. Offerings in the market include developer self-service platforms, managed products, middleware offerings, integrated offerings and best-of-breed approaches.

Business Impact

Chatbots are the face of AI and will impact all areas with communication between machines and humans. Customer service is an area where chatbots are already very influential and will have a great impact on the number of service agents employed by an enterprise and how customer service is conducted. The change from "the user learns the interface" to "the chatbot learns what the user wants" has implications for onboarding, training, productivity and efficiency inside the workplace.

Drivers

- Chatbots in social media, service desk, HR or commerce, as enterprise software front ends and for self-service, are all growing rapidly.

- For enterprises, the main challenge with chatbots has been scaling and operationalizing them out of the proof-of-concept phase. As COVID-19 has accelerated adoption of chatbots, vendors seem to have "cracked the code" on operationalization. Vendors are now able to deliver multiple bots for multiple use cases, with no-code environments allowing multiple roles to participate in operationalization. This is creating a market for enterprise conversational AI platforms fueling the next generation of chatbots.

Obstacles

- Scaling and operationalizing still remain a challenge in some cases, due to lack of dedicated internal teams to work on continuous improvements.

- Figuring out the composition of teams, and the methodologies to iterate effectively, are still emerging practices with strong vendor dependency.

- Technology is improving at an astounding pace, but best practices on adoption and use of these technological advancements are still trailing, resulting in a lot of trial and error for enterprises.

- Selected vendors are sometimes unable to keep pace with the technology and the market dynamics.

- The vendor landscape comprises over 2,000 vendors, despite some consolidation during 2020. However, this is composed of many subcategories, majority of which are tactical. With this many vendors, the majority of chatbots will have to switch their underlying technology in the near to midterm future. Still a category of enterprise-grade platforms has emerged, with an estimated 120 vendors. These enterprise-grade platforms are becoming suitable as a more tactical choice.

User Recommendations

- Select an enterprise-grade platform to develop multiple use cases with orchestration of the assets needed.

- Focus on operationalization of chatbots as a product, with the necessary organization and roles in place, to evolve and maintain chatbots over time.

Sample Vendors

Amazon; Amelia; Cognigy; Google; IBM; Kore.ai; Microsoft; Pypestream; ServisBOT; Uniphore

Gartner Recommended Reading

The 3 Decisions You Must Make Before You Begin a Chatbot Project

Consolidate Your Chatbot Initiatives Into a Single Enterprise Strategy

When Should I Use Embedded Conversational Assistants?

Microservices

Analysis By: Anne Thomas

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

A microservice is a tightly scoped, strongly encapsulated, loosely coupled, independently deployable and independently operated application service. Microservices architecture (MSA) applies the principles of service-oriented architecture (SOA), DevOps and domain-driven design (DDD) to the delivery of distributed applications. MSA has three core objectives: Continuous delivery, precise scalability and improved stability.

Why This Is Important

Microservices architecture promises powerful application agility, scalability and resilience. It is a way to build cloud-native applications, and it facilitates continuous delivery practices. But the architecture is complex, with disruptive cultural and technical impacts. Misconceptions about microservices often push software engineering teams to use them indiscriminately, leading to overly complex architectures that fail to deliver anticipated benefits and often make things worse.

Business Impact

- Microservices increase business agility by enabling teams to incrementally deliver new features and capabilities in their software products in response to changing business requirements.

- Microservices improve the scalability of the software engineering organization by enabling small teams to work independently to deliver different services within an application.

- Microservices allow teams to change one part of an application, without the delay and cost of changing the entire application.

Drivers

- Software engineering teams adopt microservices architecture to facilitate a continuous delivery practice. The architecture must be combined with strong DevOps practices to enable teams to safely deploy small, independent features to production systems at the frequency at which they are delivered.

- When applied well, the architecture increases the independence of different parts of a large application, enabling multiple development teams to work autonomously and on their own schedules.

- Microservices architecture facilitates the building of cloud-native applications that support robust scalability and resiliency requirements.

- Microservices are frequently deployed in managed container systems, which can dynamically scale service instances in response to load requirements and automatically recover services that have failed.

- When combined with chaos engineering and resiliency practices, microservices architecture enables self-healing systems that can continue to operate through partial outages.

Obstacles

- Microservices architecture and its benefits are often misunderstood, and many software engineering teams struggle to deliver outcomes that meet senior management expectations. For example, microservices should not be shared, and they will not save you money.

- If you aren't trying to implement or improve your continuous delivery practice, you will almost certainly be disappointed with the microservices cost-benefit equation.

- Microservices architecture is complex. Developers must acquire new skills and adopt new design patterns and practices to achieve its benefits.

- Microservices disrupt traditional data management models.

- Microservices require new infrastructure.

- Microservices are related to but not the same as APIs or containers.

- Many software engineering leaders underestimate the cultural prerequisites. Success depends on applying mature agile and DevOps practices and changing team structures to align with service domains.

User Recommendations

- Set clear expectations by defining business goals and objectives for microservices architecture adoption based on realistic cost-benefit analysis of the architecture.

- Use microservices architecture as a tool to help you attain those goals. Don't view microservices as a destination.

- Avoid "microservice washing" conventional SOA, three-tier architecture and integration. Recognize the difference.

- Improve outcomes by creating guidelines for where and when software engineering teams should and should not use microservices architecture.

- Keep application architecture as simple as possible to achieve your goals.

- Address cultural concerns by aligning teams along business domain boundaries, investing in distributed computing architecture skills and improving DevOps practices.

Gartner Recommended Reading

Leading Teams to Success with Microservices Architecture

Designing Services and Microservices to Maximize Agility

10 Ways Your Microservices Adoption Will Fail — and How to Avoid Them

Hybrid Cloud Computing

Analysis By: David Smith, Milind Govekar

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Hybrid cloud computing comprises one or more public and private cloud services that operate as separate entities, but ones that are integrated. A hybrid cloud computing service is automated, scalable and elastic. It has self-service interfaces and is delivered as a shared service using internet technologies. Hybrid cloud computing needs integration between the internal and external environments at the data, process, management or security layers.

Why This Is Important

Hybrid cloud theoretically offers enterprises the best of both worlds — the cost optimization, agility, flexibility, scalability and elasticity benefits of public cloud, in conjunction with the control, compliance, security and reliability of private cloud. As a result, virtually all enterprises have a desire to augment internal IT systems with external cloud services.

Business Impact

Hybrid cloud computing enables an enterprise to scale beyond its data centers to take advantage of the public cloud's elasticity. Therefore, it is transformational, because changing business requirements drive the optimum use of private and/or public cloud resources. This approach improves the economic model and agility. It also sets the stage for new ways for enterprises to work with suppliers and partners (B2B) as well as customers (B2C).

Drivers

- The key driver for hybrid cloud is a desire to evolve data centers to become more cloud-like and therefore have a private cloud that has cost and other characteristics that are more like a public cloud, while maintaining "in-house" infrastructure for key privacy, security, data residency or latency needs.

- As more providers deliver hybrid cloud offerings, they increasingly deliver a packaging of the concept. "Packaged hybrid" means you have a vendor-provided private cloud offering that is packaged and connected to a public cloud in a tethered way. Azure Stack from Microsoft is a good example of this packaging, but there is another approach as well. We call these two main approaches "like-for-like" hybrid and "layered technology" hybrid (spanning different technology bases). Packaged hybrid cloud is a key component of the distributed cloud concept.

- The solutions that hybrid cloud provides include service integration, availability/disaster recovery, cross-service security, policy-based workload placement and runtime optimization, and cloud service composition and dynamic execution (e.g., cloudbursting).

- Hybrid cloud computing is different from multicloud computing, which is the deliberate use of cloud services from multiple cloud providers for the same general class of IT service.

- Note that internally run, virtualized environments are often recast as "private clouds," and then integrated with a public cloud environment and called a "hybrid cloud." Hybrid cloud assumes that the internal environment is truly a private cloud. Otherwise, the environment is hybrid IT.

Obstacles

■ Hybrid cloud computing complements multicloud computing. Although most organizations are integrating applications and services across service boundaries, we believe that few large enterprises have implemented hybrid cloud computing beyond this basic approach — and for relatively few services. Most companies will use some form of hybrid cloud computing during the next two years, but more advanced approaches lack maturity and suffer from significant setup and operational complexity.

■ Hybrid cloud is different from hybrid IT, which is where IT organizations act as service brokers as part of a broader IT strategy, and may use hybrid cloud computing. Hybrid IT can also be enabled by service providers focused on delivering cloud service brokerage, multisourcing, service integration and management capabilities. These services are provided by vendors, such as Accenture, Wipro and TCS, and other service providers and system integrators.

User Recommendations

■ When using hybrid cloud computing services, establish security, management, and governance guidelines and standards to coordinate the use of these services with public and private services.

■ Approach sophisticated cloudbursting and dynamic execution cautiously, because these are the least mature and most problematic hybrid approaches.

■ Create guidelines/policies on the appropriate use of the different hybrid cloud models to encourage experimentation and cost savings, and to prevent inappropriately risky implementations.

■ Coordinate hybrid cloud services with noncloud applications and infrastructure to support a hybrid IT model.

■ Consider cloud management platforms, which implement and enforce policies related to cloud services.

■ Consider using hybrid cloud computing, if your organization implements hybrid IT, as the foundation for implementing a multicloud broker role and leveraging hybrid IT services and service providers to complement your own capabilities.

Gartner Recommended Reading

Top Strategic Technology Trends for 2021: Distributed Cloud

Climbing the Slope

CSPM

Analysis By: Neil MacDonald

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Cloud Security Posture Management (CSPM) offerings continuously manage cloud security posture through prevention, detection, response and proactive identification of cloud infrastructure risk. The core of CSPM offerings apply common frameworks, regulatory requirements and enterprise policies to proactively and reactively discover and assess risk/trust of cloud services configuration and security settings. If an issue is identified, remediation options (automated or human driven) are provided.

Why This Is Important

Assessing the secure and compliant configuration of a modern cloud hyperscale IaaS environment is extremely difficult. Even simple misconfiguration issues such as open storage objects represent significant and often unidentified risk. Compounding the problem is the speed and scale of modern cloud deployments. Identifying cloud risk is impossible to solve without automation. This is an urgent problem set, and one that is encouraging rapid growth in the availability and maturation of this category.

Business Impact

CSPM offerings provide business and security leaders assurance that their cloud services are implemented in a secure and compliant fashion despite the speed, complexity, dynamics and scale of public cloud deployments. For enterprises that have a multicloud strategy, CSPM offerings provide a single way to implement and monitor security and compliance guardrails across multiple IaaS providers.

Drivers

- Multiple mature offerings are now available from established vendors.

- Hyperscale cloud service providers offer built-in CSPM capabilities suitable for single-cloud deployments.

- Most CWPP and CASB vendors now offer CSPM capabilities as a result of acquisitions or open-source integration.

- CSPM tools offer an abstraction layer that allows for consistent policy management across multiple clouds — a feat that borders on the impossible if you rely entirely on each CSP's native console.

- Several OSS options are emerging with enterprise offerings available.

- Some emerging CSPM platforms leverage graph and relationship mapping technologies that enable rich simulation, detection and forensic use cases.

- Some emerging vendors offer full-stack risk visibility with an understanding of vulnerabilities within the workload itself (VM or container), typically achieved by taking a snapshot of the running workload.

Obstacles

- CSPM point solutions are under tremendous competitive pressure as the market for CSPM matures and consolidates.

- CSPM offerings need to shift left and offer infrastructure as code scanning capabilities. Not all vendors offer this or only offer a limited set of infrastructure as code scripting languages.

- CSPM capabilities are available in many adjacent markets, making it difficult for end users to select the best approach.

- There is no standard way to remediate issues identified and approaches vary.

- Organizations are reluctant to enable automated remediation from SaaS-based CSPM offerings (that require read/write access) and prefer remediation within the context and control of their own CSP tenancy.

User Recommendations

- Investigate the cloud provider's own CSPM capabilities to see if they will satisfy the requirement

- Check and see if you already have suitable CSPM capabilities from your: (1) cloud workload protection platform (CWPP) vendor; (2) cloud access security broker (CASB) vendor; (3) cloud management platforms (CMPs) — your IT operations team has already purchased a cloud management platform with suitable CSPM capabilities (typically focused on resource utilization and billing, but many now extend into security assessments as well).

- Treat investments as tactical if a point solution is used. Limit contracts to one to two years as the market matures and further consolidates.

- Evaluate the CSPM provider's capability to provide security posture management at the SaaS layer.

- Extend scanning into development, including infrastructure as code scanning.

- Evaluate and compare the response options when an out-of-compliance configuration is encountered including alerting and automated remediation alternatives.

Sample Vendors

Check Point Software Technologies; Fugue; Lacework; OpsCompass; Palo Alto Networks; Rapid7; Radware; Trend Micro; Wiz; Zscaler

Gartner Recommended Reading

How to Make Cloud More Secure Than Your Own Data Center

How to Protect Your Clouds With CSPM, CWPP, CNAPP and CASB

Market Guide for Cloud Workload Protection Platforms

Innovation Insight for Cloud Security Posture Management

Event Stream Processing

Analysis By: W. Roy Schulte, Pieter den Hamer

Benefit Rating: Transformational

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Event stream processing (ESP) is computing that is performed on streaming data (sequences of event objects) for the purpose of stream analytics or stream data integration. ESP is typically applied to data as it arrives (data "in motion"). It enables situation awareness and near-real-time responses to threats and opportunities as they emerge, or it stores data streams for use in subsequent applications.

Why This Is Important

ESP is a key enabler of continuous intelligence and related real-time aspects of digital business. ESP's data-in-motion architecture is a radical departure from conventional data-at-rest approaches that historically dominated computing. ESP products have progressed from niche innovation to proven technology and now reach into the early majority of users. ESP will reach the Plateau of Productivity within several years and eventually be adopted by multiple departments within every large company.

Business Impact

ESP transformed financial markets and became essential to telecommunication networks, smart electrical grids and some IoT, supply chain, fleet management, and other transportation operations. Most of the growth in ESP during the next 10 years will come from areas where it is already established, especially IoT and customer experience management. Stream analytics from ESP platforms provides situation awareness through dashboards and alerts, and detects anomalies and other significant patterns.

Drivers

Five factors are driving ESP growth:

- Companies have ever-increasing amounts of streaming data from sensors, meters, digital control systems, corporate websites, transactional applications, social computing platforms, news and weather feeds, data brokers, government agencies and business partners.

- Business is demanding more real-time, continuous intelligence for better situation awareness and faster, more-precise and nuanced decisions.

- ESP products have become widely available, in part because open-source ESP technology has made it less expensive for more vendors to offer ESP. More than 40 ESP platforms or cloud ESP services are available. All software megavendors offer at least one ESP product and numerous small-to-midsize specialists also compete in this market.

- ESP products have matured into stable, well-rounded products with many thousands of applications (overall) in reliable production.

- Vendors are adding expressive, easy-to-use development interfaces that enable faster application development. Power users can build some kinds of ESP applications through the use of low-code techniques and off-the-shelf templates.

Obstacles

- ESP platforms are overkill for most applications that process low or moderate volumes of streaming data (e.g., under 1000 events per second), or do not require fast response times (e.g., less than a minute).

- Many ESP products required low-level programming in Java, Scala or proprietary event processing languages until fairly recently. The spread of SQL as a popular ESP development language has ameliorated this concern for some applications, although SQL has limitations. A new generation of low-code development paradigms has emerged to further enhance developer productivity but is still limited to a minority of ESP products.

- Many architects and software engineers are still unfamiliar with the design techniques and products that enable ESP on data in motion. They are more familiar with processing data at rest in databases and other data stores, so they use those techniques by default unless business requirements force them to use ESP.

User Recommendations

- Use ESP platforms when conventional data-at-rest architectures cannot process high-volume event streams fast enough to meet business requirements.

- Acquire ESP functionality by using a SaaS offering, IoT platform or an off-the-shelf application that has embedded CEP logic if a product that targets their specific business requirements is available.

- Use vendor-supported closed-source platforms or open-core products that mix open-source with value-added closed-source extensions for mainstream applications that require enterprise-level support and a full set of features. Use free, community-supported, open-source ESP platforms if their developers are familiar with open-source software and license fees are more important than staff costs.

- Use ESP products that are optimized for stream data integration to ingest, filter, enrich, transform and store event streams in a file or database for later use.

Sample Vendors

Amazon; Confluent; Google; IBM; Informatica; Microsoft; Oracle; SAS; Software AG; TIBCO Software

Gartner Recommended Reading

Market Guide for Event Stream Processing

Adopt Stream Data Integration to Meet Your Real-Time Data Integration and Analytics Requirements

Market Share Analysis: Event Stream Processing (ESP) Platforms, Worldwide, 2020

Document-Centric Identity Proofing in Government

Analysis By: Arthur Mickoleit

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Early mainstream

Definition:

Document-centric identity proofing (DCIP), informally "ID plus selfie," aims to verify an identity claim in a remote transaction through two combined activities: (1) confirming existence of real-world identity by capturing an image of an official identity document or reading its chip, and checking for signs of forgery; (2) confirming the claimant is present and the legitimate bearer of the identity document by capturing and comparing a live image to information obtained from the document.

Why This Is Important

Establishing confidence in identity is the foundation of digital interactions involving citizens or employees. The COVID-19 pandemic has accelerated the shift to remote work and digital services delivery by governments. DCIP is a mature technology and is used to establish high-level assurance of the identity and genuine presence of an individual in a remote interaction.

Business Impact

DCIP can support a trusted and convenient process to initially enroll citizens for access to agency-specific or whole-of-government digital services. It had been adopted by some governments prior to the pandemic and has accelerated since then to provide remote services to citizens who had not previously signed up for an official digital identity scheme. DCIP can also be used to elevate trust during the authentication for a high-risk transaction such as declaring change of residence.

Drivers

- **Acceleration in remote services delivery:** The ongoing shift to digital services delivery is creating the need to securely and conveniently register first-time digital services users. In the face of closures of physical offices or travel restrictions for citizens, the digital channel is often the only channel to onboard new users and deliver services. Examples of adoption include a diverse range of government authorities in Argentina, Australia, Germany, Norway, Spain and the United States.

- **Privacy breaches and identity theft:** Document-centric solutions increasingly replace obsolete data-centric identity proofing techniques. The latter rely on checking personally identifiable information (PII) provided by the user, like date of birth or Social Security number, against internal sources and registers. In the face of continual data breaches, it is prudent to assume that PII data is not secret and should not be used to assert an identity claim.

- **Convergence of identity proofing and authentication:** Organizations are exploring opportunities to leverage DCIP beyond the point of initial registration. The biometric information obtained during the identity proofing process can also be used as an authentication credential, enabling features such as "login via selfie" for remote transactions or "your face is your ticket" for boarding transport.

- **Remote working needs:** In a world where a person could apply for a job, be interviewed, land the job and then start work without ever meeting their employer face to face, many organizations need to adapt their processes. Organizations are also looking for ways to establish high trust in the identity of an employee executing a high-risk transaction or accessing sensitive information.

Obstacles

- **Privacy concerns of citizens:** Use of biometrics in government interactions is often met with reservation by citizens. DCIP solutions designed as one-off face verification transactions without further processing of biometric data might be perceived less concerning than further use of the captured biometrics data in other transactions.

- **Costs:** Commercial costs per proofing transaction can be prohibitive for some governments. Decisions might depend on the tolerable level of confidence in a citizen's identity for a given transaction.

- **User acceptance:** Handling an identity document and taking a selfie can be viewed as too onerous, especially for lower-risk transactions. It also cannot be assumed that everyone has a smartphone, a camera-enabled computer or a suitable document in the first place.

- **Demographic bias:** Concerns persist regarding demographic bias in the face recognition process. Vendor transparency in this respect is not uniform.

User Recommendations

- Examine DCIP as a proven tool in your citizen digital identity plans by evaluating its suitability for use cases that include remote onboarding, e.g., during lockdowns, or step-up authentication needs in high-risk transactions.

- Assess whether DCIP is required for your use cases by asking stakeholders whether, in addition to evidence that real-world identity exists, it is required to have high-level assurance that the rightful claimant of identity is genuinely present in digital interaction.

- Proactively address citizen concerns by being clear and transparent about the choice of use cases where DCIP adds tangible value and about the handling of biometric data captured during the proofing transaction.

- Manage a carefully considered vendor selection process by following the guidance in Buyer's Guide for Identity Proofing.

Sample Vendors

Acuant; IDEMIA; ID.me; Nect; Nets; Onfido; Thales; Veridas; ZOLOZ

Gartner Recommended Reading

Top Trends in Government for 2021: Citizen Digital Identity

Buyer's Guide for Identity Proofing

Market Guide for Identity Proofing and Affirmation

Full Life Cycle API Management

Analysis By: Shameen Pillai

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Early mainstream

Definition:

Full life cycle API management involves the planning, design, implementation, testing, publication, operation, consumption, versioning and retirement of APIs. API management tools enable API ecosystems and publishing APIs that securely operate and collect analytics for monitoring and business value reporting. These capabilities are typically packaged as a combination of developer portal, API gateway, API design, development and testing tools as well as policy management and analytics.

Why This Is Important

APIs are widely used and accepted as the primary choice to connect systems, applications and things to build modern composable software architectures. The use of APIs as digital products monetized directly or indirectly is also on the rise. Advancing digital transformation initiatives across the world have emphasized the need for creation, management, operations and security of APIs and made full life cycle API management an essential foundational capability every organization must have.

Business Impact

Full life cycle API management provides the framework and tools necessary to manage and govern APIs that are foundational elements of multiexperience applications, composable architectures and key enablers of digital transformations. It enables the creation of API products, which may be directly or indirectly monetized, while its security features serve to protect organizations from the business impact of API breaches.

Drivers

- Organizations are facing an explosion of APIs, stemming from the need to connect systems, devices and other businesses. Use of APIs in internal, external, B2B, private and public sharing of data is driving up the need to manage and govern APIs using full life cycle API management.

- APIs that package data, services and insights are increasingly being treated as products that are monetized (directly or indirectly) and enable platform business models. Full life cycle API management provides the tooling to treat APIs as products.

- Digital transformation drives increased use of APIs, which in turn increases the demand for API management.

- APIs provide the foundational elements required for growth acceleration and business resilience.

- Developer mind share for APIs is growing. Newer approaches to event-based APIs, design innovations and modeling approaches such as GraphQL, are driving interest, experimentation and growth in full life cycle API management.

- Cloud adoption and cloud-native architectural approaches to computing (including serverless computing) are increasing the use of APIs in software engineering architectures, especially in the context of microservices, service mesh and serverless.

- Regulated, industry-specific initiatives such as open banking and connected healthcare, along with nonregulated, opportunistic approaches in other industries are increasing the demand for full life cycle API management.

Obstacles

- Lack of commitment to adequate organizational governance processes hinders adoption of full life cycle API management. This can be due to lack of skills or know-how, or due to too much focus on bureaucratic approaches rather than federated and automated governance approaches.

- Lack of strategic focus on business value (quantifiable business growth or operational efficiencies) and too much focus on technical use cases can disengage business users and sponsors. This is particularly apparent in cases where API programs fail to deliver promised return on investment.

- Traditional, single-gateway approaches to API management do not fit well to a modern, distributed application environment.

- Partial or full set of API management capabilities provided by vendors in other markets such as application development, integration platforms, security solutions, B2B offerings, etc., can create confusion and potentially shrink the market opportunities.

User Recommendations

- Use full life cycle API management to power your API strategy that addresses both technical and business requirements for APIs. Select offerings that have the ability to address needs well beyond the first year.

- Treat APIs as products managed by API product managers in a federated API platform team.

- Choose a functionally broad API management solution that supports modern API trends, including microservices, multigateway and multicloud architectures. Ensure that the chosen solution covers the entire API life cycle, not just the runtime or operational aspects.

- Use full life cycle API management to enable governance of all APIs (not just APIs you produce), including third-party (private or public) APIs you consume.

- Question full life cycle API management vendors on their support for automation of API validation and other capabilities, as well as their support for a modern, low-footprint API gateway.

Sample Vendors

Axway; Google; IBM; Kong; Microsoft; MuleSoft; Software AG

Gartner Recommended Reading

Magic Quadrant for Full Life Cycle API Management

The Evolving Role of the API Product Manager in Digital Product Management

How to Use KPIs to Measure the Business Value of APIs

API Security: What You Need to Do to Protect Your APIs

Top 10 Things Software Engineering Leaders Need to Know About APIs

LCAP in S&L Government

Analysis By: Michael Brown

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Early mainstream

Definition:

A low-code application platform (LCAP) supports rapid application development, one-step deployment, execution and management using declarative, high-level programming abstractions, such as model-driven and metadata-based programming languages. They support the development of user interfaces, business logic and data services, and improve productivity at the expense of portability across vendors, as compared with conventional application platforms, and are typically delivered as cloud services.

Why This Is Important

LCAPs allow modern cloud-based software development without the normal complexities or requirements for scarce talent, like cloud and DevOps expertise. LCAPs enable software development by state and local (S&L) governments that may lack the ability or desire to establish and maintain traditional custom software development environments. By simplifying software development, LCAPs may also accommodate business unit participation in the process.

Business Impact

IT support teams and government business units are the key stakeholders for use of LCAP products. Speed of delivery for custom solutions provided by LCAPs is a universal benefit for any S&L government. Proprietary lock-in notwithstanding, a universal platform for custom software has significant advantages in talent management and simplicity that S&L government entities may find beneficial.

Drivers

Drivers for use of LCAP by S&L governments include the need for:

- Simplicity — Talent requirements and the complexity of establishing a modern cloud-based, DevOps software development environment are burdens that force S&L entities to seek alternatives. LCAP products' simplification of software development is a common basis for adoption.

- Versatility — The ability to address business needs across the full range of government functions, particularly at local levels, is another factor that has encouraged S&L use of LCAPs.

- Maturity — Technology maturity is critical where government departments and agencies are concerned. Experimentation and risk are antithetical in many government settings. That LCAP products are plentiful, mature and widely used by government agencies makes for a lower risk choice.

- Overlays — Prebuilt customizations, or overlays, for common governmental functions are available from a number of LCAP providers. These overlays have varying names, such as module or layer or may even be described as applications, but all require subscription to the underlying LCAP. Government functions such as investigative case management, license and permit management, inspection management, grants management and others can be obtained as overlays. That sensitivity to government mission needs helps drive use of these products by S&L governments.

Obstacles

Challenges to LCAP adoption by S&L governments include:

- Cost — LCAPs are sold as subscription services and budgets for operating expenditure (opex) need to accommodate the recurring cost. Opex increases are routinely a challenge in S&L government settings.

- Lock-in — LCAPs are proprietary. Business logic captured in these platforms cannot be easily transferred. The vendor's aim is to gain entry to an agency for a single business function and expand to other business functions, increasing dependency. IT teams are likely to understand the lock-in aspect, which may deter their use of LCAP products.

- Unrealistic Expectations — Perceptions of the simplification that LCAPs offer may not match reality. LCAPs do simplify the creation and maintenance of software development environments. However, perceptions that staff without any IT skills can produce software based on the "low-code" aspect can result in disappointment and abandonment of LCAP products.
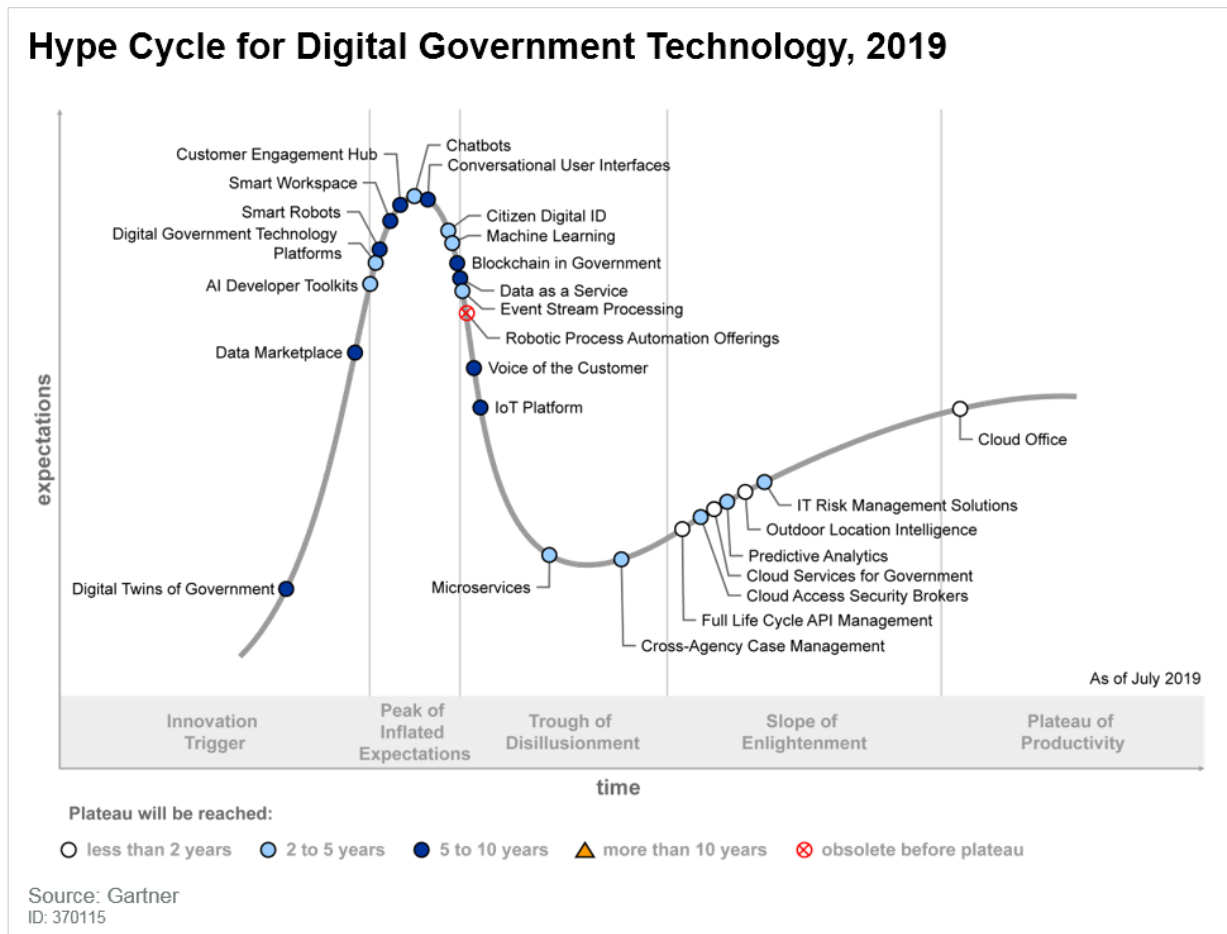
User Recommendations

Use of LCAPs is common and with a projected CAGR of 26.4% for 2020-2025, usage is growing rapidly. IT teams at S&L governments should:

- Prepare for the expense by conducting market research and including cost in budget requests. Use of LCAPs will have a recurring opex requirement.

- Temper expectations for these products by explaining to business units the training and skills that are required. Exposing appropriate business unit staff to sample development processes can help set expectations.

- Select an LCAP product best-suited for your needs by use of competition. Where practical, use of a technical challenge prior to product selection can be a decisive means for choosing an LCAP vendor.

- Accept that the relationship with an LCAP vendor is likely long term by expecting the land-and-expand business model. Initial successes producing applications with an LCAP will foster expanded use.

Appendixes

Figure 2: Hype Cycle for Digital Government Technology, 2019

Hype Cycle for Digital Government Technology, 2019

As of July 2019

Plateau will be reached:
○ less than 2 years   ○ 2 to 5 years   ● 5 to 10 years   ▲ more than 10 years   ⊗ obsolete before plateau

Source: Gartner
ID: 370115

Hype Cycle Phases, Benefit Ratings and Maturity Levels

Table 2: Hype Cycle Phases

(Enlarged table in Appendix)

Phase ↓	Definition ↓
Innovation Trigger	A breakthrough, public demonstration, product launch or other event generates significant media and industry interest.
Peak of Inflated Expectations	During this phase of overenthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the innovation is pushed to its limits. The only enterprises making money are conference organizers and content publishers.
Trough of Disillusionment	Because the innovation does not live up to its overinflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.
Slope of Enlightenment	Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the innovation's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools ease the development process.
Plateau of Productivity	The real-world benefits of the innovation are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. Growing numbers of organizations feel comfortable with the reduced level of risk; the rapid growth phase of adoption begins. Approximately 20% of the technology's target audience has adopted or is adopting the technology as it enters this phase.
Years to Mainstream Adoption	The time required for the innovation to reach the Plateau of Productivity.

Source: Gartner (July 2021)

Table 3: Benefit Ratings

Benefit Rating ↓	Definition ↓
Transformational	Enables new ways of doing business across industries that will result in major shifts in industry dynamics
High	Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an enterprise
Moderate	Provides incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise
Low	Slightly improves processes (for example, improved user experience) that will be difficult to translate into increased revenue or cost savings

Source: Gartner (July 2021)

Table 4: Maturity Levels

(Enlarged table in Appendix)

Maturity Levels ↓	Status ↓	Products/Vendors ↓
Embryonic	In labs	None
Emerging	Commercialization by vendors Pilots and deployments by industry leaders	First generation High price Much customization
Adolescent	Maturing technology capabilities and process understanding Uptake beyond early adopters	Second generation Less customization
Early mainstream	Proven technology Vendors, technology and adoption rapidly evolving	Third generation More out-of-box methodologies
Mature mainstream	Robust technology Not much evolution in vendors or technology	Several dominant vendors
Legacy	Not appropriate for new developments Cost of migration constrains replacement	Maintenance revenue focus
Obsolete	Rarely used	Used/resale market only

Source: Gartner (July 2021)

Document Revision History

Hype Cycle for Digital Government Technology, 2019 - 29 July 2019

Hype Cycle for Digital Government Technology, 2018 - 27 July 2018

Hype Cycle for Digital Government Technology, 2017 - 24 July 2017

Hype Cycle for Digital Government Technology, 2016 - 11 July 2016

Hype Cycle for Digital Government, 2015 - 14 July 2015

Hype Cycle for Digital Government, 2014 - 22 July 2014

Recommended by the Author

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Understanding Gartner's Hype Cycles

Create Your Own Hype Cycle With Gartner's Hype Cycle Builder

Table 1: Priority Matrix for Digital Government Technology, 2021

Benefit	Years to Mainstream Adoption			
↓	Less Than 2 Years ↓	2 - 5 Years ↓	5 - 10 Years ↓	More Than 10 Years ↓
Transformational	Health Pass	Data Exchange Decentralized Identity DGTP/Government Platforms Event Stream Processing Human-Centered AI Intelligent Applications in Government	Data Fabric Machine-Readable Legislation Natural Language Processing Smart Workspaces Sovereign Cloud	
High	Chatbots Full Life Cycle API Management LCAP in S&L Government	Computer Vision in Government CSPM Hybrid Cloud Computing Identity Wallets for Citizens Microservices Packaged Business Capabilities Voice-of-the-Citizen Applications	Authenticated Provenance Blockchain in Government Citizen Engagement Hub Citizen Twin Digital Twins of Government Knowledge Graphs MXDP	Machine Customers

Benefit	Years to Mainstream Adoption			
↓	Less Than 2 Years ↓	2 - 5 Years ↓	5 - 10 Years ↓	More Than 10 Years ↓
Moderate		Consent and Preference Management Document-Centric Identity Proofing in Government		
Low				

Source: Gartner (July 2021)

Gartner

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