IBM Institute for Business Value

Empowering governments through contextual computing

How context can improve decision making and mission outcomes

Government industry leadership

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By Sam Adams and David Zaharchuk

Data is growing exponentially, but only a small fraction of it is effectively leveraged today. As government leaders prepare for the next phase of business intelligence, they must be smarter in how they approach data to unlock its full value. We suggest they set their sights on contextual computing. A value multiplier, context provides meaning to data and is a key success factor in the big data world. Government entities should seek opportunities to bring context to their organizations' solutions to improve decision making and, ultimately, mission outcomes. To assist, we have identified critical capabilities, opportunities and challenges, as well as key recommendations for bringing context to government organizations.

32% Less than a third of our government industry respondents indicated familiarity with contextual computing, and only 29 percent have had implementation experience.

57% Although awareness levels are low, 57 percent indicated their organization is likely to implement a contextual computing solution in the next three years.

85% When asked about potential benefits from a contextual computing solution, 85 percent of respondents identified improved decision making as the top benefit.

48% Forty-eight percent of respondents identified lack of governance and policies for data sharing and 45 percent identified lack of skilled resources as challenges to implementing contextual computing solutions.

What differentiates the ability to read from simply memorizing large volumes of words? The difference is context. Context allows an individual to draw meaning from a word based on the conditions and other words surrounding its use. Reading entails interpreting the context of words in real time based on the how they are used in phrases or sentences. Humans are able to derive context based on relationships, rules and other conditions learned and experienced over time.

Context extends beyond words though. And with today's ever-increasing amounts of data – and the increasing importance placed on using data to make fact-based decisions – it's no surprise context has been purported by many to be "the next big thing" in the IT world. Since context is used by humans to decipher the meaning of words, can it similarly be used by systems or solutions to decipher meaning from volumes of large and seemingly complex data? That question and the challenges it addresses form the basis for contextual computing.

Con·text (noun):

1) the parts of a discourse that surround a word or passage and can throw light on its meaning 2) the interrelated conditions in which something exists or occurs.[1]

The earliest forms of context in computing were user context, which focused on a single decision maker. User context characterizes the situation of a person, place or object considered to be relevant to the interaction between a user and an application.[2] Early examples of context accumulation are the cookies collected through Web browsers, which built context about individuals based on their browsing history.

Gartner defines context-aware computing as "a style of computing in which situational and environmental information about people, places and things is used to anticipate immediate needs and proactively offer enriched, situation-aware and usable content, functions and experiences."[3] In today's mobile world, context-aware computing has become ubiquitous. For example, smart phones include context-aware features, which offer suggestions based on a user's preferences, history, location, etc. In addition, context can be derived from the information that people routinely share in social media about their views, desires, intentions, preferences, relationships, etc.

However, we believe the greatest future potential for context in computing can be found at the enterprise level – gaining contextual insight into vast amounts of data to support decision making (see Figure 1). Introduced by IBM researchers in 2013, the concept of the contextual enterprise will have a deep impact across both traditional and emerging IT domains over the next decade.

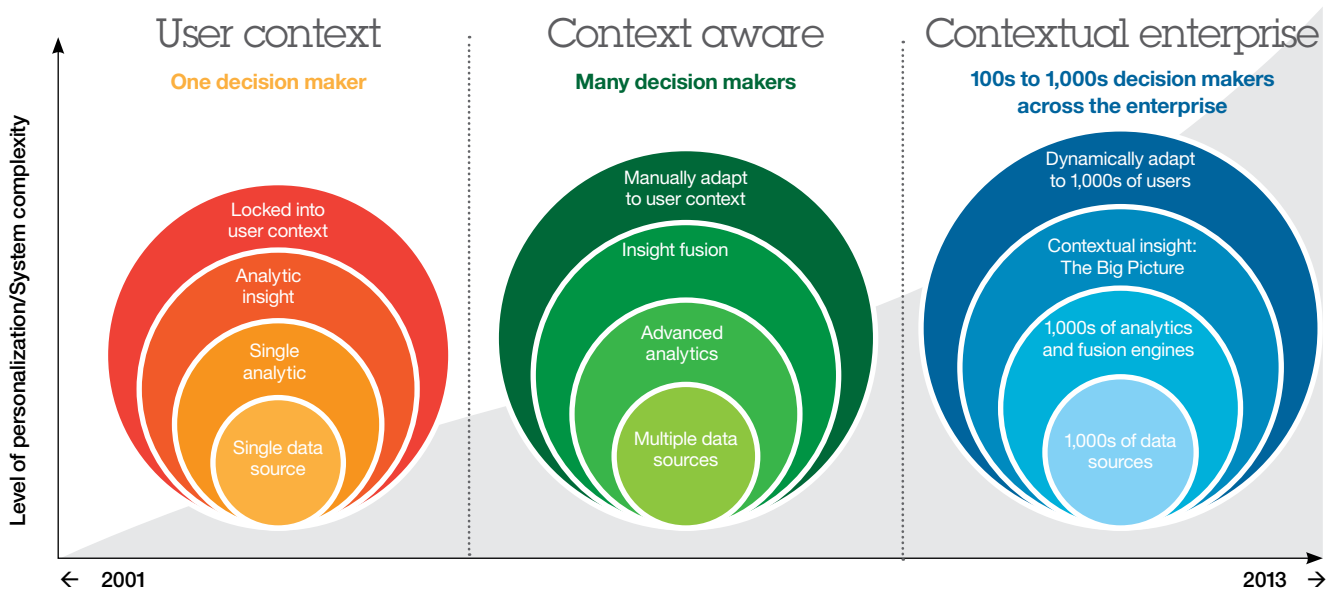


Figure 1: The application of context in computing is evolving from the individual user to the enterprise.

In this report, we explore the topic of context – what it is and why it is becoming increasingly important in the current big data environment. We also define the concept of contextual computing – where it can add value, what's required to successfully implement a contextual computing solution, where it's being done now and where leading researchers see it going in the future.

We also look at the opportunities, implications and planning considerations for implementing contextual computing solutions in government environments. We identify four critical capabilities required to successfully implement contextual computing solutions: data, skills, policy and technology. And, in addition to identifying core opportunities within government, we also recognize potential challenges – those relating to data management and sharing policies and access to appropriate skills being the greatest for government organizations.

Pioneering government organizations have already reaped benefits from contextual computing solutions, and much can be learned from their experience. Based on our research, we offer specific recommendations and steps government leaders can take today to begin bringing context to their organizations.

Study approach and methodology

Background

Published by IBM Research, the IBM Global Technology Outlook (GTO) identifies and evaluates significant, disruptive technology trends that will lead to industry-changing products and services in the next three to ten years. One of the key focus areas of the 2013 GTO was contextual computing – its future direction and potential impact. This study is a deeper dive into the concept of contextual computing and, in particular, the opportunities and implications for this technology in government operations.

Research methods

We conducted a virtual innovation session with IBM government industry subject matter experts (SMEs) to collaborate on opportunities and challenges related to contextual computing in a government environment. A 72-hour event, the session produced an initial list of opportunities and challenges related specifically to government.

In addition, we conducted a survey of more than 50 government leaders, representing 13 countries and multiple mission areas and geographic jurisdictions, to identify and assess contextual computing opportunities and challenges in their government environments. Respondents included chief information officers; chief technology officers; chief innovation officers; government agency/department leaders; technology policy, strategy and/or planning experts and advisors; heads of research organizations and/or technical directors; and business unit/division leaders.

We also conducted interviews with technical leaders responsible for the implementation of multiple contextual computing solutions around the world, as well as supplementary research on the topic of contextual computing.

What is contextual computing?

To understand contextual computing and its relevance, it's important to first consider the phenomenon that is the digital world. Citizens today are surrounded by virtual oceans of data, and that amount continues to grow.

In its 2012 Digital Universe study, IDC projected that the digital universe will reach 40 zettabytes (ZB) by 2020. To put this number into perspective, consider that 40 ZB is equal to 57 times the amount of all the grains of sand on all the beaches on earth. Another visual: If you saved all 40 ZB onto today's Blu-ray Discs, the weight of those discs would be equivalent to 424 Nimitz-class aircraft carriers.[4]

Now consider that the same IDC report estimates that less than 1 percent of the world's data has been analyzed.[5] Given that mankind has been formally exploring the ocean for more than 200 years, and 95 percent of this realm still remains unknown, is it realistic that we will ever be able to fully explore and analyze the oceans of data we continue to create?[6] (See Figure 2.) Given the exponential growth rate of data, it is not likely.

A smarter approach to big data is necessary to leverage this increasingly abundant asset. Big data remains a top priority and focus area for business and IT leaders.[7] And while much progress has been made in addressing big data challenges, there is still a long way to go.

The 2013 IBM big data and analytics study revealed that 50 percent of leaders make more than half of their decisions based on data and analytics.[8] And another IBM study revealed that 56 percent of government leaders identify analytics as the technology that will have the greatest impact on their organizations over the next five years.[9]

Organizations in both the public and private sectors have made progress in implementing analytics solutions to improve decision making. However, maturity levels are still generally low, and there are significant opportunities to better leverage data for improved decision making.[10] To be successful in this big data world, organizations must adopt innovative approaches to leverage their data and enable capabilities that help them make sense of their environments. Context will be key to these approaches.

Sources: *"Big Data, Bigger Digital Shadows, and Biggest Growth in the Far East." IDC Digital Universe Study, sponsored by EMC. December 2012; **"Ocean Facts." National Oceanic and Atmospheric Administration Web site, accessed December 5, 2013. ***"Ocean Explorer Timeline." National Oceanic and Atmospheric Administration Web site, accessed March 3, 2014.

Figure 2: **Global data is growing exponentially, but only a small portion of that data is being analyzed and leveraged to its potential.**

"Determining context is the most significant technical hurdle necessary to deliver the next generation of business intelligence."[11]

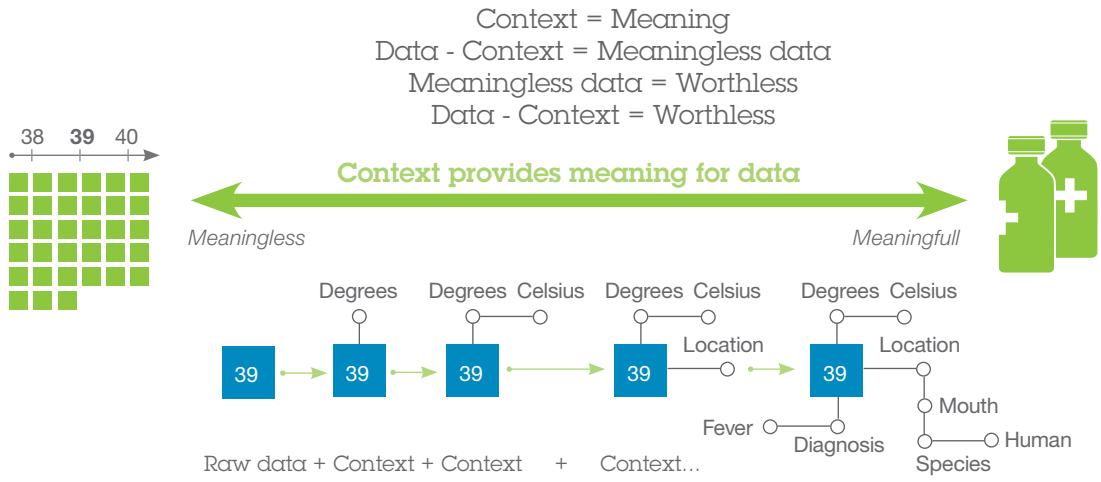
Jeff Jonas, IBM Fellow and Chief Scientist, Context Computing

Context is key

Context provides meaning to data and is a foundational capability required for "sensemaking." Introduced by organizational theorist Dr. Karl Weick, the term sensemaking refers to how people and organizations make sense of their environment and give meaning to experience. According to Weick, "Sensemaking is about such things as placement of items into frameworks, comprehending, redressing surprise, constructing meaning, interacting in pursuit of mutual understanding, and patterning."[12]

The objectives behind analytics and business intelligence capabilities are, in effect, all about "sensemaking" in an enterprise. As such, determining context will be a critical capability in next-generation business intelligence solutions. Without context, the value of an enterprise's data is not being fully realized. Context is, in effect, a multiplier of value for data and what gives it meaning. Data without context is meaningless. Meaningless data is worthless. The more context, the higher the value of the data. Contextual computing is about the relationships between the data and how different processes operate on that data and with each other.

Consider Figure 3, for example. By itself, 39 is just a number; it's simply raw data with so many potential meanings that alone it has no value. However, associating another piece of data – in this case, degrees – with the number 39 provides additional context, indicating this is likely a temperature. Yet another piece of information, Celsius, provides even more context and an understanding both of what is being measured and the scale in which it is being measured. Once we associate a location (the human body) with these other data elements, meaning can be inferred (a human being with a fever), which can then lead to decisions, actions or further investigation.



Source: "IBM Global Technology Outlook 2013." IBM Research. April 2013.

Figure 3: **Context provides meaning for data.**

The more context provided around data elements, the more valuable the individual pieces become. More context also increases the potential value of an organization's aggregate data. Moreover, every time further context is added to a data element, understanding of the meaning of the data is dramatically changed. Relationships between people, places and organizations provide the context for deeper situational understanding, which drives better decisions and more effective actions.

If a single record of data is being evaluated to support a potential action or decision, and there are other elements of related data that exist but are not made available, then there is an absence of context and, thereby, potential for poor decision making.

"In common use almost every word has many shades of meaning, and therefore needs to be interpreted by the context."

Economist Alfred Marshall in his 1890 book *Principles of Economics*

Context in an enterprise setting

Organizations leverage enterprise data to gain insights and learn about *entities* (e.g., people, places and things). Context provides further insight to better understand how entities relate to one another. *Cumulative context* is the memory and knowledge of how entities relate and interact over time. *Context accumulators* detect like and related entities from historical and current data in large, complex enterprise data environments to put data into context.[13]

Discoveries can be made with each new data element or "observation" introduced to a data environment or "observation space" (including real-time data streams). These discoveries can be used to provide information to consumers based on relevance. With context, assertions can be made about each new observation that has the potential to impact critical decisions or fundamentally alter prior assumptions or assertions (see Figure 4).

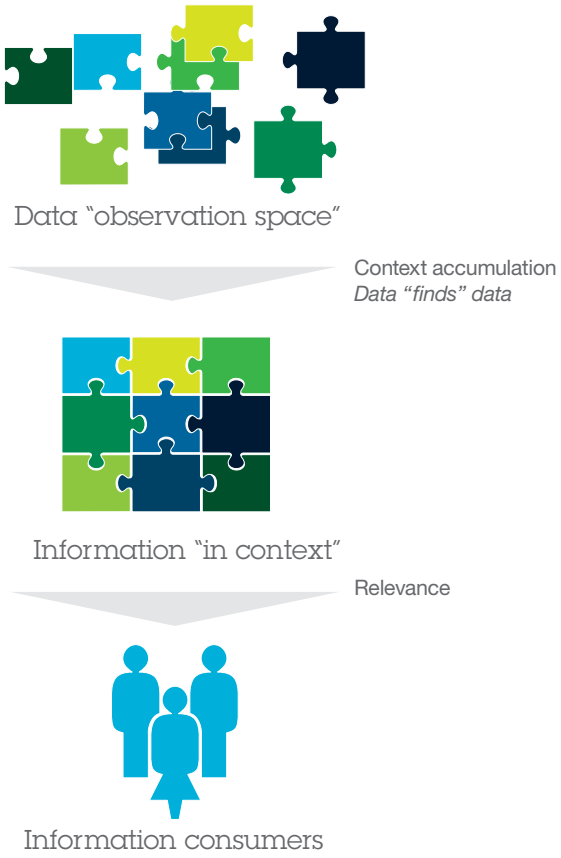


Figure 4: **Discoveries can be used to provide information to consumers based on relevance.**

Context is the cumulative history that is derived from data observations about entities. By combining context with big data, organizations can derive trends, patterns and relationships from structured data and related unstructured data to make more informed decisions. And they can provide continuous updates to assumptions and assertions based on new "observations."

While the absence of context has the potential to result in poor decision making, greater context does not necessarily guarantee the accuracy or reliability of information provided by contextual-based systems. Greater context can increase the probability of the accuracy of the information; however, there is always risk in relying solely on this information, particularly in cases where information is being used to support mission-critical decisions.

Game-show champ Watson early example of contextual computing

IBM's Watson supercomputer competed against human contestants in the American television quiz program, Jeopardy! When IBM's question-answer computing system defeated the reigning Jeopardy! champions, viewers were largely unaware that they were witnessing an early example of contextual computing.

Despite being disconnected from the Internet during the contest, Watson's own feature extraction and contextualization capabilities created a 10 to 1 increase in the data and metadata available for reasoning based solely on connecting the information it had already learned and drawing context from that data. Contextual computing is the application of a similar paradigm to every aspect of our daily life.[14]

Detecting complex patterns

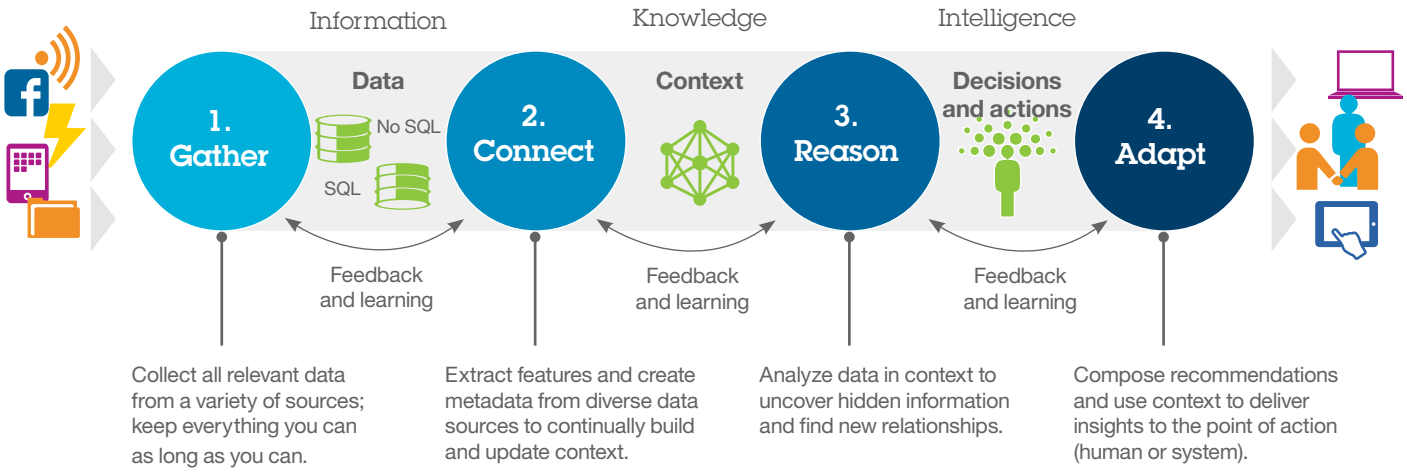
Contextual computing accelerates the detection of complex patterns in both data and processes through four key activities (see Figure 5):

Gathering refers to collecting all relevant data from a variety of sources and keeping it as long as possible to provide a dynamic, diverse data set for high-value context discovery. Because it is not possible to know what data might be of value in the future, as much is stored as is reasonable and feasible.

Connecting involves extracting features and creating metadata from diverse data sources (both structured and unstructured) to continually build and update context. The objective is to create a "contextual graph" of information to deliver enterprise-wide context awareness across all applications, which may also include drawing context from streaming data in real time.

Reasoning is analyzing data in context to uncover hidden information and find new relationships. Additional analytics add to context via metadata extraction and use existing context to broaden information exploitation. Reasoning can provide breakthrough insights, predictions and optimal action selection based on increased context.

Adapting involves composing recommendations and using context to deliver insights to the point of action, whether the client is a system or a human decision maker. The objective is to optimize decision making, customer experiences and employee effectiveness.



Source: "IBM Global Technology Outlook 2013." IBM Research. April 2013.

Figure 5: **Contextual computing accelerates the detection of complex patterns in both data and processes through four key activities.**

In all four activities, contextual computing systems continually learn from user behavior and interaction patterns to enhance the context over time. These systems capture and model the complex relationships surrounding an individual or an entity and enable improved outcomes, as well as optimized resource use.

For example, social services organizations capture very little context relating to a family or individual in existing systems-of-record – and the little that is captured is done so in a very rigid manner. Case workers typically have limited visibility into an individual's entire family situation and are often unfamiliar with deeper relationship networks (e.g., family, health and judicial history, and actions by other program or case managers) and their implications. As a result, case workers often rely on personal experience to determine next actions or are forced into reactive "fire-fighting" mode when crises arise. Capturing the complex relationships surrounding an individual can provide context in citizen engagement systems and enable improved outcomes for citizens, as well as improved efficiency in case management.

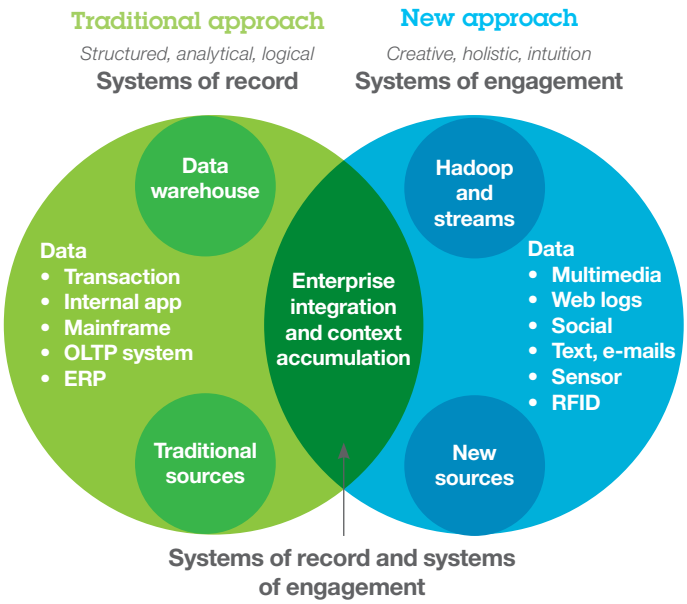
Contextual computing: A future vision

In 2013, IBM researchers introduced the concept of the contextual enterprise, which we believe has the potential not only to disrupt how IT is viewed and managed, but also how enterprises collaborate, innovate and make decisions. The contextual enterprise is all about building context from data dynamically at scale; discovering new value; and combining structured, unstructured, static and streaming data.

Traditional IT systems (i.e., systems of record) have focused on processing, recording and managing the core transactions of business operations and form the backbone of today's enterprise systems. While the structured data, linear processes and highly repeatable operations of these systems are well suited to their requirements for business, a new approach focused on the dynamic engagement with customers and partners has emerged. The contextual enterprise approach combines systems of record and systems of engagement (see Figure 6).

Trends such as mobile and social computing, which have transformed these systems of engagement into the digital front office, require a highly dynamic, more exploratory approach focused on both structured and unstructured data from a wide variety of public and private sources. Gathering and connecting these data sources over time is a crucial part of establishing the data pipeline required for achieving the vision of the contextual enterprise.

Reaching the full potential of the contextual enterprise will require technology innovations in each of the four activity areas (gather, connect, reason and adapt). Although rapid advancements are being made in each of these areas, further innovations are required. Following are some of those key challenges in each activity.



Source: "IBM Global Technology Outlook 2013." IBM Research. April 2013.

Figure 6: **Relationships between people, places and organizations provide the context for deeper situational understanding, which drives better decisions and more effective actions.**

Gather challenges

Since time is one of the most important aspects of context, not only must current values for a customer or an application be maintained, but also as much history as possible to enable continual deep learning and analysis of long-term trends. This requires the storage of petabytes of information. In addition to historical data, contextual computing at an enterprise scale will also require handing terabytes of streaming data updates as both market situations and customer context evolves.

Accessing and combining data from a large number of public and private sources create unique challenges for maintaining security and privacy, as well as meeting regulatory obligations and mitigating risk to the business. These challenges cannot be solved by the traditional "gates, guards and guns" approach to access security. Security will need to be a fine-grained and pervasive feature of both the data management and processing systems.

Connect challenges

When IBM Watson played Jeopardy (see sidebar on page 7: Game-show champ Watson early example of contextual computing), Watson's feature extraction and contextualization capabilities created a 10 to 1 increase in the data and metadata available for reasoning. IBM researchers believe this is a low average for expected data requirements for contextual computing systems of the future. As such, systems must be prepared for these large amounts of data. In addition, new data sources, as well as new analytics for feature extraction and annotation, will become available with unprecedented frequency in the age of contextual computing. To accommodate this constant source of new kinds of data, contextual data management systems will need to support highly dynamic schemas such as those provided by graph databases.

In addition, since decisions being made will be based on the current context of an enterprise and that context can change over time, systems will have to both remember contextual states that led to decisions made and actions taken, especially in the light of regulatory monitoring. This will require a full lifecycle view of the context over time.

Reason challenges

The "schema-less" nature of context and the open graph structure of contextual data result in situational models with very high numbers of dimensions, a complex and computationally challenging situation where traditional analytics algorithms fail to scale up to the necessary size to deliver insight. New algorithms and very large memory, high-performance systems will be required.

Also required will be continual analysis of ever-changing context. Since the context of an enterprise is constantly changing, analysis of that context will also have to be continual, as opposed to weekly or monthly "batch runs." This will require significantly more computing and storage resources, as the "time to action" for decision makers shortens and the requirements for high-value analytic insights move toward real time.

Adapt challenges

New methods are required to allow for continual user context profiling. Continuous polling of mobile device context can diminish battery life, adversely impact performance and use significant mobile device storage. New methods are needed to create a "wide-angle view" of mobile users and deliver a personalized experience to their mobile devices. The methods will need to efficiently gather diverse information types that are available to the mobile device – user preferences, geospatial information, mobile application information, sensor data and much more – and subsequently deliver a contextualized experience in real human interaction time, at scale.

Another challenge is context-based recommendations. Context-aware computing today focuses on selecting the right content and the right channel for displaying that content. A simple example is contextual ads displayed in social media interfaces that adapt to the individual's content, social network content, likes and activities. The challenge is to move beyond that to provide a framework for a variety of services that can adapt the content (e.g., translate, simplify visualizations, convert literacy levels, summarize), adapt the application (e.g., hide screens, execute assistive technologies), adapt devices (e.g., adjust calibration) and even adapt business processes in response to context-based recommendations.

The intelligent enterprise

As big data continues to grow exponentially, so too do the opportunities to connect and draw context from that data. The 10 to 1 increase in data and metadata experienced in the Watson experiment on Jeopardy! was based on general knowledge, not any particular industry. Connecting the dots for context between multiple domains has the potential for additional orders of magnitude of growth in data.

As rapid technological advancements continue, more and more of the previously identified challenges will be addressed. In time, the emergence of cognitive computing combined with massive amounts of contextualized information will transform enterprise computing and, ultimately, enable the "intelligent enterprise."

Context in government

As part of our study, we surveyed government industry experts to determine their current state of awareness of contextual computing. We also sought to identify opportunities for this capability across government mission areas and business functions. However, before identifying those government-specific opportunities, we looked at how contextual computing could aid business in general.

Applying contextual computing to business problems

We defined five general business scenarios in which contextual computing is particularly useful (see Figure 7). These are situations in which:

- **Guesses or hypotheses** need to be made to decide on a course of action. Context helps direct which hypotheses to make.
- Decision-making quality is impacted by the ability to **link pieces of data together**. Context can provide the "links."
- There is a **discovery element,** which might involve uncertainty about which data elements are relevant to context.
- **Data is "noisy."** Meaningless by itself, noisy data includes any data that cannot be understood and interpreted correctly by machines, such as unstructured text. In such situations, significant data cleansing is typically required to derive value from the data.
- **Master data files don't exist** or are unreasonable to create and maintain or data needs to be leveraged from **multiple sources** for a specific decision (e.g., obtaining relevant patient information for diagnosis and treatment when it is unreasonable or unrealistic to store all of the data in a single data record).

Figure 7: **We identified five types of business scenarios that are prime candidates for contextual computing solutions.**

Industry awareness

We discovered that contextual computing is a relatively new concept in government (see Figure 8). Less than a third of our respondents indicated familiarity with contextual computing, and only 29 percent have had implementation experience. When asked whether leaders in their organization understand contextual computing, 50 percent answered no. However, leaders in organizations with industry experts that have implementation experience were more likely to understand contextual computing.

Guangdong Hospital leverages contextual computing to gain critical insights for treating diseases[15]

With five branches and more than 3,000 beds, Guangdong Hospital of Traditional Chinese Medicine is the largest hospital system in southern China. It treats approximately 16,000 patients each day, and outpatient visits total more than 5.6 million annually. The hospital is renowned for its efforts to integrate traditional Chinese medicine with contemporary Western medical practices.

Challenges

- **Clinicians wanted to perform empirical studies on outcomes based on the use of traditional Chinese treatments and compare them with Western treatments used as alternative or complementary therapies in treating Chronic Kidney Disease (CKD).**
- **While more and more health data is available through electronic medical records (EMRs) and other systems, it can be difficult and time consuming for clinicians to extract and compile relevant patient data in a way that allows them to quickly pinpoint critical issues and detect data patterns.**

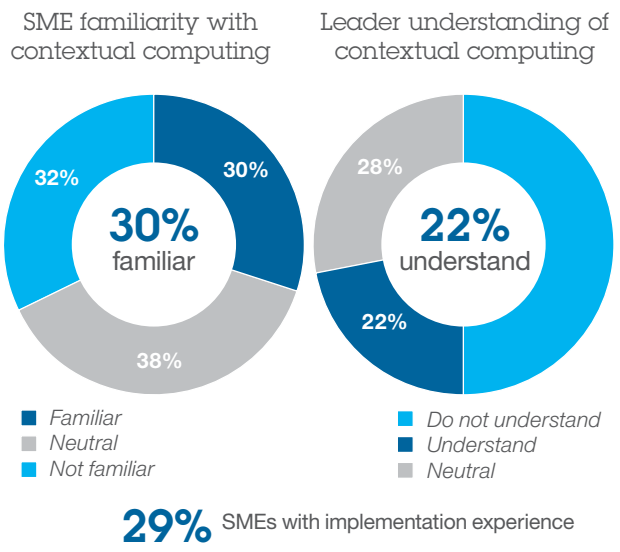
Solution

- **The hospital launched a first-of-a-kind information warehouse for analytics that enables clinicians to study the effects of traditional Chinese medicine in conjunction with Western medicine in treating Chronic Kidney Disease (CKD).**
- **The system stores and synthesizes anonymized patient data and provides doctors with detailed, context-based reports that correlate patients' conditions and demographics – such as age and gender – as well as the presence of other health conditions, like heart disease or diabetes.**

Results

Providing context through extracting and combining relevant patient data and clinical events helps doctors understand how different populations are affected by and respond to medical treatments, which helps them better customize treatment plans. The system may also assist researchers in conducting in-depth analysis of data for clinical and operational studies.

Interestingly, although awareness levels are relatively low, 57 percent of respondents indicated their organization is likely to implement a contextual computing solution in the next three years. Only 18 percent indicated they did not anticipate implementing a contextual computing solution, either because they were either unfamiliar with contextual computing or felt the implementation challenges were too great.



Source: IBM Institute for Business Value Contextual Computing in Government Study.

Figure 8: **Because contextual computing is a relatively new concept in government, awareness and experience levels are still low.**

Organizations whose respondent had past contextual computing implementation experience were much more likely to have plans to implement a contextual computing solution in the next three years. Additionally, all organizations whose respondent had prior contextual computing experience have plans to implement a solution in the next five years.

Applications in government

By aligning the five key situations for which contextual computing is particularly useful (see Figure 7) with key government mission areas and business functions, we identified multiple opportunities for contextual computing in government. We have organized them into nine core areas:

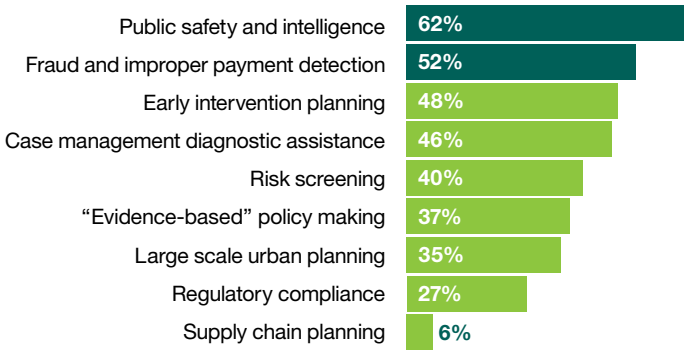
- **Public safety and intelligence:** Leveraging contextual capabilities to provide greater situational awareness to support real- and near real-time decision making by identifying linkages in highly complex data environments.
- **Fraud detection and improper payment prevention:** Leveraging increased context to provide greater levels of confidence in information and to identify and prevent potential fraudulent activity (e.g., tax, social benefits, voter registration).
- **Early intervention planning:** Leveraging increased context about individuals and/or entities for deeper situational understanding to drive better decisions for early intervention planning in education, social programs, healthcare, etc.
- **Diagnostic assistance for case management:** Leveraging increased context to better understand and model the complex relationships surrounding an individual to provide context in citizen engagement systems and enable improved outcomes for citizens, as well as improved efficiency in case management (e.g., social programs, healthcare, parole).
- **Risk screening:** Leveraging increased context to gain greater insights around individuals or entities to enable improved risk screening, including detection, assessment and mitigation (e.g., customs, port and border protection).

- **"Evidence-based" policy making:** Leveraging increased context to better understand and model complex relationships between policy, planning and budget decisions and potential outcomes to assist policy and decision makers in making more informed decisions.
- **Large scale urban planning:** Leveraging increased context to better understand and model the relationships between various infrastructure planning projects (e.g., water, transportation) and investments at various levels (e.g., national, regional, state, municipal) to support improved decision making across multiple jurisdictions.
- **Regulatory compliance:** Leveraging increased context to provide officials with greater awareness of potential violations to improve compliance levels and improve efficiency of enforcement resources.
- **Supply chain planning:** Leverage increased context of supply chain operations (e.g., entity usage activity and locations, manufacturing repair turn-around and shipping times) to better understand and model supply chain complexities to minimize and prevent disruptions to operations.

We asked respondents in which areas they felt the most opportunities existed for contextual computing in the next five years (see Figure 9). They believe the area of public safety and intelligence has the most opportunities, which is not surprising given the complexity and importance of information to support real- and near real-time decision making in this area. Also, this is one of the mission areas in which contextual analytics solutions have already been adopted (see sidebar: Contextual computing helps protect strategic maritime trade routes).

Fraud detection was also identified by more than half of the respondents as a prime area for contextual computing in government. And fraud detection is another area in which solutions have been adopted and benefits demonstrated (see sidebar: Context helps improve efficiency, confidence in voter registration). The area in which respondents foresee the least amount of opportunity is supply chain planning.

Most likely opportunities for contextual computing in government in the next 5 years



Source: IBM Institute for Business Value Contextual Computing in Government Study.

Figure 9: **Respondents predict the areas of public safety and fraud will provide the most opportunities for contextual computing in government in the next five years.**

Respondents' answers were similar when asked in which area *their* organization is most likely to implement a contextual computing solution in the next three to five years, with public safety and fraud at the top of the list and supply chain planning at the bottom.

When asked about potential benefits from a contextual computing solution, 85 percent of respondents identified improved decision making as the top benefit. However, a significant percentage also believe their organization could experience improved mission outcomes (63 percent), improved customer experiences and satisfaction (52 percent), improved employee effectiveness (52 percent) and cost savings (52 percent).

Contextual computing helps protect strategic maritime trade routes

In response to resource constraints and the emergence of advanced war-fighting technologies, a national defense organizational has focused on developing and implementing leading-edge capabilities to effectively meet new security challenges.

Challenges

- Securing strategic shipping lanes and waterways is critical to national security; however, monitoring activity in a marine region is extremely difficult and resource intensive.
- The organization needed additional capabilities to better protect globally significant waterways in an increasingly resource-constrained environment.

Solution

- The organization deployed a first-of-a-kind maritime solution that analyzes huge amounts of data gathered from various coastal and satellite sensors, databases and open source intelligence.
- The solution's context-accumulating engine generates higher quality predictions as to which vessels merit the most focus.
- This capability conducts context accumulation over structured, social and geospatial data; provides a ranked list of potential entities of interest; and indicates to the analysts why a particular vessel warrants focus.
- This capability is a real-time, sub-second, sense and respond service that provides crucial information to decision makers fast enough to allow them to respond while events are still occurring.

Results

The solution has improved decision making, incident response times and resource efficiency through increased situational awareness.

Context helps improve efficiency, confidence in voter registration[16]

The Electronic Registration Information Center (ERIC) is a non-profit organization created to assist states in improving the accuracy of the United State's voter rolls and increasing access to voter registration for eligible citizens. Governed and managed by states that choose to join, ERIC was formed in 2012 with assistance from The Pew Charitable Trusts, an independent, nonprofit, non-partisan, non-governmental organization dedicated to serving the public.

Challenges

- A democratic political process requires an effective system for maintaining accurate voter registration information. Unfortunately, U.S. voting systems are plagued with errors and inefficiencies. For example, one in eight registrations are no longer valid or are significantly inaccurate and 1.8 million deceased individuals are listed as voters.
- ERIC sought a solution that would help ensure the validity of voting rolls to improve voter confidence, reduce unnecessarily high costs and reduce partisan disputes over the integrity of elections.

Solution

- ERIC's data center is an advanced analytics capability solution that allows states to securely and safely compare information on eligible voters from official data sources. The states receive reports informing them when there is a highly confident match indicating a voter moved or died or the existence of a duplicate record.
- Using the data analysis from ERIC, states can then begin the process under federal and state law to clean up the voter rolls, targeting their efforts based on reliable data.
- Participating states also receive information on unregistered individuals who are potentially eligible to vote – allowing them to reach out to those citizens to encourage them to register in the most efficient way.

Results

Results include more accurate voter rolls with the near elimination of duplicate and invalid registrations, reduced opportunity for and perception of potential election fraud, improved protection of voters' privacy and reduced costs. As of January 2014, the seven states that have adopted ERIC have recovered costs within two to four years – and continue to realize cost savings.

Challenges

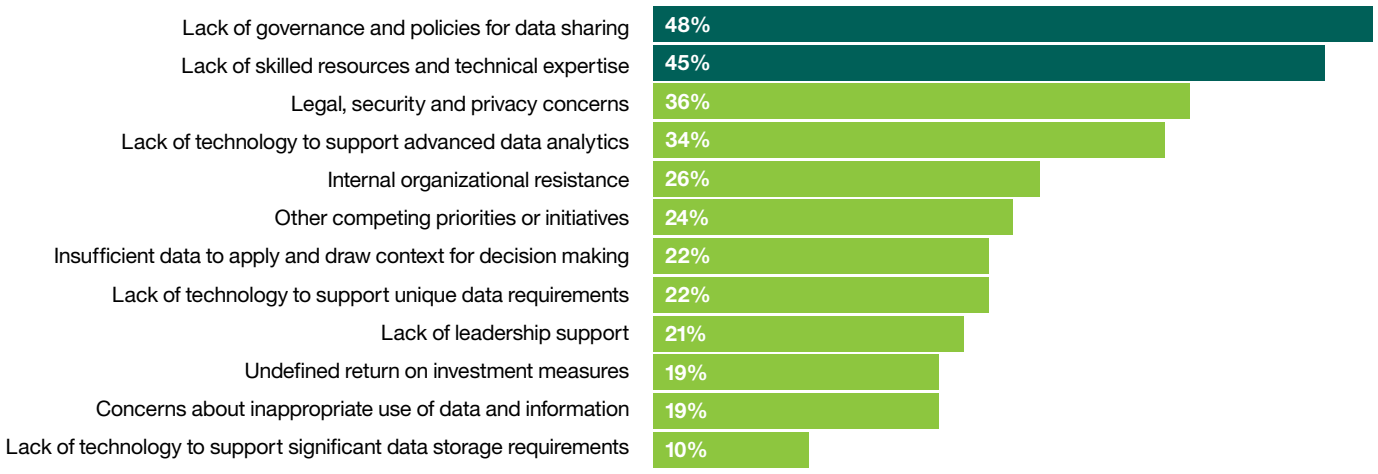
While survey respondents clearly believe there are opportunities for contextual computing in government, they also identified potential challenges in adopting contextual computing solutions. Almost half of those surveyed identified lack of governance and policies for data sharing as the most significant challenge, followed by lack of skilled resources and technology expertise (see Figure 10).

That legal, security and privacy concerns were high on the list is consistent with prior study findings. Government executives surveyed for the IBM 2013 Global C-Suite Study identified legal, security and privacy concerns as the biggest hindrance to implementing a digital strategy in their organization.[17]

Unfortunately, on average less than a third of respondents expressed confidence in government organizations' abilities to cope with these obstacles. They were most confident in government's ability to tackle challenges related to insufficient data and lack of skilled resources and least confident in capabilities relating to legal security and privacy concerns, competing priorities and technology to support unique data requirements. They similarly expressed low confidence levels in their own organizations' abilities.

> *"I think that the legal limitations regarding data protection laws will be the challenge to beat."*
>
> *European government official*

Most significant challenges in implementing a contextual computing solution



Source: IBM Institute for Business Value Contextual Computing in Government Study.

Figure 10: **While opportunities exist for contextual computing in government, so too do challenges.**

"I strongly believe that contextual computing will play a major role in the service delivery model for my agency. The biggest concern that I have is cultural willingness and the ability to find and leverage the critical skills to drive strategy implementation."

Adrian Gardner, CIO, U.S. Federal Emergency Management Agency (FEMA)

When asked about their organization's expertise in implementing a contextual computing solution, only 27 percent indicated they had the internal resources for such an implementation. As such, we expect most organizations will look to external sources for the necessary skills and expertise.

Making contextual computing a reality: Critical capabilities

Our research revealed four capabilities that are crucial to a successful contextual computing implementation: Data, policy, technology and skills (see Figure 11). All four of these capabilities are required to be successful; lack of just one could put the solution implementation in jeopardy. For example, an organization with the most advanced technology and skilled personnel won't be successful if it is unable to access and leverage data due to policy restrictions.

Data

The ability to apply and draw context relies on the diversity and quality of data. Jeff Jonas, an IBM chief scientist and contextual computing pioneer, refers to this as a "sufficient observation space." Assessing the observation space requires skilled resources and knowledge of sources and planning. And expanding the observation space may require increased partnering and changes to policy. Jonas indicates that a common reason many organizations are unsuccessful in business analytics is that they do not have sufficient data available to them to support the decisions they are trying to make.[18]

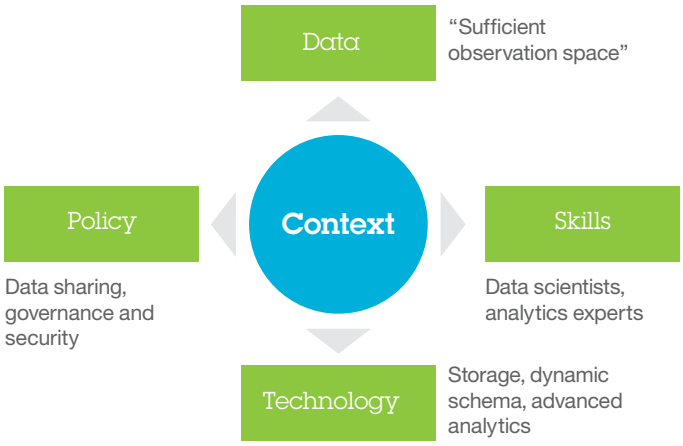


Figure 11: **Four key capabilities are critical to successful implementation of a contextual computing solution.**

Policy

Creating or providing a sufficient observation space will often require data sharing between organizations within an enterprise and with entities outside of traditional enterprise boundaries. Policies and governance structures facilitate both the sharing and protection of data. Organizations must leverage existing or create new governance models to develop standards and policies to facilitate data sharing while balancing risks in what can be an extremely complex policy and regulatory environment.

"Our biggest challenge was getting the data… plain and simple."

Sarah Knoop, IBM Research [explaining the greatest challenge in implementing a contextual computing solution]

While requirements for security and privacy will vary based on the scope of a solution and the domain in which it is implemented, in general, managing data from multiple disparate sources will likely require security, privacy and governance to be built into the infrastructure, along with associated policies and procedures to enforce compliance.

Consider, for example, the Electronic Registration Information Center (ERIC), a multistate partnership created to improve the accuracy and efficiency of state voter registration systems (see sidebar on page 15: Context helps improve efficiency, confidence in voter registration). Privacy was built into the design of the solution from the beginning to mitigate security risks by applying proven safeguards that had been used successfully in the private sector and other areas of government.[19]

One of the drivers of growth in IT has been the rising volume and complexity of government policies about data security, privacy and governance. Globally, a majority of countries have enacted laws relating to data protection, and often it's a variety of laws rather than a single law that governs the protection of personal data.

As enterprises, public and private organizations, and consumers move more of their business to the Internet, the need for secure communications, backup and disaster recovery will grow. These issues have special implications when the privacy of an individual is involved, distribution channels may be disrupted or mission-critical deliveries are required. With governments debating the need for new far-reaching mandatory reporting of data breaches on companies with large databases of personal data, technology to mitigate risk and the ability to rapidly inventory the nature of content breached will be imperative.[20]

Technology

As discussed in detail previously, several key technology capabilities are required to meet the demands of contextual computing. In particular, organizations will need new storage requirements, advanced analytics capabilities, unique data requirements/dynamic schema, and enhanced security and privacy requirements.

Obviously, contextual computing solutions will require increased storage – the greater the context, the greater the storage requirements. As stated previously, IBM researchers observed a 10 to 1 expansion of data in the Watson Jeopardy! experience. A similar expansion is expected across enterprises as information from both public and proprietary sources is analyzed and contextualized.

In addition, continual ingestion and curation will require continual deep analytics to discover new insights. And, since context will be continually updated, contextual solutions will need to support continuous ingestion, context accumulation and deep analytics. Since new features and relationships in the data will be discovered frequently over time, and older ones may become obsolete, database requirements for contextual data must include support for dynamic schema, where the relationships themselves are data that can be captured without requiring traditional schema migration.

Finally, while requirements for security and privacy will vary based on the scope of a solution and the domain in which it is implemented, in general, managing data from multiple disparate sources will likely require that security, privacy, policy and governance be built into the infrastructure, along with the associated policies and procedures to enforce compliance.

Skills

Implementing contextual computing solutions will require individuals with deep experience in analytics and data fusion. The term "data scientist" is most often used to describe this experience and skill set.

These critical skills, similar for those necessary for analyzing big data, are in high demand. A recent report estimates that by 2018, the United States alone could face a shortage of almost 200,000 resources with deep analytical skills. Additionally, the study estimates a shortage of 1.5 million managers and analysts with the skills to make effective decisions based on big data analysis.[21] A global shortage of these skills will make recruitment and retention a key organizational priority

How to move forward

Much can be learned from organizations that have pioneered the implementation of contextual computing solutions. Based on our research and observations, we recommend following some key steps as you move forward with a contextual solution in your government organization (see Figure 12).

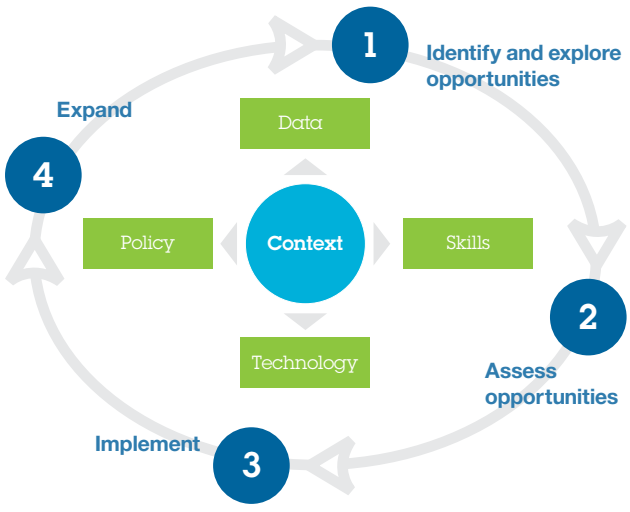


Figure 12: We recommend following four key steps to move forward with contextual computing.

"We are partnering with vendors that provide rich predictive analytics that are sure to bring contextual computing to the forefront of Palo Alto decision making."

Peter Pirnejad, Director of Development Services, City of Palo Alto (California, USA)

Identify and explore opportunities

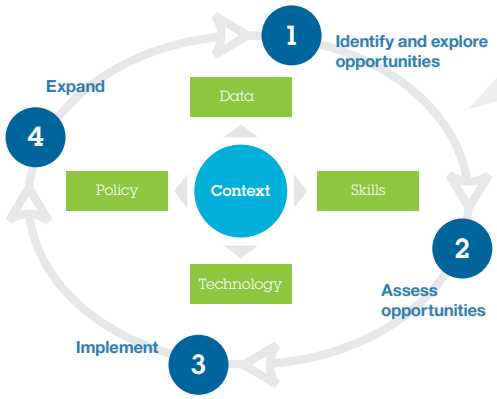
First, identify opportunities and the potential value for leveraging context to address the most pressing issues facing your organization. As discussed, there are multiple ways in which contextual computing can help address issues critical to government. The five scenarios depicted in Figure 7 can be leveraged as a guidepost to explore opportunities within your own operations. Potential value drivers include improved decision making, improved mission outcomes, improved customer experiences, improved employee effectiveness, cost savings and increased revenues.

Assess opportunities

This is a critical step, which requires an investment of both time and resources: Assess your organizational readiness in the four capability areas (data, policy, skills and technology) to determine implementation feasibility, required capabilities and priorities (see Figure 13).

Data

As previously discussed, success in implementing a contextual computing solution relies on drawing context from a "sufficient observation space." Jeff Jonas, IBM research scientist, offers some tips and recommendations to assess whether your observation space is, in fact, "sufficient" to meet the defined business objectives of the solution being considered:[22]



Key questions for consideration

Data:

Do we have a "sufficient observation space" to support our business objectives? Can it be expanded or enhanced?

Policy:

Do we have a governance structure and the proper legal basis to get and/or integrate data from multiple disparate sources?

–OR–

Do we have the ability to influence stakeholders to change policy to enable the sharing of this data?

What levels of security and privacy will be required based on assessed obligation and risk?

Skills:

Do we have the required talent internally or do we need to seek external partners or vendors?

Technology:

What changes to our infrastructure and what investments in new capabilities are or may be required?

Figure 13: **As part of the "assess" step, consider key questions in each capability area.**

- *Assess based on past events* – Do real examples from the past of what you're trying to detect exist in the observation space? If not, then the observation space is not sufficient.
- *Assess data source and elements* – Inventory your data sources and the essential data elements for the solution and then test and inspect data sources to validate the quality and completeness of essential data elements in those data sources.
- *Evaluate common features* – Evaluate data sources to identify those that share common features between them (e.g., customer number, address, phone number). Generally more is good. If common features do not exist or are very limited, then problems will likely exist in leveraging the defined observation space.

This shouldn't be considered a binary pass/fail test of the observation space or the ability to move forward with a solution. Options may exist to widen and expand the observation space. This is where creativity and innovation must be tapped. Potential options include:[23]

- *Creating additional data* – This is certainly not easy and requires a deep understanding of how that data flows in and out of the enterprise, as well as any potential legal and/or policy implications. Opportunities may also exist to automate existing processes to enable the capture of valuable information not currently recorded and retrievable digitally for reuse (e.g., detailed notes captured by a social service agency worker related to specific conditions in a child's living environment). This will require organizations to embrace efforts to automate existing manual processes.

- *Seeking new, previously untapped data sources* – New data sources may exist a) inside the enterprise based on data collected for other purposes, b) outside the enterprise in other agencies, nongovernmental organizations or stakeholder organizations or c) outside the enterprise from proprietary data sources available for purchase from data aggregators.
- *Collecting additional data* – The option may exist to modify existing processes and/or transaction systems or deploy additional data collection "sensors" to collect data required to enhance the observation space.

"A new type of thinking is essential if mankind is to survive and move forward toward higher levels."

Albert Einstein[24]

Policy

Nearly half of the SMEs in our study rated lack of governance and policies for data sharing as a significant challenge, and slightly more than a third believed legal, security and privacy concerns will be a challenge to government organizations implementing contextual computing solutions. This is not surprising given the complex, and often risk adverse, legal and policy environments that exist within government organizations.

Government leaders must weigh the risks and benefits of implementing new digital strategies and contextual computing solutions with an informed understanding of the capabilities (and limitations) of current technology. This should also involve an assessment of an organization's obligation and risk before making determinations of levels of security and privacy required for solutions. This may also serve as a catalyst for organizations to revisit and assess existing policies.

Models for governing and facilitating data sharing are beginning to emerge. For example, the Victorian Information Network for Emergencies (VINE) is a services-based, unified information interoperability and decision support platform for emergency management in Victoria, Australia. VINE enables the sharing of information pertinent to an emergency, as well as the creation of tools for combining, processing and analyzing this information to provide decision makers with additional insight.[25]

Skills

The skills required to implement contextual computing solutions are in high demand. Government organizations should evaluate their accessible talent base (i.e., those skills available within their existing direct workforce and other partner organizations). If they discover these critical skills are absent or insufficient, they should develop strategies to acquire or gain access to individuals with these skill sets, which might include the use of external partners or vendors.

Technology

Organizations must assess their current technology capabilities to determine if they are equipped to meet the demands of a contextual computing solution, which include increased data storage, advanced analytics and unique data structures. As technology continues to advance rapidly, leaders need to maintain their awareness of emerging capabilities in the marketplace.

"It's [contextual computing] the future. We need to align with this to move forward."

Paul Haugan, CIO, Johnson County (Kansas, USA)

Implement and expand

As organizations enter the implementation and expansion phases, they should let the information discovered during the assessment guide them. As they progress, they should continuously evaluate whether they are adequately addressing the four key capabilities (data, policy, skills and technology) and realizing the expected benefits. In addition, they should investigate how they can expand on existing solutions to gain even greater context, as well as determine what other mission or functional areas could benefit from greater context.

Conclusion

Government organizations have long been one of the biggest generators, collectors and users of data. And while the potential to gain valuable insights grows with increasing amounts of data, so, too, do the challenges associated with obtaining those insights. The data paradox of having too much data and too little insight is a familiar one. But in our complex world – amid an information explosion – government organizations must improve their abilities to extract value from data.

We believe the future of business intelligence is all about context. Context can help government organizations extract latent value from their data to drive improved insights and decision making. Indeed, astute organizations are already reaping benefits from contextual computing solutions, and significant opportunities exist for those government agencies that follow the trail blazers. With the right data, skills, policy and technology capabilities, government agencies can make quantum leaps in leveraging big data for big results.

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