Hype Cycle for Human Services in Government, 2023

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By Analyst(s): Ben Kaner

Initiatives: Government Verticals Digital Innovation and Application Modernization

This Hype Cycle presents emerging and maturing technologies that are critical to the effective delivery of human services and social programs. Government CIOs can use this research to inform their decisions about the timing, risks and rate of adoption for technology investments.

More on This Topic

This is part of an in-depth collection of research. See the collection:

- 2023 Hype Cycles: Deglobalization, AI at the Cusp and Operational Sustainability

Analysis

What You Need to Know

Human services and social programs are under pressure on multiple fronts. CIOs are confronted with challenges such as high caseloads and increasing demand to mitigate COVID-19-pandemic-induced disruption, cost of living crises and, in some areas, continuing societal disruptions.

To address these challenges, technologies can be exploited to help reduce workloads, increase accuracy and speed up necessary interventions. As per the 2023 Gartner CIO and Technology Executive Survey, 93% of government CIOs and technology executives state that they are currently, or planning within the next three years, to deploy artificial intelligence (AI) and machine learning techniques. [1]

Innovations and technologies can help outcomes and delivery in all areas of human services business delivery. Human services usually involve handling a significant amount of often sensitive information, and, therefore, emphasize administration and knowledge work. Many technologies are in active use across industry and can be used to inspire innovation. As detailed in A Business Capability Reference Model for Human Services, there are a number of capabilities within human services that are distinct to which technology may be applied. CIOs should use this Hype Cycle when considering what technologies are appropriate when considering a given business capability.

The Hype Cycle

Technologies or incoming standards that might significantly affect a capability within human services are important considerations when CIOs and their executive colleagues are planning strategic investments. These include:

- **Identity technologies:** Important in engaging constituents, enrollment, and during referrals and placements.
- **Consent and preference management, natural language processing, and social care informatics disciplines:** Important in establishing and managing case information and enabling management of cases through organizational boundaries or case management as a service.
- **Program integrity, data and analytics, and artificial intelligence technologies such as graph analytics:** Important in screening, investigating and monitoring/updating cases.
- **Generative AI:** Useful in communication and outreach, as well as summarization of complex background information.
- **Machine-readable legislation, blockchain in government:** Relevant in arranging services and cross-agency coordination.
- **Event stream processing:** Relevant to monitoring and managing outcomes.
- **Low-code application platform (LCAP), platforms, digital twins, automation and associated approaches:** Important to orchestration and delivery across the whole life cycle.

Human services and social programs constitute around 50% of government spending in most developed jurisdictions, and can be both financially complex and of high societal impact. This makes a measured approach particularly important, with the ability to exploit technology in line with the ability of the organization and the service recipients to adapt to the use of that technology. CIOs must work through a deliberate, sequenced adoption of new capabilities to ensure that they can scale and to support these societally critical services.

The Priority Matrix

Table 1: Priority Matrix for Human Services in Government, 2023

(Enlarged table in Appendix)

Benefit	*Years to Mainstream Adoption*			
	Less Than 2 Years	*2 - 5 Years*	*5 - 10 Years*	*More Than 10 Years*
Transformational	Event Stream Processing	Decentralized Identity Generative AI Predictive Analytics in Government	Composable D&A Data Fabric Natural Language Processing	
High	LCAP in Government Predictive Analytics	Composable Applications Digital Twin of a Citizen Digital Twins of Government Identity Wallets Knowledge Graphs Packaged Business Capabilities	Program Integrity Analytics Standardized Human Services Informatics	
Moderate		Consent and Preference Management Conversational AI Graph Analytics		
Low				

Source: Gartner

On the Rise

Standardized Human Services Informatics

Analysis By: Ben Kaner

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Informatics is the systematic approach of transforming collected data into actionable information and knowledge. Human services systems that use a consistent, externally defined set of taxonomies to support their data are considered to be informatics-enabled.

Why This Is Important

Social programs are following healthcare in applying consistent standards and rigor, which will enable more scalable applications and greater delivery impact. Until now, informatics in social care has, to a large extent, been treated as a subset of the more mature health informatics. Drivers such as Social Determinants of Health (SDOH) require consistent data across multiple programs and departments, which can only be addressed with consistent taxonomies and data structures.

Business Impact

Social expenditure accounts for an average of 20% of GDP across Organisation for Economic Co-operation and Development (OECD) countries (Social Spending), yet the decision process and impact of such spending are inconsistent even within single countries.

A systematic approach to the use of information lowers barriers to entry, enabling competition between vendors driving both innovation and function. Also, the outcome can be significantly improved through the ability to track and compare results.

Drivers

There are many parallel challenges for social spending, such as increased spending due to both the pandemic and cost of living, and a potential recession driven by conflict, energy and food prices. Being able to direct such large expenditures effectively will be critical to policymaker's credibility and the perceived competence of the agencies involved.

This can be seen in the U.S. federal initiatives around Social Determinants of Health and at state level such as California Advancing and Innovating Medi-Cal (CalAIM). In Europe, it can be seen around the NextGenerationEU funding for health and social care to address health inequalities.

This allows optimization of expenditure across multiple government interventions. It can also support improving equitable access to and participation in benefits and services, whether government organization, provider or community-based.

In many activities, such as manufacturing and software, standardization of core components is a precursor to a rapid increase in reach and function. Common approaches are being developed using healthcare approaches as a base. However, while there has been academic research in this area for a long time (Informatics for Health & Social Care: Impact Factor & Key Scientometrics), the data held in systems has not significantly changed.

This is beginning to shift through the influence of other trends such as data sharing and use of data analytics, pushing data to be usable outside dedicated case management systems.

The technologies for interpreting and resolving “soft matches,” like different name and relationship records in different systems, provide a low-risk approach to establishing the core commonalities between records, making sharing at scale somewhat more practical.

Obstacles

- Making changes to data storage structures in social care is challenging partly due to the longevity of the datasets and the perceived high risk of loss of records continuity.
- Although the social environment is complex, it is significantly affected by changing cultural and political conditions. This drives siloed funding to attend to current political priorities, with little to no integration across programs.
- The records structure is, therefore, often built around immediate legislative requirements and current processing workflows, embedding historical structures in the systems and making transition to a standard more difficult.
- Often, stakeholders are driven by a vocational agenda that makes alignment on the best course of action difficult.
- Risk-averse approaches driven by a misunderstanding of data protection constraints are common.

- Data literacy and rigorous evidence-based practice are far from universal.
- What is considered as a service varies between jurisdictions.

User Recommendations

- Work with peers/center to establish a method for coalescence around existing and developing standards.
- Pressure current suppliers, and qualify new suppliers, based on their ability to support such standards.
- Emphasize on the ability to migrate and share data in appropriately consistent (structured) forms.
- Ensure providers are compliant or able to map to compliance with standards, such as United States Core Data for Interoperability.

Program Integrity Analytics

Analysis By: Ben Kaner

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

Program integrity analytics is the combined use of advanced analytics, automation and AI to enhance the compliance and oversight functions of human services programs. The purpose of program integrity analytics is to ensure public funds are appropriately spent by accurately targeting funds. This includes identifying and preventing fraud and waste in critical processes, such as eligibility determination, program enrollment, provider management, claims adjudication, and investigation or audits.

Why This Is Important

Social spending averages 20% of GDP and up to 50% of total government spending across the Organization for Economic Co-Operation and Development, as shown in the Social Expenditure Database (SOCX), of which a majority is financial support programs of various kinds. Complex application processes can be both costly to operate and unpopular. Program integrity uses analytics to reduce fraud, waste and abuse in human services programs, and to assure the delivery of the intended societal outcomes.

Business Impact

When applied, solutions in this field will enable organizations to monitor and improve program:

- Reach: The proportion of target population receiving support
- Accuracy: Ensuring that more of the funds go to the qualifying population
- Outcome: Achieving the desired policy effect

In turn, this improved targeting and impact means:

- Desired impact can be achieved with less resources, releasing them for other programs
- Improved credibility of government administration

Drivers

The COVID-19 pandemic has disrupted schooling and socialization, increased social isolation for the elderly, and created a major backlog in health support across all of society. In addition, supply chain disruptions caused by the pandemic, increase in fuel costs, and impact on transport and agriculture due to extreme weather events (drought and floods) in North America, Europe and Asia are creating major societal challenges.

Stressed systems require care to ensure they are having the intended effect. This has always been a challenge for social programs. Attempts to increase finance provided can skew the economic response; attempts to reduce it risks popular backlash. This creates a need for being able to evidence that the economic policies for social support delivered are working as a system — and that any controls are appropriately targeted. This forms a short-term set of drivers that require strong analytics on the targeting and decision-making side.

Social program and human services leaders are aware that incorrectly targeted interventions can significantly increase social dislocation and create further problems. A better intervention is always one that reduces future costs by breaking the cycle of dependence as far as possible.

From a digital standpoint, many government leaders now have a much higher expectation derived from the flood of data created to handle COVID-19 logistics and interventions. AI techniques such as machine learning can now discover patterns in data that may signal earlier and with more accuracy whether an intervention is required or whether an application for support should be rejected. As the data in the system grows, and becomes tractable with architectures such as data fabrics, the likely results — both on individual cases and at a population level — become predictable. The current analytics make it possible to close the loop between the need for an intervention, its accurate provision and determining whether it is being effective.

Obstacles

Social and human services systems have four separate but related classes of obstacles:

- Existing data is held in legacy systems, which are often custom-built, making data difficult to share and compare.
- Diverting funds from direct delivery into IT systems can be politically difficult and the organizational incentives often act against attempts to make change.
- Data quality is variable, and there is often inherent bias in the data; any integrity analytics must navigate a difficult line of interpreting that data to provide real accuracy without leading to a pushback on the basis of perceived bias or differential outcomes between recipients.
- Interlinked systems where people have habituated to a current level of benefit, potentially creating a backlash to any direction of change.

User Recommendations

CIOs considering this area should:

- Ensure that data collected is consistent, accurate and well-characterized such that it can be accurately used for initial decisions, and later for AI to improve future decisions and policy.

- Pay close attention to AI and decision support vendors that can maintain data privacy through their approach and processes.
- Confirm that the algorithms developed meet the tests of explainability and transparency.
- Identify vendors that deal with fraud analytics, which requires similar technology though it is differently applied, and repurposing that technology for program integrity.

Sample Vendors

Alteryx; Cardinality.ai; Deloitte HHS NextGen for Children Services ; Granicus (Firmstep); IBM; Merative; Salesforce; SAS; Thomson Reuters; Xantura

Composable D&A

Analysis By: Peter Krensky, Erick Brethenoux, Julian Sun, Carlie Idoine

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Composable data and analytics (D&A) utilizes container or microservices architectures and data fabric to assemble flexible, modular and consumer-friendly D&A capabilities from existing assets. This transforms monolithic data management and analytics applications into assemblies of D&A building blocks. This is achieved via composition technologies enabled by low- and no-code capabilities, supporting adaptive and intelligent decision making.

Why This Is Important

Organizations are looking for flexibility in assembly/reassembly of D&A capabilities, enabling them to blend more insights into actions. Time to insight, reuse and agility are top requirements. Modular D&A capabilities enable faster and more proactive insight delivery.

Business Impact

The transition from monolithic D&A applications to composable D&A capabilities can be used with application development to assemble AI-augmented decision-making solutions. The focus of collaboration will transition from technology integrations to business problem solving. Organizations can create advanced analytics capabilities by composing the best capabilities from different vendors, rather than using them separately. Composability also relates to data fabric and data mesh in terms of being able to correctly identify data objects that exhibit wide reuse and separating them from those that are business-process-unique.

Drivers

- Container- or microservices-based analytics and business intelligence (ABI) and data science and machine learning (DSML) platforms with improved APIs enable the assembly of analytics applications in a more flexible way than custom code-based solutions.
- For most organizations, AI is still at the piloting stage, but ABI has been in production for years. Organizations can use composition to connect ABI to AI, extending ABI capabilities and empowering users with a comprehensive, tailored and even personalized solution without having to use different applications.
- Organizations need to assemble descriptive, diagnostic, predictive and prescriptive analytics capabilities dynamically to generate insights along with the decision-making process. Use analytics to inform decision making and drive effective actions in a more connected, continuous and contextual way.
- Both D&A and software development teams will need composable data and analytics to enable emerging business technologies.
- As more data and analytics are integrated into digital platforms, traditional embedded analytics will need more modular capabilities to be assembled and reassembled for faster delivery.
- Embedded analytics are usually implemented by IT, but business users can use low- or no-code capabilities to source more data and compose more capabilities, such as interactive data visualization and predictive modeling, independently enriching more comprehensive embedded analytics.
- Cloud-based marketplaces are becoming an effective channel for organizations to distribute and share analytics applications, and composable D&A enables them to easily find the required components and add value to their applications by infusing analytics.

Obstacles

- New technologies and data have been the key drivers to evolve an analytics platform, resulting in less of a connection with business outcomes. Making data more accessible and composable often raises quality, governance and security concerns, among others.
- Software application development teams and data and analytics teams have not collaborated closely before. Composable D&A requires more involvement from the application development side, including applying XOps practices to maximize its value.
- Today's ABI and DSML markets are not zero-sum games. Many vendors of all sizes and specialties can thrive. No single vendor or tool offers all functions at the same level. It is unrealistic to implement a full D&A stack all at once, so many companies do so in stages. The composability of the existing products is not mature enough without technology partnership.

User Recommendations

- Improve decision making and business impact of data and analytics by incorporating and assembling modular, reusable D&A capabilities.
- Leverage composable analytics to drive innovation by incorporating advanced DSML capabilities into analytics applications.
- Exploit opportunities to add analytics capabilities to applications by building a joint team of application developers and business analysts with ongoing collaboration. Rethink organization, processes and skills to support agile assembly and reassembly of analytics services.
- Pilot composable analytics in the cloud, establishing an analytics marketplace to drive and support collaboration and sharing.

Gartner Recommended Reading

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

Adopt Cloud Analytics to Drive Innovation

3 Steps to Build and Optimize a Portfolio of Analytics, Data Science and Machine Learning Tools

At the Peak

Generative AI

Analysis By: Svetlana Sicular, Brian Burke

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

Generative AI technologies can generate new derived versions of content, strategies, designs and methods by learning from large repositories of original source content. Generative AI has profound business impacts, including on content discovery, creation, authenticity and regulations; automation of human work; and customer and employee experiences.

Why This Is Important

Generative AI exploration is accelerating, thanks to the popularity of Stable Diffusion, Midjourney, ChatGPT and large language models. End-user organizations in most industries aggressively experiment with generative AI. Technology vendors form generative AI groups to prioritize delivery of generative-AI-enabled applications and tools. Numerous startups have emerged in 2023 to innovate with generative AI, and we expect this to grow. Some governments are evaluating the impacts of generative AI and preparing to introduce regulations.

Business Impact

Most technology products and services will incorporate generative AI capabilities in the next 12 months, introducing conversational ways of creating and communicating with technologies, leading to their democratization. Generative AI will progress rapidly in industry verticals, scientific discovery and technology commercialization. Sadly, it will also become a security and societal threat when used for nefarious purposes. Responsible AI, trust and security will be necessary for safe exploitation of generative AI.

Drivers

- The hype around generative AI is accelerating. Currently, ChatGPT is the most hyped technology. It relies on generative foundation models, also called “transformers.”

- New foundation models and their new versions, sizes and capabilities are rapidly coming to market. Transformers keep making an impact on language, images, molecular design and computer code generation. They can combine concepts, attributes and styles, creating original images, video and art from a text description or translating audio to different voices and languages.
- Generative adversarial networks, variational autoencoders, autoregressive models and zero-/one-/few-shot learning have been rapidly improving generative modeling while reducing the need for training data.
- Machine learning (ML) and natural language processing platforms are adding generative AI capabilities for reusability of generative models, making them accessible to AI teams.
- Industry applications of generative AI are growing. In healthcare, generative AI creates medical images that depict disease development. In consumer goods, it generates catalogs. In e-commerce, it helps customers "try on" makeup and outfits. In manufacturing, quality inspection uses synthetic data. In semiconductors, generative AI accelerates chip design. Life sciences companies apply generative AI to speed up drug development. Generative AI helps innovate product development through digital twins. It helps create new materials targeting specific properties to optimize catalysts, agrochemicals, fragrances and flavors.
- Generative AI reaches creative work in marketing, design, music, architecture and content. Content creation and improvement in text, images, video and sound enable personalized copywriting, noise cancellation and visual effects in videoconferencing.
- Synthetic data draws enterprises' attention by helping to augment scarce data, mitigate bias or preserve data privacy. It boosts the accuracy of brain tumor surgery.
- Generative AI will disrupt software coding. Combined with development automation techniques, it can automate up to 30% of the programmers' work.

Obstacles

- Democratization of generative AI uncovers new ethical and societal concerns. Government regulations may hinder generative AI research. Governments are currently soliciting input on AI safety measures.
- Hallucinations, factual errors, bias, a black-box nature and inexperience with a full AI life cycle preclude the use of generative AI for critical use cases.

- Reproducing generative AI results and finding references for information produced by general-purpose LLMs will be challenging in the near term.
- Low awareness of generative AI among security professionals causes incidents that could undermine generative AI adoption.
- Some vendors will use generative AI terminology to sell subpar “generative AI” solutions.
- Generative AI can be used for many nefarious purposes. Full and accurate detection of generated content, such as deepfakes, will remain challenging or impossible.
- The compute resources for training large, general-purpose foundation models are heavy and not affordable to most enterprises.
- Sustainability concerns about high energy consumption for training generative models are rising.

User Recommendations

- Identify initial use cases where you can improve your solutions with generative AI by relying on purchased capabilities or partnering with specialists. Consult vendor roadmaps to avoid developing similar solutions in-house.
- Pilot ML-powered coding assistants, with an eye toward fast rollouts, to maximize developer productivity.
- Use synthetic data to accelerate the development cycle and lessen regulatory concerns.
- Quantify the advantages and limitations of generative AI. Supply generative AI guidelines, as it requires skills, funds and caution. Weigh technical capabilities with ethical factors. Beware of subpar offerings that exploit the current hype.
- Mitigate generative AI risks by working with legal, security and fraud experts. Technical, institutional and political interventions will be necessary to fight AI’s adversarial impacts. Start with data security guidelines.
- Optimize the cost and efficiency of AI solutions by employing composite AI approaches to combine generative AI with other AI techniques.

Sample Vendors

Adobe; Amazon; Anthropic; Google; Grammarly; Hugging Face; Huma.AI; Microsoft; OpenAI; Schrödinger

Gartner Recommended Reading

Innovation Insight for Generative AI

Emerging Tech Roundup: ChatGPT Hype Fuels Urgency for Advancing Conversational AI and Generative AI

Emerging Tech: Venture Capital Growth Insights for Generative AI

Emerging Tech: Generative AI Needs Focus on Accuracy and Veracity to Ensure Widespread B2B Adoption

ChatGPT Research Highlights

Conversational AI

Analysis By: Naveen Mahendra

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Conversational artificial intelligence (AI) platforms for procurement use natural language interfaces such as voice and text chat, including messaging platforms, to enable people (and machines) to discover and purchase goods and services via a dialogue with a machine.

Why This Is Important

Conversational AI enables users to interact with technology using spoken or written natural language. Virtual assistants and chatbots can guide business users through the requisitioning process, recommend the best options, gather data and help suppliers with common queries. As this technology continues to evolve, it is expected to merge with generative AI-based solutions, which will offer even more advanced and efficient procurement capabilities.

Business Impact

Conversational AI will provide productivity benefits across the entire source-to-settle process. User training costs will go down significantly as users just answer questions on what they need versus entering in data. Procurement application users who are not in a position to interact with a traditional user interface will have access to procurement processes via voice and/or chat.

Drivers

- Conversational AI has the potential to transform the way users interact with technology by allowing easy voice- or text-based requests, eliminating the need for complex menus and input methods. Examples include chatbots for suppliers to answer common questions and guided-buying virtual assistants for procurement.
- The utilization of conversational AI in the sourcing phase can assist in supplier discovery and evaluation, and provide insights into supplier performance.
- Improved guided buying is the most common use case in development by procure-to-pay (P2P) suite vendors.
- Other important drivers include simplifying contract creation and data analysis, saving time and reducing the need for training.
- Conversational platform makes it easy for a user to navigate through the buying process without needing to understand policy or process and yet achieving compliance.

Obstacles

- Conversational AI technology has come a long way and is now able to handle linear or lightly branching conversations with ease.
- While conversational AI is still in its early stages of adoption in procurement, its ability to handle more complex interactions and languages means it will become increasingly relied upon.
- Benefits of conversational AI can be realized only if it can seamlessly integrate with existing workflows and systems, which can be a challenge.

User Recommendations

- Evaluate and proceed with caution to start with small pilots as Conversational AI in sourcing and procurement gains traction.
- Prioritize and evaluate sourcing and procurement vendors with conversational platform capabilities, as well as other emerging technologies like generative AI, for risk-tolerant organizations.
- Include conversational platform capabilities in the overall evaluation for risk-averse organizations, without overemphasizing the value because change management issues could completely derail any project.
- Monitor the progress of generative AI solutions and their potential to replace or enhance conversational AI in procurement. Stay updated on emerging technologies and be ready to adjust procurement strategies accordingly.

Sample Vendors

Amelia; BotCore; BotSupply; Chyme; Google, IBM; Microsoft; SAP Ariba; Zycus

Gartner Recommended Reading

Cool Vendors in Conversational and Natural Language Technology

Best Practices for Localizing Your Chatbot Initiative

Selecting Conversational AI Solutions for Chatbot and Virtual Assistant Initiatives

Emerging Technologies: Research Roundup for NLP and Conversational UI

Emerging Technologies: Tech Innovators in Conversational AI and Virtual Assistants

Digital Twins of Government

Analysis By: Milly Xiang, Bill Finnerty

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

A digital twin of government (DToG) is a virtual representation of government and partner assets, people, and operations to mirror reality and provide real-time analysis, operation automation and scenario-based planning. Key features include a single point for data visualization, access to APIs for issuing commands to things and processes, and the ability to model systems and the built world. A mature DToG is a system of systems that requires strong integration capabilities.

Why This Is Important

It is becoming increasingly important to visualize cross-jurisdiction impacts through a single and collaborative interface. DToG addresses the challenge of establishing common operations across interdependent systems. It enables democratization of insights for public administration, the private sector and citizens. A fully realized future state will:

- Integrate data from multiple sources
- Enable real-time decision making
- Drive scenario planning
- If applicable, add control capabilities

Business Impact

- Short term, piloting digital twins for identified business use cases can help governments exploit their capabilities and impact on operations.
- Medium term, digital twins empower governments with real-time decision-making capabilities for all types of operations centers.
- Longer term, digital twins enable modeling and testing scenarios related to policy, legislation, and infrastructure rollout and changes.
- Over time, digital twins will enable automation of command and control for governments.

Drivers

- **Advances in vendor solutions** — In addition to new vendors entering the market for digital twins of the built world, existing providers are expanding their capabilities. These vendors frequently include low-code integration to IoT datasets; integration with indoor GIS, building information modeling and computer-aided design solutions; and inclusion of AI and machine learning capabilities. These solutions are contributing to cost savings related to preventative maintenance, improved operations through better uptime and real-time decision-making support.
- **Progress on establishing national digital twin programs** — Governments in Australia, China, the U.K. and other countries are 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 DToGs, an essential component of their use across jurisdictions.
- **The growing application of digital twins to real-world problems** — The number of prominent DToGs being developed to solve real-world problems continues to grow. Examples include Virtual Singapore, New South Wales Spatial Digital Twin, Shanghai's digital twin, the Dutch government's digital twin of The Hague, Helsinki's Kalasatama Digital Twins Project and Boston's digital twin of the city.
- **Future-state drivers** — These will include the use of digital twins, combined with other technologies (such as augmented reality and metaverse), to plan, design and engage stakeholders in building and optimizing physical spaces such as parks or government buildings. The ability to shift a twin used in this phase to one supporting operations will be essential. Inclusion of this type of twin will become a standard part of contracting for design and development of new spaces.

Obstacles

- Foundationally, DToGs are integrated systems that span the silos of government, and silos are an ongoing challenge for governments. Breaking the silos requires coordination on data standards, integration capabilities and, most importantly, governance.
- In many jurisdictions, expectations of DToGs are high. However, due to their technical complexity and the cost, skills and time required, sustaining interest, budget and business unit participation in developing a twin will require focus over multiple administrations.
- CIOs planning for DToGs will need to address fundamental questions of any emerging technology — those related to privacy, ethics and business value. This means that, at first, 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 talent.

User Recommendations

- Engage elected officials and program leaders in defining the DToG vision in business terms to maximize understanding and buy-in.
- Use 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 stages. The DToG 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.
- Assess 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

AVEVA; Cityzenith; Esri; Eutech Cybernetic; Hexagon; IBM; Idrica; Worldsensing

Gartner Recommended Reading

Market Guide for Technologies Supporting a Digital Twin of an Organization

Emerging Tech: Tech Innovators for Digital Twins — ET/OT Providers

Emerging Tech: Tool — Digital Twin Business Value Calculator

Composable Applications

Analysis By: Yefim Natis, Anne Thomas, Paul Vincent

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Composable applications are built, in part or in whole, as flexible assemblies (compositions) of software components that represent well-defined business capabilities, packaged for programmatic access. The business-centric modularity of composable applications empowers democratized access to technology and business innovation. Composable applications support faster, safe and efficient digital business innovation. Advanced use of composable applications allows cross-application compositions.

Why This Is Important

Composable applications help support resilience, adaptability and growth of business in the context of increasingly frequent challenges, disruptions and opportunities. They support fast-paced business change while protecting the integrity of the outcomes, and bridge application software and business operations by using coarse-grained business-centric software modularity. Organizations that use composable applications maintain customer loyalty by better tracking their changing needs.

Business Impact

The more composable applications there are in the organization's portfolio, the better the organization is prepared to support changing business requirements through digital innovation. In return, greater confidence in the agility of applications promotes faster business thinking. The improved agility of business technology strengthens the ability of an organization to maintain and grow its business, a high value in the modern context of fast innovation, frequent challenges and opportunities.

Drivers

- In the continuously changing business context, demand for business adaptability directs organizations toward technology architecture that supports fast, safe and efficient application change.
- The demand for active participation of business decision makers in the design of their digital experiences promotes the adoption of technology models that are accessible and useful to business experts in addition to, and in cooperation with, technical professionals.
- The need to reduce the costs of redundancy in software capabilities across applications and business units drives organizations to reusable business modularity and from there to composability.
- The increasing number of vendors offering API-centric SaaS (also known as API products or "headless" SaaS) builds up a portfolio of available business-centric packaged application components — promoting their use as building blocks of composable business applications.
- The emerging architecture of micro front ends and superapps advances the principles of composability to the multifunctional user experience, promoting broader adoption of composability in application design.
- Fast-growing competence in mainstream organizations for the management of broad collections of APIs and event streams creates a technology foundation for safe operation of a composable business technology environment.
- The emerging business model of industry cloud, promotes the architecture of modularity and composition inside and across vertical use cases.

Obstacles

- Limited experience of composable thinking and planning in most software engineering organizations complicates composable design efforts and transition plans.
- Limited practice of business-IT collaboration for application design delays the effective composable design that depends on the complementary expert talents in multidisciplinary fusion teams.
- Most legacy applications can participate in composition via their APIs and/or event streams, but their architecture provides only minimal autonomy, delaying the full positive effect of composable architecture.
- Limited development and platform tools dedicated to composable application architecture limit the early success to advanced design teams capable of adapting precursor technologies to new objectives.
- Insufficient mapping of architectural thinking and models between business and technology planners makes digital representation of business functionality less prepared to track real-world business change.

User Recommendations

- Promote modular thinking as the means to great flexibility in business and software innovation.
- Champion API-first business software design, whether or not the application is also packaging the traditional UI capabilities.
- Build competence in API and event stream management as the precursor to managing composable business software modularity.
- Prioritize the formation of business-IT fusion teams to support faster and more effective adaptive change of business applications.
- Use low-code/no-code technologies to facilitate design collaboration of business and technology experts in fusion teams.
- Build an investment case for composability by highlighting how aging digital assets endanger the future success of the business by forming barriers to innovation, competition and customer satisfaction at the pace of market change.
- Gradually modernize (or replace) existing applications toward an architecture of business-centric modularity.

Sample Vendors

Elastic Path Software; Mambu; Novulo; Olympe; Spryker Systems

Gartner Recommended Reading

Becoming Composable: A Gartner Trend Insight Report

Quick Answer: Who's Who in the Life Cycle of Composable Applications?

Case Study: Composable Platform Strategy to Drive Business Agility (Nike)

Predicts 2023: Composable Applications Accelerate Business Innovation

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

Digital Twin of a Citizen

Analysis By: Milly Xiang, Alfonso Velosa

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

A digital twin of a citizen (DToC) is a technology-enabled proxy that mirrors the state of a person. National, state and local governments use DToC to support citizen services such as health or safety management. Its elements are the model, data, a unique one-to-one association and the ability to monitor it. It integrates data into the DToC from siloed sources such as health records, credit scores, phone logs, criminal records, customer 360 records, and sensors such as cameras.

Why This Is Important

Governments are developing DToCs to address health, safety, environment, travel and contextualized social media impacts on society. The spectrum of the complexity of the models and tools can help governments make better decisions for monitoring and supporting constituents, such as patients, prisoners, passengers or the elderly. The Chinese government has been building and improving its social credit scoring methodology. Aggregated DToCs can help map broad patterns and drive resource allocation.

Business Impact

Governments can use DToC to better orchestrate personalized services and manage crises, for example, modulate climate crisis against human loss. Aggregated data can help citizens expedite government services, especially in smart city environments. Citizens or governments can drive DToC-based crowdsourcing analysis that mirrors reality to assess government services in real time. Governments can integrate services into systems such as passport control, social credit system and shopper tracking solutions.

Drivers

- The Chinese government is gradually improving and optimizing regulatory and organizational foundations. Examples include Data Security Law of the People's Republic of China, Personal Information Protection Law of the People's Republic of China, and the upcoming National Data Bureau, to promote secure and controllable data exchange across public and private sectors.
- There is an increasing 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 are driving pilots of DToC in multiple areas.
- Citizens' interest in improved health and safety systems is increasing. And the need for proactive, real-time, personalized government services customized to citizens (for example, for emergency medical services) and longer-term, more complex solutions that serve elderly patients or inmates is driving investment from a broad range of government organizations. Some examples include solutions to monitor elderly patients using IoT-enabled trackers, smart camera monitoring systems that track 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 government agencies to build out citizen services to serve individuals as well as the public at large.

Obstacles

- Concerns around privacy and government access to citizen data are leading to citizen concerns and pushback.
- High costs for DToC projects inhibit scaled deployment, especially with a lack of commensurate benefits to citizens or government agencies.
- 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 government, commercial and healthcare silos, driving high costs for data governance, integration and analytics, affecting incident handling efficiency and limiting communication.
- Lack of skills to drive the use of the citizen twin and knowledge on possible use cases in government agencies slow down adoption.
- There is an overall low awareness of DToC by government organizations and urban partners, in terms of how a DToC approach can be built and used in an effective manner.

User Recommendations

- Establish clear benefits for the government agency(ies) to justify not just the cost of developing the DToC, but also of changing the culture and adapting processes to the new data.
- Establish clear benefits to citizens such as shortening passport control lines, simplifying access to medical care, or aligning payments from citizens for use of a toll road.
- Test and validate acceptance by the public by communicating the DToC offering and its benefits.
- Build robust privacy and digital ethics policies that clarify what data is collected, who has access to it, how it is protected, and citizen remediation processes.
- Test IoT sensor and analytics capability to ensure accuracy and validity for the physical part of a DToC.
- Invest in integration skills to connect into a heterogeneous set of applications and data sources and critical incident handling.
- Build data exchanges to protect data, while enhancing the granularity of citizen data used to drive government services.

Sample Vendors

Alibaba Cloud; Apple; Google; Taiji Computer; Tencent; Vantiq; ZKBRAIN

Gartner Recommended Reading

Market Insights: Unique Regional Dynamics Require Tailored Strategies for Smart Cities in Asia

Life Cycle Management of Software-Defined Vehicles: Step 3 — Vehicle Digital Twin 2.0

Quick Answer: Privacy Basics for a Digital Twin of a Customer

Emerging Tech: Tech Innovators for Digital Twins — Digital Business Units

Sliding into the Trough

Decentralized Identity

Analysis By: Michael Kelley, Akif Khan, Arthur Mickoleit

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Decentralized identity (DCI) allows an entity to control their own digital identity by using decentralized identifiers (DIDs) to connect and authenticate themselves to other entities. Private keys and verifiable credentials (VCs) are contained in digital wallets, supported by an identity trust fabric for making DIDs discoverable. By establishing trust, privacy and security, DCI is an attractive alternative to traditional models of storing, sharing and verifying identity data.

Why This Is Important

Identity fragmentation is a problem due to service providers (banks, retailers and governments) forcing consumers to create individual identities for every service. DCI offers an attractive approach with increased security, privacy and usability compared to traditional digital identity approaches like federated identity. While legislative efforts to secure privacy and ensure interoperability are multiplying around the world, standards continue to be refined, and DCI use cases continue to emerge.

Business Impact

Users gain greater control of their identities and data, and service providers gain higher trust, speed and confidence. Currently, providers collect huge amounts of identity information about users to increase assurance to an acceptable level. DCI can provide trust, security, privacy and convenience, and can provide portability of identity data for end users without needing centralized data, reducing risks of data breaches, account takeovers and privacy compliance violations.

Drivers

- Vendor investments in DCI: Due to the volume and influence of vendors investing in this space, there is high potential to drive the DCI market forward, and significant investments have been made by IBM, Microsoft and Ping Identity. In addition, Gartner has been tracking more than 80 startups and vendors of DCI technologies and DCI components (e.g., digital wallets and trust fabrics).
- Government activity: Public sectors are increasingly shaping digital identity trends around DCI. The EU, national governments like Finland or Canada, as well as states and provinces like Utah and Ontario are actively pursuing and investing in DCI use cases that span public and private sector interests.
- Privacy regulations: Countries continue to formalize the requirement for user privacy, specifically for collecting and securing large amounts of user data through regulations. DCI provides a more user-centric way of complying with privacy regulations through decentralized user data.
- 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, employment status, professional credentials, educational credentials without exposing sensitive personal data.
- Standards: Standards are maturing, led by entities such as the World Wide Web Consortium (W3C), the Decentralized Identity Foundation (DIF), the OpenWallet Foundation and OpenID for verifiable credentials to create a consistent approach to DCI. Expanding and maturing standards will help move the market forward.
- User experience: Asking users to repeatedly go through identity proofing and affirmation processes for every online interaction with a service provider is a broken model. Significant friction can be removed from UX if users could assert their identity using a digital wallet with full control over their identity data.

Obstacles

- Authority of issuers: Ensuring that an organization is authoritative to issue a VC (e.g., only an accredited facility issuing educational credentials).
- Adoption: Service providers may resist accepting identity claims via DCI unless they see user adoption, and users may be reluctant to adopt DCI wallets unless they see meaningful use cases for them.

- Interoperability: Adoption is slow due to most development taking place in pockets and a continued lack of standards.
- Technical challenges: Concerns about performance, interoperability, scalability and maturity, as well as wallet standards.
- Regulations: More work is required for how verifiable claims can be used in regulated use cases such as KYC, as required in financial services, online gambling and other industries. Governments are exploring regulatory needs for citizen interactions.
- User interface challenges, ID proofing and account recovery processes are vulnerable for security and privacy, and will require standard approaches.

User Recommendations

- Explore use cases for verifiable claims by identifying tasks and processes that are expensive, complex and time-consuming in the real world, which will benefit from a verifiable claims approach.
- Build a business case for trialing acceptance of DCI by targeting reduced identity proofing and affirmation costs and an improved UX.
- Identify attainable use cases through following successful POCs, such as a DCI solution focused on remote employee onboarding, educational credentials, health credentials and passwordless authentication.
- Partner with existing vendors to understand the possibilities and potential of DCI. Track government activities around use cases for citizen IDs.
- Be cautious of overly optimistic vendor claims. Evaluate the technical security aspects of centralized and partially decentralized identity trust fabrics or using blockchain platforms under consideration. In particular, examine vendor plans for support of standards, such as W3C, DIF and the OpenWallet Foundation.

Sample Vendors

1Kosmos; Evernym; IBM; IdRamp; Microsoft; Nuggets; Ping Identity; Scytale; SecureKey; Wise Security Global

Gartner Recommended Reading

Guidance for Decentralized Identity and Verifiable Claims

Innovation Insight for Decentralized Identity and Verifiable Claims

Predicts 2023: Users Take Back Control of Their Identities With Web3 Blockchain

Top Trends in Government for 2022: Digital Identity Ecosystems

Packaged Business Capabilities

Analysis By: Yefim Natis, Paul Vincent

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Packaged business capabilities (PBCs) are the building blocks of composable application architecture. PBCs represent well-defined modular business capabilities, packaged as software components to maximize the effectiveness of their autonomy, orchestration and discovery. Created by advanced technologists, PBCs are designed to be accessible for application development and composition by business technologists and fusion teams.

Why This Is Important

Composable architecture is adopted to better support the pace of change required by the fast-changing needs of the business. PBCs help separate the creators of the composable modular building blocks and the composers of the delivered solutions. Such role separation forms the foundation for composability and, consequently, better prepares organizations to sustain and grow their businesses in the face of present and future disruptions.

Business Impact

With composable architecture and PBCs:

- Business technologists and fusion teams are better equipped to control and quickly adapt business processes and experiences to the changing business needs, improving the organization's potential for resilience, adaptability and innovation.
- IT and business professionals are better equipped to combine their talents in the creator-composer process, shifting organizations closer to an effective business-IT operational continuum.

Drivers

- High fragmentation, disruptive change and fierce competition in some industries demand fast realignment and adjustment of business and its digital resources.
- To take advantage of the pace of business change, leading organizations seek faster, safer and more efficient tools for digital business innovation.
- Increasing participation of business professionals in software engineering requires more business-oriented expression in software modeling, replacing or augmenting the traditional programmatic orientation.
- The growing orientation of vendor applications (including SaaS) to API-first and API-only ("headless") design is leading organizations toward composition and integration.
- The increasing sophistication of agile development practices and managed product delivery of applications demands more advanced modularity, autonomy, orchestration and discovery for functions and features of applications.
- Generative AI code generation can operate closer to the business semantics of prompt engineering when building blocks of the generated logic are expressed as business components.

Obstacles

- Engineering challenges include the lack of a standard PBC markup language and minimal support for metadata services. This reduces PBC definitions to mostly just simple groupings of managed APIs or limits PBC deployment to proprietary low-code tools.
- Cultural resistance to change, fear of the shifting business priorities and familiarity bias form barriers to the rapid adoption of the composability architecture.
- Many application design and composition initiatives remain in central IT, limiting the direct participation of business.
- Fusion team's effectiveness may be limited, due to cultural challenges and inertia compromising both the technology and the business value of their outcomes.
- Without an effective separation of creators and composers, the architecture fails to deliver the business benefits of composability.
- Enterprise and business architecture designs often lack direct mapping to the modularity of application architectures.

User Recommendations

- Explore and experiment applying generative AI technologies to enable business users to communicate their application requirements using natural language, and generate gluecode to smooth out the last-mile misalignment/conflicts between PBCs.
- Prioritize expertise in API and event management as precursors of composable architecture.
- Separate the responsibilities of the creators of PBCs and the composers that use them to deliver application processes and experiences to business users.
- Plan to renovate or replace the existing applications, to enable their participation in composition.
- Prioritize democratized tools suitable for business-IT fusion teams supporting the development of composed application experiences.
- Build up the business-IT collaboration by forming fusion teams and promoting shared objectives and incentives across areas of the organization contributing resources to a common business outcome.

Gartner Recommended Reading

Innovation Insight for Composable Modularity of Packaged Business Capabilities

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

How to Design Enterprise Applications That Are Composable by Default

Fusion Teams: A Proven Model for Digital Delivery

Data Fabric

Analysis By: Mark Beyer, Ehtisham Zaidi, Roxane Edjlali, Sharat Menon, Robert Thanaraj

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

A data fabric is a design framework for attaining flexible and reusable data pipelines, services and semantics. The fabric leverages data integration, active metadata, knowledge graphs, profiling, ML and data cataloging. Fabric overturns the dominant approach to data management which is "build to suit" for data and use cases and replaces it with "observe and leverage."

Why This Is Important

Data fabric leverages traditional approaches while enabling the enterprise to adopt technology advances and avoids "rip and replace." It capitalizes on sunk costs and simultaneously provides prioritization and cost control guidance for new spending for data management. It leverages concepts and existing platforms/tools or implementation approaches. It offers flexibility, scalability and extensibility in infrastructure for humans or machines to assure data is consumable across multiple use and reuse cases on-premises, multicloud or hybrid deployments.

Business Impact

Data fabric:

- Increases identification, deployment and availability of data for reuse at scale.

- Provides insights to data engineers by standardizing repeatable integration tasks, improving quality, and more.
- Adds semantic knowledge for context and meaning, and enriched data models.
- Evolves into a self-learning model that recognizes similar data content regardless of form and structure, enabling connectivity to new assets.
- Enables observability across the data ecosystem.
- Reduces maintenance, support and optimization costs associated with managing data.

Drivers

- The dearth of new staffing or personnel seeking data management roles and the attrition of experienced professionals leaving the practice area has increased the demand for more efficient data reuse.
- Demand for rapid comprehension of new data assets has risen sharply and continues to accelerate, regardless of the deployed structure and format.
- Increased demand for data tracking, auditing, monitoring, reporting and evaluating use and utilization, and data analysis for content, values and veracity of data assets in a business unit, department or organization.
- Catalogs alone are insufficient in assisting with data self-service. Data fabrics capitalize on machine learning (ML) to provide recommendations for integration design and delivery, reducing the amount of manual human labor that is required.
- Significant growth in demand and utilization of knowledge graphs of linked data, as well as ML algorithms, can be supported in a data fabric to assist with graph data modeling capabilities and use-case generic semantics.
- 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

- Organizations will keep applying budget or staff to one-off and point-to-point integration solutions.
- Differing design and semantic standards used by various vendors to document and share metadata create challenges in its integration and effective analysis to support a data fabric design.
- Fabric needs analytic and ML capabilities to infer missing metadata. This will be error-prone at first with staffing and resources assigned to competing demands in advanced analytics, data science and AI near the data consumption layer.
- Active metadata management practices lag behind data fabric adoption but are critical to its implementation.
- Diverse skills and platforms demand a cultural and organizational change from data management based upon analysis, requirements and “design then build” to discovery, response and recommendation based upon “observability and leveraging.”
- Improper split from data mesh implies choosing one approach over another and not a complementary relationship.
- Inexperience in reconciling a data fabric with legacy data and analytics governance programs will confound implementers.

User Recommendations

- "Active metadata" and leveraging the inherent practices to it is mandatory in a data fabric (covered separately).
- Invest in an augmented data catalog that permits multiple ontologies over top of business data taxonomies and is alerted to new use cases for data and the related business units utilizing data.
- Deploy data fabrics that populate and utilize knowledge graphs in targeted areas where adequate metadata and metadata management practices already exist.
- Ensure business process experts can support the fabric by enriching knowledge graph capabilities with business semantics.
- Evaluate all existing data management tools to determine the availability of three classes of metadata: design/run, administration/deployment and optimization/algorithmic metadata. When adopting new tools, favor those that share the most metadata.
- Do not permit SaaS solutions to isolate their metadata from access by PaaS solutions that orchestrate across solutions.

Sample Vendors

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

Gartner Recommended Reading

Data and Analytics Essentials: How to Define, Build and Operationalize a Data Fabric

Quick Answer: What Is Data Fabric Design?

Emerging Technologies: Critical Insights on Data Fabric

Identity Wallets

Analysis By: Michael Kelley, Akif Khan, Arthur Mickoleit

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Definition:

Identity wallets, both in the form of mobile and web apps, enable users to store, manage and selectively disclose digital identity data from different sources and for various purposes. Users can also use identity wallets to hold their credentials to validate claims. Overall, identity wallets represent an interface for issuing and verifying credentials.

Why This Is Important

A digital identity wallet provides individuals greater control over their identity data and has the potential to enable higher trust for validation of identity claims. For service providers, identity wallets can enable new service models that require consented sharing of identity data. Use cases can involve commercial and government entities for verifiers and issuers of credentials and attributes. Governments are exploring the need for standards and regulations around identity wallets.

Business Impact

Identity wallets help individuals manage personal data from any public or private source. For example, ID cards, driving license data, employer data, COVID-19 vaccination, digital passports and tickets. Use cases span from in-person identity verification and online transactions to contactless check-ins. The data managed by identity wallets include verifiable claims for decentralized identity (DCI), digital representation of electronic data, like airline or concert tickets, and even cryptocurrency and non-fungible tokens (NFTs).

Drivers

- **Privacy and security:** Digital wallets prioritize benefits like security, privacy and anonymity through zero-knowledge protocols and data minimization.
- **Health information:** Digital wallets can safely and securely communicate health information from patients to medical providers.
- **Citizen credentials:** Mobile driver's licenses and other documents providing proof of citizenship. These specific use cases contribute to the growing public interest and debate about digital wallet services on the smartphone.
- **Growing traction of decentralized identity:** Interest in identity wallets is growing with increased interest in DCI. Global standards, like World Wide Web Consortium (W3C) verifiable credentials (VCs) and decentralized identifiers (DIDs), are driving additional use cases for verifiable claims in digital wallets. These enable the creation of open, interoperable identity wallet services.
- **Payments and fintech:** Identity wallets are serving payment-related use cases. For example, to manage financial assets and transactions. The confluence of identity and payment use cases in mobile apps, like Apple Wallet, are already visible today.
- **User experience (UX):** Identity wallets will reduce the need for users to repeatedly prove their identity across multiple service providers. Mobile devices will become the primary means for proving identity claims. Asserting an identity claim from already verified identity attributes will reduce onboarding friction and likely become a competitive advantage.
- **Future monetization of identity data:** Today's identity wallets are focused on nonremunerated consent for sharing personal identity data. Future iterations and use cases for identity wallets may include an individual granting consent of their personal data for commercial use in return for remuneration or other rewards.

Obstacles

- **Market understanding:** There is confusion about the term “identity wallets.” The term can refer to proprietary mobile ID apps — where identity data is confined to a centrally defined ecosystem — and to open standards-based wallets that enable decentralized, portable and interoperable identity.
- **Wallet standards:** The market and governments are actively working on standards and strategies for interoperability. The OpenWallet Foundation is currently working on defining an open standard for interoperability.
- **User acceptance:** The adoption of identity technologies will be driven by relevant use cases. Focus on use cases that effectively communicate the tangible benefits of identity wallets.
- **User experience (UX):** The interface for the identity wallet must be easy to use and intuitive. Alternatives to mobile devices must be explored.
- **Trust and recoverability:** When users begin to store and manage personal or payment data with their wallet, data security, encrypted keys and recoverability after loss or theft will be a top priority.

User Recommendations

- As soon as standards evolve, be prepared to support multiple wallets for varied use cases. For example, a wallet for concert tickets, a government-issued wallet for citizen-identity information, a personal wallet holding banking, employment and educational credentials, or a wallet for storing cryptocurrency or processing payments.
- Explore emerging use cases, like verifiable claims for decentralized identity, cryptocurrency and NFTs, while supporting traditional use cases — for example, digital representations of physical things, such as airline and events tickets, driver’s licenses, digital passports and other government-related documents.
- Observe or participate in shaping regulations, standards and reference frameworks that are relevant to your geography. For example, the EU’s ongoing large-scale pilots and electronic identification, authentication and trust services (eIDAS) regulation revision.
- Investigate the value of digital wallets for representing identity in online digital communities, like Web 3.0 and metaverse applications.

Sample Vendors

1Kosmos; Apple; Evernym; ID.me; Google; Microsoft; Nuggets; Ping Identity; Scytáles; SecureKey

Gartner Recommended Reading

Guidance for Decentralized Identity and Verifiable Claims

Innovation Insight for Decentralized Identity and Verifiable Claims

Predicts 2023: Users Take Back Control of Their Identities With Web3 Blockchain

Predicts 2022: Identity-First Security Demands Decentralized Enforcement and Centralized Control

Top Trends in Government for 2022: Digital Identity Ecosystems

Consent and Preference Management

Analysis By: Tia Smart

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

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 digital 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

Protections for personal data collected digitally continue to expand across the globe as more countries and U.S. states consider legislation similar to or stronger than GDPR, CCPA, CPRA and CPA. Technologies and organizations must quickly adapt to the global transformation. Consent and preference management platforms (CPMPs) empower organizations to comply with new laws, preserve and extend essential capabilities, and demonstrate to customers and stakeholders that they care about privacy.

Business Impact

- As new legislation is introduced worldwide, organizations must use CPMPs to demonstrate to consumers that they value their privacy and are in compliance to avoid costly violations and consumer mistrust.
- Protecting your organization from compliance violations while maintaining the ability to utilize customer data for business purposes can be technically and operationally challenging. CPMPs help to address these issues.

Drivers

- **New laws and variations in legislation.** With additional countries and regions seeking to implement their own consumer privacy laws, tracking laws in each country and region is a tedious but integral task to ensure compliance. CPMPs address specific requirements, such as auditing websites, enforcing consent choices and making data available for subject rights requests.
- **Reliance on first-party data.** The shift to an increased dependence on first-party data instead of third-party cookies forces organizations to reevaluate the enterprise's data structure. Managing consent and preference choices throughout the ever-convoluted enterprisewide structures takes time, and some CPMPs try to solve this. CPMPs' importance is ever more apparent in countries like the U.S., where implicit consent is still allowed in most states. Organizations need to take a state-by-state approach or risk messing up direct marketing opportunities available to them.
- **Societal norms and consumer expectations.** Consumers now expect to have control over their personal data as well as transparency from organizations on how it is used. However, consent flow banners and dialogues can significantly downgrade user experience, driving the need for better design solutions enabled by certain CPMPs.

Obstacles

- **Ever-changing global laws and best practices.** With regions and countries implementing their own data privacy legislations, organizations must adapt to each one to remain in compliance. CPMPs tend to oversell their ability to make managing consent options simple, often downplaying the complexity of managing an organization's internal and external databases.
- **Lack of UX design support.** Forcing too many privacy choices on consumers degrades UX and leads to high opt-out and abandonment rates. Yet, having too few choices limits the ability to tailor experiences. To strike the right balance requires cross-functional, collaborative activities across the organization.
- **Complex technology architectures.** Digital transformation acceleration efforts propelled organizations to rethink how technology solutions work together and how data flows throughout the ecosystem. Adopters need to factor in the number of connections — both native and customized (e.g., APIs, ETL) — that are needed to effectively use a CPMP.

User Recommendations

- Prioritize consent management policies and initiatives as a critical priority for all functions. Establish a cross-functional customer data and privacy council to review and update policies and processes for the enterprise to follow.
- Avoid "dark patterns" or deceptive language for consent dialogues that attempt to influence users' choices (see the FTC's Press Release).
- Use a "telescoping" approach to disclosures and preference dialogues that allow users to go as deep as they choose into specific details. Offer consistent, easy access to preference settings that can be viewed and changed on demand to ensure that you are undertaking a privacy-by-default approach.
- Compare and assess CPMP offerings against your organization's highest-priority data privacy protection and integration requirements and internal costs.
- Develop a CPMP where the market cannot effectively connect and integrate with legacy internal tools.
- Take a modular approach to adoption and avoid excessively broad project scopes. Anticipate sufficient time to resolve unforeseen complications in these projects.

Sample Vendors

BigID; Didomi; Ketch; OneTrust; PossibleNOW; Syrenis; TrustArc

Gartner Recommended Reading

Market Guide for Consent and Preference Management

Market Guide for Consent and Preference Management for Marketers

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, interpreting and, sometimes, generating human language. NLP techniques deal with the pragmatics (contextual), semantics (meanings), grammatical (syntax) and lexical (words) aspects of 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 and receipts. With speech-to-text, NLP can process speech, including livestreams of text and speech. As a result, NLP enables a vast array of applications and automation that was previously unachievable by machine, offering businesses significant process improvement.

Business Impact

- NLP is an enabler that is typically useful when built into applications that support business workflows.
- Because so many tasks involving text rely on human labor, the potential for savings and new business processes is vast.
- Business value reported from some applications using NLP, such as machine translation, are thousandfold efficiency improvements and operational cost savings.

Drivers

- Growth in transcription and translation services.
- Language-generation applications (chatbots, text summarization) 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.
- Autocorrect and autocompletion tools and services.
- Content moderation services that analyze user-generated content (text or images) to flag potentially offensive content or identify fake news in social media.
- Sentiment analysis to identify the effective states and subjective information in statements — for example, from negative to neutral to positive.
- Search improvements through better understanding of the intent of a search query or through summaries of the retrieved content.
- Text analytics and intelligent document processing (IDP) to quickly process large numbers of an organization's documents and determine compliance or legal validity.
- Advances in insight engine text capabilities combined with more-advanced NLP functionality.
- The introduction of new machine learning (ML) techniques, including transformer-based large language model (LLM) approaches, such as BERT and GPT-3. This has enabled new use cases and improvements to existing use cases, with special regard to those involving text generation.

Obstacles

- Despite progress made in NLP methods, many subtle nuances properly processing the complex and enormous variety found in human languages are deeply influenced by cultural and other idiosyncratic conditions. Significant customization of tools and products is often needed.
- Although recent NLP methods that leverage deep neural networks have provided significant and useful improvements to many applications, some are experimental and are not yet mature.
- Support for low-resource languages. Although common languages have support for templates, data and algorithms, lesser-used languages can be difficult to develop for, and require more custom-made effort.
- Despite advances in new techniques, the hyped expectations surrounding NLP may result in unrealistic expectations, leading to disappointing results.
- Many of the 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 (affecting cost, service levels, customer satisfaction and upselling) and employee support (including augmenting them as they perform tasks). Another example is automation of paper- and document-based tasks (e.g., 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 initiatives, new skills should be explored that better leverage new NLP methods.
- Verify the effectiveness of solutions before making significant commitments, because the quality of NLP solutions can vary.
- Evaluate master metadata implications. Ensure that language assets are considered from a master metadata management point of view to ensure reuse and portability of assets between algorithms and systems.

Sample Vendors

Baidu; Expert.ai; Google; IBM; Microsoft; Narrative Science; NLTK; Openstream; Rasa

Gartner Recommended Reading

Applying AI — A Framework for the Enterprise

Applying AI — Techniques and Infrastructure

Tool: Vendor Identification for Natural Language Technologies

Use-Case Prism: Artificial Intelligence for Customer Service

Cool Vendors in Natural Language Technology for Processing Enormous Volumes of Unstructured Data

Cool Vendors in Conversational and Natural Language Technology

Knowledge Graphs

Analysis By: Afraz Jaffri

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Knowledge graphs are machine-readable representations of the physical and digital worlds. They include entities (people, companies, digital assets) and their relationships, which adhere to a graph data model — a network of nodes (vertices) and links (edges/arcs).

Why This Is Important

Knowledge graphs capture information about the world in an intuitive way yet are still able to represent complex relationships. Knowledge graphs act as the backbone of a number of products, including search, smart assistants and recommendation engines. Knowledge graphs support collaboration and sharing, exploration and discovery, and the extraction of insights through analysis. Generative AI models can be combined with knowledge graphs to add trusted and verified facts to their outputs.

Business Impact

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

- Digital workplace (e.g., collaboration, sharing and search)
- Automation (e.g., ingestion of data from content to robotic process automation)
- 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

- The need to complement AI/ML methods that detect only patterns in data (such as the current generation of foundation models) with the explicit knowledge, rules and semantics provided by knowledge graphs.
- 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.
- The emerging landscape of Web3 applications and the need for data access across trust networks, leading to the creation of decentralized knowledge graphs to build immutable and queryable data structures.
- Improvements in graph DBMS technology that can handle the storage and manipulation of graph data structures at scale. These include PaaS offerings that take away the complexity of provisioning and optimizing hardware and infrastructure.
- The desire to make better use of unstructured data held in documents, correspondence, 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 where meaning, usage and consumption patterns are not well-defined.
- The use of graph algorithms and machine learning to identify influencers, customer segments, fraudulent activity and critical bottlenecks in complex networks.

Obstacles

- Awareness of knowledge graph use cases is increasing, but business value and relevance are difficult to capture in the early implementation stages.
- Moving knowledge graph models from prototype to production requires engineering and system integration expertise. Methods to maintain knowledge graphs as they scale — to ensure reliable performance, handle duplication and preserve data quality — remain immature.
- The graph DBMS market is fragmented along three properties: type of data model (RDF or property), implementation architecture (native or multimodal) and optimal workload (operational or analytical). This fragmentation continues to cause confusion and hesitation among adopters.
- Organizations want to enable the ingestion, validation and sharing of ontologies and data relating to entities (such as geography, people, events). However, making internal data interoperable with external knowledge graphs is a challenge.
- In-house expertise, especially among SMEs, is lacking, and identifying third-party providers is difficult. Often, expertise resides with vendors of graph technologies.

User Recommendations

- **Create a working group of knowledge graph practitioners and sponsors** by assessing the skills of D&A leaders and practitioners and business domain experts. Highlight the obstacles to dependable and efficient data delivery for analytics and AI, and articulate how knowledge graphs can remove them.
- **Run a pilot to identify use cases that need custom-made knowledge graphs.** The pilot should deliver not only tangible value for the business, but also learning and development for D&A staff.
- **Create a minimum viable subset that can capture the information of a business domain to decrease time to value.** Assess the data, both structured and unstructured, needed to feed a knowledge graph, and follow Agile development principles.
- **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 D&A governance and management.** To avoid perpetuating data silos, investigate and establish ways for multiple knowledge graphs to interoperate and extend toward a data fabric.

Sample Vendors

Cambridge Semantics; Diffbot; eccenca; Neo4j; Ontotext; Stardog; TigerGraph; TopQuadrant; Trace Labs

Gartner Recommended Reading

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

3 Ways to Enhance AI With Graph Analytics and Machine Learning

Working With Graph Data Stores

How Large Language Models and Knowledge Graphs Can Transform Enterprise Search

Graph Analytics

Analysis By: Afraz Jaffri, Rita Sallam, Jim Hare, Mark Beyer

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Graph analytics techniques allow for the exploration and discovery of relationships between entities and concepts such as organizations, people or transactions. Graph analytics consists of models that determine the connectedness across data points. Graph analytics is typically portrayed via data visualization where surfacing relationships can lead to better-informed insights and decisions.

Why This Is Important

- Graph analytics has proven value in specific use cases (disease tracking, supply tracing, crime prevention).
- Graph analytics can often be the only effective way of analyzing data where connections and links between data items need to be identified.
- Graph analytics is an enabler of knowledge graphs, which are also accelerating in terms of market adoption.
- Graph analytics enable the exploration of connected data without the limitation of legacy data models.

Business Impact

Graph analytics helps in the following ways:

- Analyzes data for insights into relationships in complex, connected data.
- Highly effective at assessing risks to analyze fraud, route optimization, clustering, outlier detection, Markov chains and more.
- Application to digital twin scenarios where network effects and impacts of proposed changes need to be simulated.
- Identifies outlier and unusual patterns that cannot be detected by other methods.
- Augments data discovery capabilities in augmented analytics and business intelligence platforms.

Drivers

- Rapid uptake in use cases that require analysis across complex models or datasets is developed and used within machine learning (ML) with the output stored in graph databases.
- The availability of low- or no-code tools for domain experts and business users to take advantage of graph analytics techniques for complex investigations.
- The increasing maturity of graph databases for storing, manipulating and analyzing the widely varied perspectives in the graph model due to their graph-specific processing languages, capabilities and computational power.
- Established AI techniques (such as Bayesian networks) are increasing the power of knowledge graphs and the usefulness of graph analytics by adding further representational power.

Graph analysis on data can be further augmented by leveraging metadata from unexpected sources adds to the graph analysis capabilities in the following ways:

- Certain evaluations can build data “push” models by analyzing data access logs and users’ analytical model development, graph analytics can track and recommend data based on data’s relationships and users’ acceptance.
- Augmented data profiling combined with graphs can evaluate unfamiliar assets for similarities as compared to currently used datasets — identifying characteristics that are aligned to production AI techniques or ML features.

Obstacles

- Transforming data into graph data models suitable for analysis remains a substantial challenge for large-scale usage. The tooling available is largely concentrated on facilitating end-user ease of use but there is still a need for low code tools that can manage complete graph analytics workflows and life cycles or "GraphOps."
- Graph analytics and closely related graph databases are driving demand for new skills related to graph-specific knowledge, which may limit growth in adoption. Some vendors have created graph analytic solutions that make it possible to execute graph analytics using SQL.
- New skills required include knowledge and experience with graph algorithms and applying the right algorithm to solve a problem.

User Recommendations

- Prototype graph analytics techniques to address use cases that exhibit development, coding and data models that are overly complex using traditional SQL-based queries and visualizations.
- Examine graph analytics to enhance pattern analysis — especially in verticals and core use cases.
- Transition data catalog search and discovery into a graph analysis model to identify user communities' usage patterns and drive personalization applied to shared datasets.
- Implement multiexperience user interfaces with graph elements to find insights and analytic results, and store the outputs/results for repeated use in a graph database.
- Train existing personnel on how to align data assets, statistical processes and algorithms to create training datasets and build identification processes to detect data changes that will drive changes in the analytical models.
- Evaluate existing tools to determine their graph capabilities.

Sample Vendors

DataWalk; Linkurious; Neo4j; Siren; TigerGraph; Virtualitics

Gartner Recommended Reading

Graph Technology Applications and Use Cases

3 Ways to Enhance AI With Graph Analytics and Machine Learning

Use Multistructured Analytics for Complex Business Decisions

Predictive Analytics in Government

Analysis By: Ben Kaner

Benefit Rating: Transformational

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Predictive analytics in government uses data mining and modeling techniques to achieve mission outcomes. It leverages internal and external data to inform public policy development, optimize government processes and improve real-time decision making. The responsible and ethical use of predictive analytics in government requires care and due diligence to limit the impact of biases inherent in historical datasets.

Why This Is Important

Swift, quality decisions are critical to outcomes in all branches of government. Predictive approaches allow consequences of decisions to be considered ahead of time and enable plans to be adapted accurately as needed. This delivers better outcomes at lower risk than a reactive approach. Predictive analytics, enabled by advances in machine learning, makes this shift feasible and scalable. To maintain the public's trust and ensure accountability, it should be deployed transparently.

Business Impact

Government agencies that use predictive analytics can change service delivery models to proactively achieve mission outcomes:

- Resources can be optimized based on demand.
- Interventions — in all areas, including public safety, human services and taxes — can be made more swiftly and more accurately.

- Closing the loop to feed outcomes back into the predictive model will deliver evidence-based and constantly improving interventions.

Drivers

- Advances in machine learning provide a broader set of models and reduce implementation and operational costs.
- Solution providers are supplementing their solutions with emerging technologies from ecosystem partners to gain competitive advantage.
- Society is pushing for equity in service delivery; predictive analytics helps anticipate the impacts, including those that are unintentional, on all impacted recipients.
- There is demand for government organizations to reduce costs and operate more efficiently.
- A growing number of providers are developing predictive analytics, location intelligence and machine learning solutions that are being delivered in a SaaS model. Therefore, agencies are not required to have data science, AI modeler or other related skills in-house.
- Expanded datasets available through cross-disciplinary response efforts are making additional, previously untapped data available through improved data sharing efforts.

Obstacles

- Data quality and management capabilities may limit government agencies' ability to leverage predictive analytics.
- Public concerns about using data collected to provide support being used instead for enforcement predictions may limit trust in data necessary for essential human services or even create open resistance.
- Public concerns over access to significant sensitive data, data bias and misuse may cause leadership to be hesitant in experimenting with predictive analytics.
- Agencies' aversion to change, particularly where there have been previous difficulties, may manifest as hesitation to implement a new solution.
- Predictive approaches will work only if decision makers adapt their decision-making process and understand both the power and the limits of such models. This requires an uplift in the adaptability and data maturity of both the executive and operations.
- Limited data discovery and data sharing capabilities can limit the ability to develop the needed models for predictive analytics.

User Recommendations

- Establish, if not already active, a data governance program that supports data quality and management. Exploit data standards where available, such as the U.S.-based National Information Exchange Model (NIEM).
- Engage current vendors to understand their roadmaps for implementation of predictive analytics or what partnerships they have to bring these capabilities to their solutions or platform.
- Work with internal and external stakeholders to establish standards for the acceptable use of predictive analytics and processes to determine continual acceptance of its use.
- Establish guidelines for adopting predictive analytics solutions that build trust by requiring models that are explainable to leadership, staff, stakeholders and the public.
- Include predictive analytics and AI in the risk management process. Implement regular, independent audits of predictive analytics and AI solutions to check for system bias and data misuse. Be transparent with finds and activity to remediate any findings.

Sample Vendors

Alteryx; DataWalk; IBM; Microsoft; Palantir; Qlik; SAS; Semantic AI

Gartner Recommended Reading

Market Guide for Multipersona Data Science and Machine Learning Platforms

Top Trends in Data and Analytics, 2023

Combine Predictive and Prescriptive Analytics for Better Decision Making

Tool: Predictive Analytics Use Case Prioritization

Quick Answer: What Changes Are Expected in Data and Analytics as Governments Become Postdigital?

Quick Answer: How Should Data and Analytics Vendors Respond as Governments Move to Postdigital?

Climbing the Slope

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

Business Impact

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

Drivers

Six factors are driving ESP growth:

- Organizations have access to ever-increasing amounts of low-cost streaming data from sensors, machines, smartphones, corporate websites, transactional applications, social computing platforms, news and weather feeds, and other data brokers. Many new AI and other analytical applications need this streaming data to satisfy business requirements for situation awareness and faster, more-accurate decisions.
- The wide use of Apache Kafka and similar streaming messaging systems is reducing the cost and complexity of ingesting, storing and using streaming data.
- Conventional data engineering pipelines take hours or days to prepare data for use in BI and analytics, causing delays that are unacceptable for some purposes. Therefore, an increasing number of data engineering pipelines are being reimplemented as real-time data flows (continuous ETL) in ESP platform products or stream data integration tools with embedded ESP. These real-time data flows filter, aggregate, enrich, and perform pattern detection and other transformations on streaming data as it arrives.
- 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 30 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. Cloud ESP platforms have lowered the cost of entry.
- Vendors are embedding ESP platforms into a wide variety of other software products, including industrial IoT platforms, stream data integration tools, unified real-time platforms (aka continuous intelligence platforms), insider threat detection tools and AI operations platforms.
- Vendors are adding highly productive development tools that enable faster ESP application development. Power users can build some kinds of ESP applications via low-code techniques and off-the-shelf templates.

Obstacles

- ESP platforms are overkill for many applications that process low volumes of streaming data (i.e., under 1,000 events per second), or that do not require fast response times (i.e., less than a minute). Conventional BI and analytics tools with data-at-rest architectures are appropriate for most stream analytics with these less-demanding requirements.

- Many architects and software engineers are still unfamiliar with the design techniques 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.
- Some streaming applications are better-implemented on unified real-time platforms that process both data in motion and data at rest. Some unified platforms use embedded open-source ESP platform products, while others get their ESP capabilities from custom internal code.

User Recommendations

- Use ESP platforms when conventional data-at-rest architectures cannot process high-volume streams fast enough to meet business requirements.
- Acquire ESP functionality through a SaaS offering, an IoT platform or an off-the-shelf application that has embedded ESP logic if a product that targets specific business requirements is available.
- Use vendor-supported closed-source platforms or open-core ESP products that mix open-source with closed-source extensions for applications that need enterprise-level support. Use free, community-supported, open-source ESP products if developers are familiar with open-source software, and license fees are more important than staff costs.
- Use ESP platforms or stream data integration tools to ingest, filter, enrich, transform and store event streams in a file or database for later use.
- Choose a unified real-time platform with embedded ESP capabilities over a plain ESP platform if the application uses both data at rest and data in motion.

Sample Vendors

Confluent; EsperTech; Google; Hazelcast; IBM; Microsoft; Oracle; SAS; Software AG; TIBCO Software

Gartner Recommended Reading

Market Guide for Event Stream Processing

5 Essential Practices for Real-Time Analytics

Create an Optimal IoT Architecture Using 5 Common Design Patterns

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

LCAP in Government

Analysis By: Michael Brown

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Mature 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 enable software development by government organizations where commercial off-the-shelf (COTS) or software as a service (SaaS) products cannot meet business needs. LCAPs allow cloud-based software development without requiring scarce talent, like cloud and DevOps expertise, enabling business unit participation throughout the process. LCAP products provide development capability where an agency lacks ability, or desire, to maintain a traditional custom software development environment.

Business Impact

IT support teams and government business/mission 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 government entity. When used across multiple development teams, a universal platform for custom software has significant advantages in talent management and simplicity that government entities often view as beneficial.

Drivers

Drivers for use of LCAP by government include the need for:

- **Simplicity** — Talent requirements and the complexity of establishing a modern cloud-based, DevOps software development environment are burdens that force government 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 is another factor that has encouraged government 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 make 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 generally 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 governments.

Obstacles

- **Cost** — LCAPs are sold as subscription services and budgets for operating expenditure (opex) need to accommodate the recurring cost. Shifting costs from capital expenditures to opex is often a challenge in government settings.
- **Lock-in** — LCAPs are proprietary. Business logic captured in these platforms cannot be easily transferred. 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. Each of the platforms requires familiarity and training on its use — platform expertise. Expectations that staff without any IT skills can produce well-constructed software can result in disappointment and abandonment of LCAP products.

- **Business Process Reengineering** — LCAPs do not preclude automating inefficient processes Without coupling to business process reengineering, LCAPs could inappropriately solidify workflows and processes that should be changed.

User Recommendations

Use of LCAPs is common with a projected compound annual growth rate of more than 20% (see Magic Quadrant for Enterprise Low-Code Application Platforms). Hence, government IT teams should:

- Gain the most from use of LCAP products by first examining, and redesigning as needed, business processes.
- Plan for recurring opex by conducting market research and including the cost in budget requests.
- Temper expectations for these products by explaining the training and skills that are required. Help set expectations by exposing appropriate business unit staff to sample development processes.
- Select an LCAP vendor by use of competition and, where practical, technical challenges.
- 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. Use LCAP to your advantage by negotiating a contract that locks-in price caps for a longer period of time.

Sample Vendors

Appian; Microsoft Power Apps; Pegasystems; Salesforce; ServiceNow

Entering the Plateau

Predictive Analytics

Analysis By: Peter Krensky

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Predictive analytics is a form of advanced analytics that examines data or content to answer the question, “What will happen?” or more precisely, “What is likely to happen?” It is characterized by techniques such as regression analysis, multivariate statistics, pattern matching, predictive modeling and forecasting.

Why This Is Important

Predictive analytics was in early mainstream adoption before the COVID-19 pandemic and adoption has accelerated since. Early adopters have proven and refined use cases with clear value. Most organizations have numerous initiatives underway related to predictive analytics, and many organizations are just getting started. In addition, client searches on gartner.com for “predictive analytics” continue to trend upward.

Business Impact

Predictive analytics prioritizes identifying and providing an understanding of likely future outcomes to enable improved decision making, as well as threat/opportunity identification. As a result, organizations can be proactive, rather than reactive (e.g., predictive maintenance of equipment, demand prediction, fraud detection and dynamic pricing). Interest and investment continue to grow in new use cases, as well as more traditional applications of predictive analytics.

Drivers

Project underperformance and ROI failure are low, and this technology is on the doorstep of the Plateau of Productivity. Although related artificial intelligence (AI) and machine learning (ML) innovations continue to be hyped, this technology's journey on the Hype Cycle is nearly at an end. The value derived from predictive analytics is well-aligned with expectations. Interest continues to be driven by improved availability of data, lower-cost compute processing (especially in the cloud) and a growing body of proven, real-world use cases. Predictive models are no longer just produced by data science platforms; predictive analytics is embedded in more business applications than ever. Additional drivers of predictive analytics hype and adoption include:

- Lessons learned from the COVID-19 pandemic on the need for agile and adaptable predictions
- Application developers leveraging pretrained models and cloud AI services to add predictive analytics to applications
- Embedded predictive analytics in enterprise applications and other software
- Augmented analytics capabilities and support for low-code/no-code model building
- Education and upskilling programs for citizen data scientists and augmented consumers
- Growing numbers of practicing expert data scientists
- Emerging roles, such as ML engineer and chief data scientist

Obstacles

- Poor data quality/availability, combined with the data engineering burden placed on data scientists
- Technical debt — i.e., deploying predictive models without proper consideration of ongoing maintenance costs and need for IT support
- Properly defining, designing and supporting XOps (MLOps, ModelOps, DataOps, PlatformOps, etc.)
- Talent recruitment, development, retention and organization
- Predictive model value estimation and project prioritization, and ongoing collaboration with consumers of predictive analytics

- Reliance on black-box models, and evolving standards and regulations around model explainability and bias detection

User Recommendations

- Prepare to manage a heterogeneous portfolio across multiple analytics communities.
- Evaluate the buy option first. Predictive analytics can be quite easy to deploy and use if delivered via a packaged application or a cloud AI developer service. However, packaged applications pretrained models do not exist for every analytics use case. Packaged applications and AI cloud services often may not provide enough agility, customization or competitive differentiation.
- Build solutions through an external service provider (ESP), or with skilled in-house staff using a combination of open-source technologies and a data science platform.
- Use a combination of these tactics (buy, build, outsource) and explore vendors with offerings that combine two or more of these approaches.
- Focus on an operationalization methodology, including ML engineering roles, formal processes and investment in vendor platforms in the initial stages of planning.

Gartner Recommended Reading

Magic Quadrant for Data Science and Machine Learning Platforms

Critical Capabilities for Data Science and Machine Learning Platforms

Maximize the Benefits of Augmented Analytics With a Strategic Action Plan

Top Trends in Data and Analytics for 2021: The Rise of the Augmented Consumer

When and How to Combine Predictive and Prescriptive Techniques to Solve Business Problems

Appendixes

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 (August 2023)

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 (August 2023)

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 (August 2023)

Evidence

[1] **2023 Gartner CIO and Technology Executive Survey:** This survey was conducted to help CIOs and technology executives overcome digital execution gaps by empowering and enabling an ecosystem of internal and external digital technology producers. It was conducted online from 2 May through 25 June 2022 among Gartner Executive Programs members and other CIOs. Qualified respondents are each the most senior IT leader (e.g., CIO) for their overall organization or some part of their organization (for example, a business unit or region). The total sample is 2,203 respondents, with representation from all geographies and industry sectors (public and private), including 241 from government. Disclaimer: Results of this survey do not represent global findings or the market as a whole, but reflect the sentiments of the respondents and companies surveyed.

Recommended by the Author

Some documents may not be available as part of your current Gartner subscription.

A Business Capability Reference Model for Human Services

Predicts 2023: Accelerating Transformation in Human Services

Quick Answer: What Are the Implications of LLM Applications Such as ChatGPT for Government CIOs?

Top Trend in Government: Case Management as a Service

Industry Vision: Close the Loop in Human Services and Social Programs

Table 1: Priority Matrix for Human Services in Government, 2023

Benefit	*Years to Mainstream Adoption*			
↓	*Less Than 2 Years* ↓	*2 - 5 Years* ↓	*5 - 10 Years* ↓	*More Than 10 Years* ↓
Transformational	Event Stream Processing	Decentralized Identity Generative AI Predictive Analytics in Government	Composable D&A Data Fabric Natural Language Processing	
High	LCAP in Government Predictive Analytics	Composable Applications Digital Twin of a Citizen Digital Twins of Government Identity Wallets Knowledge Graphs Packaged Business Capabilities	Program Integrity Analytics Standardized Human Services Informatics	
Moderate		Consent and Preference Management Conversational AI Graph Analytics		
Low				

Source: Gartner

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Source: Gartner (August 2023)